DIAGNOSTIC

AND

THERAPEUTIC TECHNIC

A Manual of Practical Procedures Employed in Diagnosis and Treatment

BY

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To the memory of my Father

PRINCE A. MORROW, M. D.,

This book is dedicated

PREFACE TO THE THIRD EDITION

In the desire to have the third edition of this book contorm to the latest advances in methods of diagnosis and treatment, a very careful revision of the text has been made and the book has been entirely reset. While the general plan of the original work has been followed without change, several sections have been rewritten and considerable new material has been added. Additional illustrations have been supplied to elucidate the new text, and some of those that appeared in previous editions have been redrawn. This work has been efficiently performed by Mr. Howard J. Shannon under the author's supervision. Every effort has been made to bring the present volume up-to-date and maintain the practical character of the previous editions, and it is hoped that the changes and additions that appear in this new edition will add materially to the usefulness of the book.

A. S. M.

New York City,
January, 1921.

PREFACE

In this volume the writer has endeavored to bring together and arrange in a manner easily accessible for reference a large number of procedures employed in diagnosis and treatment. The book has been given the comprehensive title "Diagnostic and Therapeutic Technic." The scope of the work, however, can be best appreciated by consulting the table of contents on page 7.

While some of the methods herein detailed belong essentially to the domain of the specialist, the majority are the every-day practical procedures which the hospital interne or the general practitioner may at any time be called upon to perform. So far as the writer is aware there is no single book to which one may turn for information along these lines. Text-books of the present day, treating exhaustively as they do of the larger problems of medicine and surgery, must of necessity, if they are to be kept within reasonable limits, omit or else describe in a most condensed manner these so-called minor procedures. If the reader desires fuller and more detailed information it not infrequently happens that it is necessary for him to consult a number of works before he obtains all the desired information. To supply such a want is the object of this book.

The plan of the work comprises, first, a description of certain general diagnostic and therapeutic methods and, second, a description of those measures employed in the diagnosis and treatment of diseases affecting special regions and organs of the body. Operative methods have been omitted as far as possible, only those having been considered which are required in emergencies or which form a necessary part of some of the measures described. Each procedure has been given in detail, leaving nothing to the reader's imagination. For this reason, and that each section might be complete in itself without referring the reader to other portions of the text, some unavoidable repetition occurs.

All important steps have been illustrated so that the reader may grasp at a glance the technic of the various procedures, no expense having been spared in this direction. Nearly all the illustrations are line drawings made by Mr. John V. Alteneder, head of the W. B.

Saunders' art department, from photographs under the author's supervision. The excellence and high character of his work has done much to elucidate the text. In instances where illustrations from other sources have been utilized due credit has been given.

I desire here to express my heartiest thanks to my father, Dr. Prince A. Morrow, and to Drs. T. J. Abbott, J. M. Lynch, J. H. Potter, and J. F. McCarthy for many valuable suggestions and criticisms, and to others who have assisted me in various ways in the preparation of the manuscript.

My thanks are also due the Kny-Scheerer Co., of New York, for having kindly furnished many of the instruments from which drawings have been made.

A. S. M.

NEW YORK CITY.

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DIAGNOSTIC AND THERAPEUTIC TECHNIC

CHAPTER I

THE ADMINISTRATION OF GENERAL ANESTHETICS

The term anesthesia denotes a condition of insensibility to pain and an anesthetic is any agent which produces such a state. Anesthetics are divided into general and local. The drugs most used for general anesthesia are ether, chloroform, nitrous oxid gas, and ethyl chlorid administered separately, in sequence, or in combination with one another.

The choice of the anesthetic agent and the decision as to the method of its administration are questions of vital importance. Under general anesthesia the patient is brought practically to the border-line between life and death, and, in many case, the life of the patient depends upon the selection of the anesthetic, as well as upon the way in which it is administered. While the safety of the patient should always be the first consideration and the main guide in the choice of the anesthetic, it is unfortunately impossible to lay down any hard and fast rules. Each case must be studied separately, and the anesthetic selected that is best suited to that particular case. The production of narcosis with the same anesthetic under all conditions, even though the particular agent chosen were statistically safe, would certainly be unjustifiable. An anesthetic that could be used with safety under some conditions would be a menace to life under others. The condition of the patient, the nature of the operation, the anesthetist, and the operator himself are all factors that enter into consideration. Furthermore, in estimating the relative safety of the different anesthetics, one must consider not only the immediate dangers, but also the more remote toxic effects that frequently do not appear until some time later. No general rules will be laid down at this time as to the selection of the anesthetic, but in considering each agent an attempt will be made to indicate the cases for which it is best suited.

Preparations for Anesthesia and Precautions.—A certain amount of preparation of the patient is necessary before the administration of a general anesthetic. Experience teaches that the patient takes an anesthetic better if he be placed upon a light but nutritious diet for several days before operation, and the bowels be properly regulated. In some special cases it may be necessary to subject the patient to a very careful régime, beginning even some weeks before operation in order to put him in the best possible condition. In other cases where only a light anesthesia—as from nitrous oxid—is required, but little preparation will be necessary.

Care of the Bowels.—When possible, the intestinal canal should be emptied a number of hours before anesthetization. The usual custom is to give a purge, consisting of castor oil, calomel, compound licorice powder, or magnesium sulphate, the night before the operation, followed by a soapsuds enema in the morning. Often, however, the nature of the operation or lack of time does not permit of the administration of cathartics. In such cases, a purgative enema is relied upon.

Diet.—The diet for twenty-four hours before the operation should be of an easily digestible character, and moderate in amount to prevent overloading the alimentary canal. If the operation is set for early in the morning, no food should be given after a light supper the previous night; if it is fixed for the afternoon, a very light breakfast may be taken, not later than 8 A. M. A feeling of faintness or weakness may necessitate the giving of a cup of hot broth or beef tea even later than this in some cases, but it should be a general rule not to give any food by mouth within three hours of the time for anesthesia, since, if the stomach is not empty at the time of operation, vomiting is almost sure to occur, adding not only to the danger of the anesthetic, but to the subsequent distress of the patient. In some cases of special gravity on account of shock or marked feebleness, a nutrient enema (see page 75), with the addition of whisky or brandy, may be given half an hour before the anesthesia is commenced.

In an emergency, lavage of the stomach may be performed when a full meal has been taken shortly before. Preliminary washing out of the stomach will be required when that organ is the seat of operation; it should also be practised if a general anesthetic is to be administered when intestinal obstruction with vomiting is present, for, in such cases, patients have been known to fairly drown from the contents of the stomach suddenly pouring out under the relaxation of the anesthetic. To avoid undue excitement, the lavage may be performed just as the patient is under complete anesthesia.

Preparation of the Mouth, Teeth, Etc.—Preparation of the nose, mouth, and teeth lessens the dangers of aspiration pneumonia and septic bronchitis. As a rule, cleansing the nose and mouth with an antiseptic solution and thoroughly brushing the teeth is sufficient, but, in some instances, the neglect of the teeth results in a very foul and septic condition, necessitating systematic treatment for several days before the anesthetic can safely be administered.

The Preliminary Use of Drugs.—A good night's rest does much to fortify the patient and put him in the best possible condition for the operation. In the case of some patients simply a rub-down with alcohol at bedtime suffices to induce sleep; for others, especially if nervous, the administration of a sedative is indicated.

Many surgeons administer morphin hypodermically before anesthesia. In some cases this is of advantage, shortening the stage of excitement and necessitating less of the anesthetic to maintain insensibility, but it should not be a routine practice. In highly excitable, vigorous, alcoholic individuals it is of distinct advantage. With its use, however, it is necessary to maintain lighter anesthesia than without it. The chief objection to morphin is that it depresses respiration and, by its action upon the pupils, may mask symptoms of overnarcosis; furthermore, it delays the awakening from the anesthesia. In children or the very old it must be used with caution. Any condition producing embarrassed or obstructed respiration is a contraindication as is, of course, any idiosyncrasy against the drug. It should not be given to very weak subjects or to those in stupor.

By some operators atropin gr. 1/100 (0.00065 gm.) is given half an hour before the anesthetic is started as a routine procedure for the purpose of suppressing the secretion in the upper air passages and bronchi, thus lessening irritation of the respiratory mucous membrane.

Physical Examination.—A thorough physical examination should be made in all cases as a routine preliminary to general anesthesia, for exact knowledge as to the state of health is essential to an intelligent selection of the anesthetic and its safe administration. Such an examination has a good moral effect upon the patient, and, if assurance can be given that nothing abnormal can be discovered, it does much to allay the natural fear and timidity of a nervous individual. This examination should include a record of the pulse, temperature, and respirations, a physical examination of the heart, arteries, and lungs, and a blood and urine examination, and should be made, when possible, before the day of operation, so that if the results of the examination demand it, the operation may be postponed without subjecting the patient to unnecessary preparations. In the presence of acute bronchitis or coryza, a postponement of the operation is advisable. Chronic bronchitis, however, is sometimes improved by an anesthetic. Heart disease, with good compensation, is not a contraindication to general anesthesia.

The urine should always be examined if the case is such that time allows, noting the total amount for twenty-four hours, the specific gravity, and the amount of urea, and making tests for albumin, sugar, etc., as well as a microscopical examination for casts. The quantity of urea eliminated within twenty-four hours is quite important. A normal adult male will pass 460 to 525 gr. (30 to 34 gm.), and females less. If the quantity eliminated falls much below this normal minimum, the operator should be put on his guard, and, when the total urea falls below 100 gr. (6.5 gm.), no one can safely be given a general anesthetic (Fowler). If albumin be present, the dangers of a general anesthetic are increased, especially with ether. In the presence of large quantities of albumin and casts the operation should be postponed or local anesthesia substituted. The presence of acetone and diacetic acid is of especial dangerous significance.

Another important point is the arterial tension. When time permits, the blood-pressure should be taken in all cases (see Chapter III). If it is found to be abnormally high, nitrites should be administered for several days, and, where there is not time for this, nitroglycerin should be given by hypodermic before the anesthetic is begun. In the presence of hypotension, cardiac stimulants for several days previous to the operation are indicated.

Care of the Patient.—While the patient is on the operating-table care should be taken to maintain the bodily heat and prevent chilling by a proper amount of covering. The habit of washing patients with quarts of solution and leaving them lying in a pool of chilly water is to be condemned. It is preferable to arrange the patient upon the table before the anesthetic is begun. Anesthetizing a patient in one room and then moving him to the operating-room is not, as a rule, advisable; the lifting around of the patient allows him to partly come out, and often starts up vomiting.

The position assumed by the patient upon the operating-table should be unconstrained and as comfortable as is consistent with the needs of the case. A supine position, with the head elevated sufficiently upon a small pillow to allow freedom in breathing, answers in the majority of cases. Ether and nitrous oxid may be given with the patient's head and trunk elevated, but great caution should be observed in administering chloroform to a patient sitting up or semi-upright, on account of the danger of cerebral anemia. In weak anemic individuals the upright position should, for the same reasons, be avoided with any anesthetic.

Before administering the anesthetic, anything that interferes with or obstructs the respiration in the slightest degree should be removed. Tight collars, bandages about the neck, clothing, belts, straps, braces, etc., should invariably be loosened, no matter how short the anes-

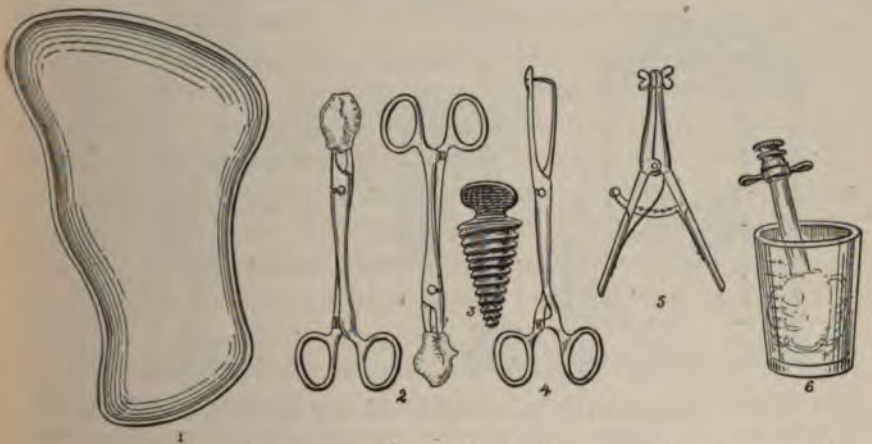

FIG. 1.—The anesthetist's supplies. 1, Pus basin; 2, mouth wipes on artery clamps; 3, mouth wedge; 4, tongue forceps; 5, mouth gag; 6, hypodermic syringe.

thesia. The mouth should be examined, and false teeth, obturators, plates, chewing gum, tobacco, etc., should be removed lest they fall back into the larynx and cause choking. No noise or talking should be permitted in the anesthetic room. It is always well to have a third person present in case help is needed, and in the case of a female patient this is very necessary, as erotic dreams may lead to damaging accusations against the anesthetist.

The Anesthetist's Supplies.—Besides the apparatus necessary for the actual administration of the anesthetic, the anesthetist should be provided with the following: a mouth gag, a wedge or screw-shaped piece of hard rubber to force the jaws apart, tongue forceps, a hypodermic syringe in good working order, with whisky, camphor, adrenalin, atropin, and strychnin at hand, a number of small mouth wipes with an artery clamp as a holder, and a small pus basin (Fig.

1). A cylinder of oxygen should be ready for use, and an infusion set and tracheotomy tube should be accessible.

Duration of Anesthesia.—The anesthetic should be administered no longer than is absolutely necessary. It should not be started until everyone, including the surgeon and his assistants, is nearly ready, and the completion of the anesthesia should be so timed that the patient is coming out when he leaves the table.

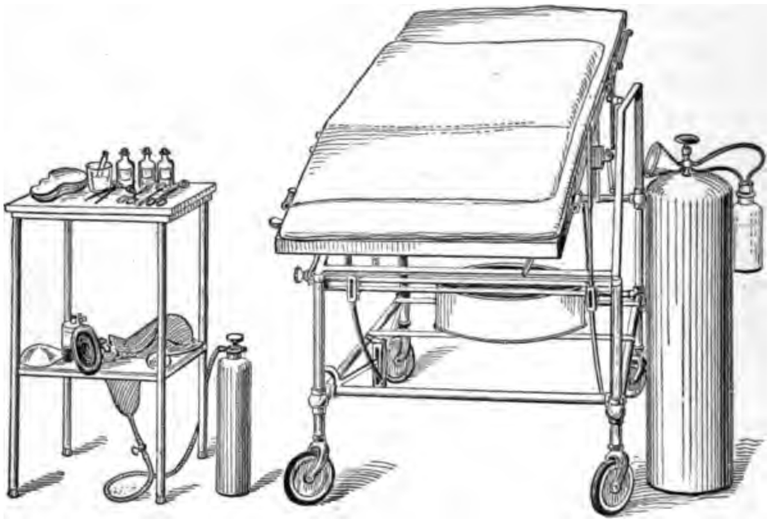

Fig. 2.—Arrangement of the operating-table and the anesthetist's supplies.

Stages of Anesthesia.—Anesthesia from most of the general anesthetics passes through four stages: (1) The initial, or stage of irritation; (2) the stage of excitement; (3) the stage of surgical anesthesia; and (4) the stage of coming out. With some anesthetics the early stages may be more or less modified, or entirely absent, and the rapidity with which the patient passes through the different stages depends upon the drug employed and the technic of its administration.

The Initial Stage.—The inhalation of ether or chloroform produces irritation of the mucous membrane of the respiratory tract and a profuse secretion of mucus with some coughing and frequent acts of swallowing. To some persons, the odor and taste of the anesthetic are exceedingly unpleasant, so that temporary holding of the breath is not uncommon. If the vapor is given in too concentrated a form, violent coughing will be induced, accompanied by cyanosis, and frequently a sense of suffocation is experienced and the patient tries to tear off the mask. If given slowly, the coughing passes off and the respirations become rapid and regular. Spots appear before the eyes and the patient becomes drowsy. A flushed face, rapid and full pulse, with hurried respirations are characteristic of this stage. The pupils dilate, but react to light, and the cornea responds to touch. In this stage the reflexes are increased, so that a painful examination or sudden shock is dangerous.

The Stage of Excitement.—Following this preliminary stage, the patient rapidly passes into a condition of excitement or intoxication. His speech becomes incoherent, and often the imagination is excited and hallucinations occur. The patient begins to struggle, throws his arms about, kicks, tries to tear off the mask, and frequently laughs, sings, yells, cries, moans, or swears. He may breathe deeply and rapidly, or hold his breath and refuse to breathe, so that he becomes markedly cyanotic. The jaws are often held together tightly by a spasm of the masseter muscles. Contractions of the muscles of the trunk and extremities occur. The eyes are often rolled from side to side. While the patient usually hears those around him talking, he fails to understand what is said. Consciousness and sensation are gradually diminished. The pupils are still dilated. The pulse is rapid and full, with very marked pulsations in the large vessels of the neck.

Stage of Surgical Anesthesia.—Following this period of rigidity and excitement, comes one of general relaxation. The contracted muscles relax; the pulse becomes slower and regular; the breathing becomes more superficial and less hurried, and is accompanied by a deep snoring due to the relaxation of the soft palate. The skin becomes cool, pale, and moist. The pupils contract but still react slowly to light, and the conjunctival reflex disappears. Total insensibility is now produced, and the anesthesia is complete. The loss of the conjunctival reflex is taken as a sign that unconsciousness is present. This is the time for operation.

The guide to the depth of anesthesia after the disappearance of the conjunctival reflex is the condition of the pupils. With light anesthesia, the pupils are moderately contracted and readily react to light; under deeper anesthesia, the pupils are contracted and fail to react to light; and when a very profound and dangerous stage of anesthesia is established, the pupils dilate widely and remain so without reaction to light, and the respirations become shallow and gasping. In the early stages of anesthesia, and when the patient is coming out, the pupils also dilate, but they still react to light and the corneal reflex is also present. After complete anesthesia has been once reached, it may be readily maintained by adding small amounts of the anesthetic from time to time; just enough should be administered to keep the pupils midway between contraction and dilatation, with a response to light at all times.

Stage of Recovery.—The recovery from the anesthetic is characterized by the occurrence of these same stages in reverse order. In some cases the recovery is more rapid than in others. The breathing becomes slower and less audible, and there is frequent sighing. The conjunctival reflex reappears, the pupillary reflex becomes active, and the patient rolls the eyes about. Frequent swallowing occurs, followed by retching. Vomiting of frothy and often bile-stained mucus is present in most cases, and may be continued for an hour or more. Partial consciousness, with laughing, crying, or incoherent speech follow, and it is usually some hours before the mental equilibrium is completely regained. Hyperesthesia is marked in the period of recovery, and general irritability, complaints of discomfort, and pain are to be expected. Some, however, especially children, pass into a deep sleep lasting for several hours.

ETHER ANESTHESIA

Ether is a very volatile, colorless liquid, with a strong, pungent odor and a burning, sweetish taste. It is very inflammable, and should not be used near a flame, cautery, or X-ray apparatus. An artificial light held well above it is safe, however, as the ether fumes tend to sink downward. Only the purest ether should be used for anesthetic purposes, and it should be kept in hermetically sealed tin cans, as exposure to light and air cause it to decompose into acetic acid and other irritating products.

Ether fumes, when inhaled, prove very irritating to the mucous membranes of the nose, mouth, and respiratory tract, and produce an increased secretion of mucus and saliva, often accompanied by coughing. Lesions of the lungs are thus apt to follow its use, and may be due to the aspiration of saliva as well as to the direct irritation of the ether vapor. Ether is a distinct cardiac stimulant, accelerating the heart action and raising blood-pressure; this effect is well shown when ether is administered to a very ill person, the character of the pulse often showing immediate improvement and continuing so until the end of the anesthesia. While its primary effect is one of stimulation, in toxic doses it acts as a depressant, especially upon the respiratory centers. It is estimated that ether is about five times as safe as chloroform, and, as it is less rapid in its action, danger signs can be recognized and proper treatment instituted with more chance of success than with the latter. Upon the kidneys it acts as an irritant, and prolonged anesthesia often results in postoperative albuminuria. Ether produces a distinct leukocytosis, a slight diminution of the hemoglobin, and a marked decrease in the coagulation-time of the blood (Hamburger and Ewing). According to Graham the phagocytic power of the blood is reduced after an ordinary ether anesthesia.

Owing to its low boiling-point and volatility, ether is very rapidly eliminated from the lungs, and it is necessary to give it in a more or less concentrated form, differing in this respect from the administration of chloroform. The administration of ether is rendered safer if preliminary anesthesia is induced by some quick anesthetic, as nitrous oxid or ethyl chlorid; furthermore, oxygen and ether is a safer mixture than air and ether. The oxygen may be administered by passing the oxygen tube under the mask, or, in the closed inhalers, the tube may be attached directly to the ether bag.

Suitable Cases.—When a general anesthetic is necessary and the operation is not suited to nitrous oxid, ether is preferable to chloroform unless direct contraindications to its use are present. In the hands of an expert, many of the dangers attributed to chloroform are absent, but it must be remembered that under the same conditions ether is also less dangerous. In unskilled hands, however, there can be no doubt that ether is always the safer.

For the stimulating effects in cases of shock or hemorrhage, or when it is necessary to obtain a profound degree of narcosis with abolition of the reflexes, ether is by all means the best agent to use. In anemia ether is preferable to chloroform, as it has less marked an effect upon the hemoglobin. If the patient's hemoglobin is below 30 per cent., however, any general anesthetic is contraindicated (Da Costa). In heart disease, if the compensation is good, ether is safe, but with broken compensation or when there is high arterial tension and degenerative changes in the blood-vessels, it is contraindicated on account of the danger from overstimulation. In myocardial disease it is unsafe, but not so dangerous as is chloroform.

On account of its irritant action, ether should be avoided in bronchitis or acute lung troubles, and, for the same reason, in advanced Bright's disease. In individuals over sixty years old, ether, as a rule, is to be avoided, as they are very likely to be afflicted with respiratory troubles, and the circulatory system is usually the seat of degenerative changes. For children, a mixture of chloroform and ether, or chloroform alone, is the better anesthetic, ether proving irritating to the delicate respiratory mucous membrane of a child, and often producing such a flow of mucus and saliva that breathing is seriously interfered with.

Ether is not recommended in cerebral operations—at the beginning, at any rate—on account of the struggling, resultant congestion, and increased liability to hemorrhage. *It should never be administered in operations about the mouth or face requiring the use of a cautery near by.*

Apparatus.—Ether may be satisfactorily administered by the drop method, the semiopen, the closed, or the vapor method. Different

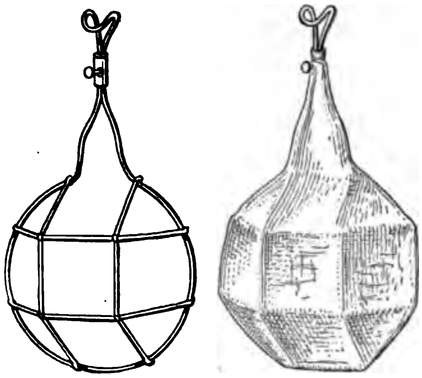

FIG. 3.—The Esmarch mask.

forms of inhalers are used, according to the method employed. Of the open inhalers, any of the chloroform masks, such as Esmarch's (Fig. 3) or Schimmelbusch's (Fig. 4), will be found satisfactory. They are very simple, consisting of a wire frame covered with canton flannel or several layers of gauze, upon which the ether is dropped. Such inhalers permit a very plentiful supply of air. An ordinary chloroform bottle (Fig. 5) may be used for the dropping, or a very convenient dropper may be improvised by cutting a groove in opposite sides of the cork of the ether can—one to admit air and the other to allow the escape of the ether.

The Allis inhaler (Fig. 6) is a type of the semiopen cone. It consists of an outer rubber case in the upper part of which is fitted a metal frame provided with slits through which is threaded a cotton or flannel bandage. A very simple semiopen inhaler may be made by rolling several thicknesses of heavy brown paper into a cuff and covering it with a towel. The top of the cone, which is held partly closed by safety pins, is filled with gauze upon which the ether is poured (Fig. 7).

There are many excellent closed inhalers, such as the Clover (Fig. 8) the Bennet (Fig. 9), the Gwathmey, the Pedersen, the Davis,

FIG. 4.—The Schimmelbusch mask. FIG. 5.—Chloroform dropper

etc. These consist essentially of a metal face-piece surrounded by an inflatable rubber rim, an ether chamber filled with gauze, and a closed rubber bag into and out of which the patient breathes. They are also provided with suitable openings for the entrance of air.[1] With such inhalers, the temperature of the ether vapor is raised by the

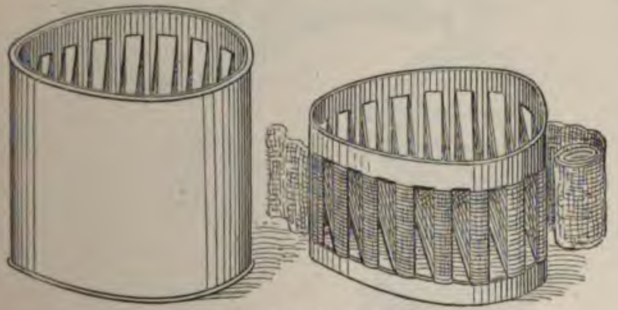

FIG. 6.—The Allis inhaler.

expired air and the supply of carbon dioxid, the normal stimulant of the respiratory and cardio-vascular centers, is maintained through the rebreathing, thus adding to the value and safety of the anesthetic.

[1] Space does not permit a detailed description of these inhalers, nor is it necessary, as a description of the mechanism and full instructions are furnished with each instrument.

To obtain the benefit of the warm vapor without the disadvantages of the closed inhalers, the vapor method of etherization is preferred by some. It is an excellent method of anesthesia to use in operations about the mouth, as the vapor can be delivered through a small tube passed into the mouth or two nasal tubes without inter-

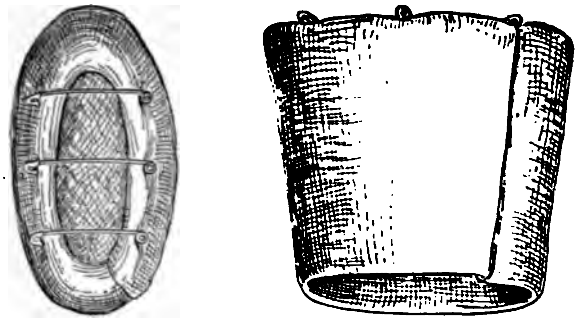

FIG. 7.—Towel cone.

fering with the operation. The curved glass nasal tubes divised by Lumbard (Fig. 10) are admirable for this purpose. There are a number of inhalers suitable for the vapor method of etherization, of which Gwathmey's apparatus is a type. Gwathmey's vapor apparatus (Fig.

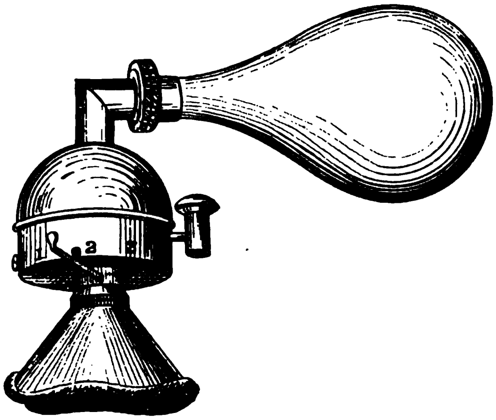

FIG. 8.—The Clover ether inhaler.

11), as described by him (*Journal of American Medical Association*, October 27, 1906), consists of two six-ounce (180 c.c.) bottles, one for chloroform and one for ether. Both bottles are placed in a tin vessel containing thermolite. This "thermolite warmer," if placed in boiling water for three minutes, will remain warm for over one and a half hours.

If the heat is to be continued, this can be accomplished by simply taking the stoppers out, thus exposing the thermolite to the atmosphere. The liquid then begins to recrystallize, and on turning to

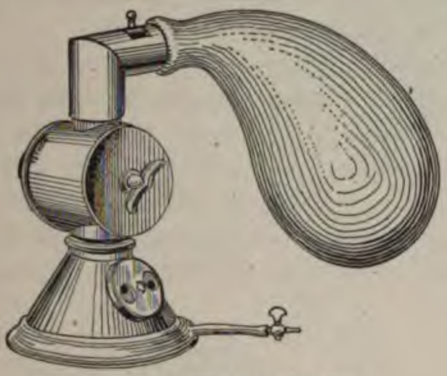

FIG. 9.—The Bennet ether inhaler.

a solid form gives off heat for another hour and a half. In each of the bottles there are three tubes, varying in length from one that reaches to the bottom of the bottle to one that penetrates only the

FIG. 10.—Lumbard's glass nasal tubes for anesthesia (Warbasse).

stopper, and representing three degrees of vapor strength. The small switches at the top of each bottle are so arranged that chloroform or ether can be given, combined or separately, and in any strength desired. In addition, by simply turning a small lever, without removing the mask, the patient receives pure air or a mixture of oxygen and air. By compressing the hand bulb, air or oxygen is forced into the apparatus and the warmed ether or chloroform vapor is carried to the patient by the efferent tube.

Inhalers, whatever the variety, should always be sterilized after use. Disregard of this precaution has been the cause of many of the cases of postoperative pneumonia. Metal portions of the inhaler should be boiled and the rubber parts soaked in a 1 to 20 solution of carbolic acid after each administration. The parts are then dried, and fresh gauze packing is supplied for the closed inhalers and the open ones are covered with new gauze or canton flannel.

FIG. 11.—Gwathmey's vapor apparatus.

Administration.—*Drop Method.*—The usual precautions already detailed having been observed, and the eyes of the patient being protected by a folded piece of gauze, the mask is placed over the mouth with the request that the patient breathe naturally and regularly. As soon as several breaths have been taken, a few drops of ether are poured upon the mask. After a few more breaths, more ether is added, gradually increasing the amount each time. If the patient struggles or begins to cough and choke, the amount of ether should be reduced for the time being. In from five to six minutes the stage of excitement and struggling begins, and the ether should then be dropped more rapidly. Large amounts should never be poured on suddenly, however, as this simply irritates the respiratory tract and produces laryngeal spasm, causing the patient to cough, choke, or hold his breath. If the dropping is properly performed, full anesthesia should be obtained in from ten to fifteen minutes. By the drop method an even anesthesia without cyanosis is produced.

As soon as the patient is thoroughly anesthetized, just sufficient ether should be given to keep him thoroughly under its influence.

During the anesthesia the breathing must be carefully watched, together with the pulse and the eye reflexes. Under the stimulation

FIG. 12.—Showing the administration of ether by the drop method.

of the ether, the respirations are increased in frequency and depth, and are rather noisy in character on account of the increased amount of mucus and saliva that collects in the throat. Irregular rapid respiration approaching a gasping type is unsafe. The breathing

FIG. 13.—Proper method of holding the jaw forward.

should not be allowed to become gurgling or obstructed. To prevent this, the jaw should be held well forward by placing the fingers back of the angle, as shown in the accompanying illustration (Fig. 13). This prevents the relaxed epiglottis from being forced back by the tongue over the opening in the larynx, since, if the jaw is pushed forward, the tongue goes with it, giving a clear passage. In holding the jaw forward, care should be taken not to use force or bruise the tissues. If this maneuver does not overcome the obstruction from the tongue, the latter should be pulled out and held well forward by means of a tongue forceps or a silk thread passed through its tip. This, however, is seldom necessary if the jaw is properly held and the head is turned to one side to allow the mucus and saliva to flow out through the corner of the mouth. Should vomiting occur, the inhaler must be removed and the patient's head turned to one side so that the vomited matter can escape; and, before the mask is reapplied, the mouth should be well cleared of vomitus.

The pulse under the effect of ether becomes somewhat rapid, but of greater volume and increased tension. At first the pupils are widely dilated and then tend to moderately contract. Should they suddenly dilate and remain so without responding to light in the absence of the conjunctival reflex, it is a sign of overnarcosis. Other danger signs are a weak, thready, or irregular pulse, and marked pallor or cyanosis. Hiccough usually means that the patient is getting ready to vomit. Rolling of the eyes and repeated acts of swallowing are preliminaries to the patient coming out. Both conditions require more ether.

As the operation progresses, smaller quantities of ether should be used, and the anesthesia should be so regulated that the patient will be just coming out by the time that he is ready to be moved from the table. The amount of ether used will depend upon the skill of the anesthetist and the form of inhaler. With the open inhaler, from two to four ounces (60 to 120 c.c.) should suffice for an hour; in the closed inhalers, much less will be consumed. It should always be the aim of the anesthetist to use just as little as may be necessary to keep the patient under control.

Semiopen Method.—Etherization with a semiopen inhaler differs in no material way from the drop method. The anesthesia should be started slowly by pouring into the top of the cone small quantities of ether at a time. After complete anesthesia is obtained, it may be maintained by the use of less ether than with the drop method, as the ether does not volatilize so rapidly.

Closed Method.—The gauze in the ether chamber is well saturated with ether before commencing the anesthesia. The cone is then applied and the patient is instructed to take regular breaths, breathing back and forth through the bag. As soon as he becomes accustomed to the apparatus, ether is *slowly* turned on during an inspiration by gradually revolving the drum of the ether chamber (Fig. 14). If cough or signs of irritation occur, the amount of ether should be cut down. Care should always be taken not to push the anesthetic too fast. As the patient breathes into and out of the rubber bag, it should be seen that the latter is kept about two-thirds full of air—it should never be allowed to become empty. Usually with a closed inhaler anesthesia can be produced in from four to six minutes. On account of rebreathing the same air, some duskiness of countenance is to be expected, but this may be regulated by admitting more air or by administering oxygen. A distinct livid color should not be allowed to

FIG. 14.—Showing the administration of ether with a closed inhaler.

persist with either a closed or an open inhaler. Such a condition is a sign of poor administration of the anesthetic, or else the particular anesthetic is not suited to the case.

Anesthesia by the closed method, besides being more rapid, reduces considerably the amount of ether used. Recovery from the effects of the anesthesia is more prompt, and such after-effects, as nausea and vomiting, are greatly diminished. Furthermore, the ether vapor inhaled from the bag, being warm, is safer, more effective, and less apt to produce irritation of the respiratory tract.

Vapor Method.—It is preferable to start the anesthesia by some of the quick methods, as nitrous oxid gas followed by ether, or by ethyl chlorid followed by ether. and, when the patient is well under its influence, the ether vapor is substituted. The vapor method may, however, be used from the beginning, if desired, starting with a medium percentage of vapor, and then working to the highest. When completely under, a medium or low percentage of vapor is used, according to the depth of anesthesia desired. The mask used in this method is covered with gauze, over which an impermeable material, as rubber tissue or oil silk is placed, with a small opening in the center about the size of a ten-cent piece, through which additional anesthetic may be dropped if it is found to be difficult to induce narcosis with the vapor alone.

The vapor method gives a light anesthesia, just abolishing the reflexes. The breathing more nearly approaches the normal, without the snoring rapid respiration usual to ether. The pulse is nearer normal, and the duskiness of countenance often present with the closed method is absent.

CHLOROFORM ANESTHESIA

Chloroform is a clear, colorless, heavy, volatile liquid with a sweetish taste and characteristic odor. When used for anesthetic purposes, it should be absolutely pure and neutral to litmus. Under the influence of heat or light, it decomposes into hydrochloric acid, chlorin, etc., hence it should always be kept in well-stoppered, dark amber-colored bottles and in a cool place. It is more irritating to the skin than ether and, if confined, will produce blisters. For this reason the lips, nose, and cheeks with which it may come in contact during anesthesia should be well protected with vaselin.

When inhaled, chloroform vapor has a depressant effect upon all the vital functions, but especially upon the circulation, lowering blood-pressure to a marked degree through vasomotor depression. Like ether, it produces a leukocytosis. It is less of an irritant to the respiratory tract and more agreeable to take than ether, hence the primary stage of excitement is milder. Upon the kidneys, it is likewise less irritating. It causes slight temporary fatty changes in the kidneys, heart muscle, and liver (more marked upon the latter) which may be severe and later lead to fatal results if these organs are already diseased.

Death from chloroform is usually sudden and with few premonitory signs. Vasomotor paralysis causing dilatation of the vessels and capillaries and fatal syncope is the primary cause, though the inhibitory action of the drug upon the heart itself may contribute.

Respiratory failure is not common as a primary complication, but is secondary to the failure of the vasomotor centers. Many of the deaths from chloroform occur early in its administration when, during the stage of excitement and struggling, more of the drug is inhaled than is realized, or it is pushed too rapidly in an attempt to overcome the struggling. With a trained and watchful anesthetist, chloroform is robbed of many of its dangers, but in inexperienced hands it is a most dangerous drug, being estimated to be about five times more fatal than ether.

Chloroform is the strongest anesthetic we possess, and should always be administered well diluted with air. A stronger vapor than 2 per cent. is a dangerous dose. In this respect it differs from nitrous oxid and ether, in the use of which a well-saturated vapor is required. A mixture of chloroform and oxygen is safer than chloroform and air. The use of this combination is less often accompanied by circulatory depression, while cyanosis and postoperative vomiting are less frequent.

Chloroform should always be administered warm. This can be accomplished by using some one of the warm vapor inhalers, or by simply placing the bottle containing the drug in warm water (100° F., 38° C.).

Chloroform should not be given with the head very high, or with the patient sitting up, on account of the danger of syncope; this precaution is also to be borne in mind when lifting or moving persons under the influence of chloroform. As a rule, the recovery from chloroform anesthesia is quicker than from ether, though the vomiting may last longer.

Suitable Cases.—Chloroform is generally preferred to ether in young children and in those over sixty years of age who are free from myocardial disease, for the reason that it causes less irritation of the respiratory tract. It is preferred to ether for patients with advanced Bright's disease who are free from myocardial trouble, in obstructive conditions of the larynx or trachea, and for those suffering from tuberculosis, asthma, bronchitis, etc.

In heart disease with broken compensation and dyspnea, in aneurysm, and in cases of marked degeneration of the blood-vessels, chloroform is preferable to ether on account of the milder preliminary stages In cases of myocarditis and of fatty degeneration it is dangerous and some other drug should be employed.

In parturition it is safer than in health, because only a partial action is required, and fright and apprehension which may be the cause of some of the fatalities are absent. When, however, deep surgical anesthesia is required in such cases, ether is indicated. In eclampsia chloroform should not be used on account of its destructive action upon the liver. In fact, in the presence of any liver lesion it should be avoided.

Chloroform should be avoided as an anesthetic in hemorrhage or shock, on account of its depressant effect upon the circulation; and likewise in anemia, as it decreases hemoglobin. In cerebral surgery, it is preferred by many surgeons, and also in operations about the face and mouth, as it causes but little cough and flow of saliva, and the anesthesia can be maintained with but a small amount of anesthetic. As its vapor is not inflammable, it can be employed in operations about the mouth or face while the cautery is being used. In minor surgical cases, where the operation is often performed under

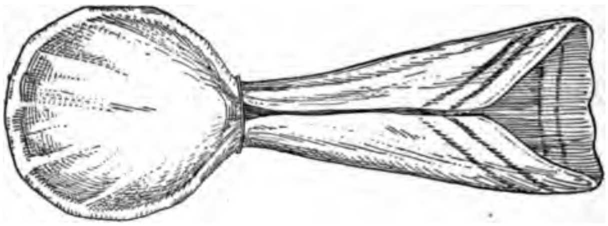

FIG. 15.—Chloroform mask improvised from the corner of a towel.

incomplete anesthesia, chloroform is contraindicated. In ophthalmic operations, where the condition of the pupil cannot be ascertained, ether is preferred to chloroform.

Apparatus.—Chloroform should never be administered in a closed inhaler. Either the open drop method, with a free mixture of air, or the warm vapor method are employed. For the former, a handkerchief, the corner of a towel (Fig. 15), or a piece of gauze will suffice, but a mask, such as Skinner's, Esmarch's (see Fig. 3), or Schimmelbusch's (see Fig. 4), covered with canton flannel or several layers of gauze, is more suitable. In addition, a drop bottle (see Fig. 5) from which the flow can be accurately regulated, and a receptacle for warm water will be required.

Different forms of apparatus for accurately estimating the strength of vapor, as Junker's (Fig. 16), Braun's, Gwathmey's (see Fig. 11), etc., are often used. These are supplied with a tracheal tube and are especially useful in operations about the mouth or throat. By squeezing the bulb, air is forced through the warmed chloroform, and a vapor containing a definite mixture of chloroform and air is administered. By attaching the inflow tube to an oxygen cylinder, oxygen may be readily administered instead of air.

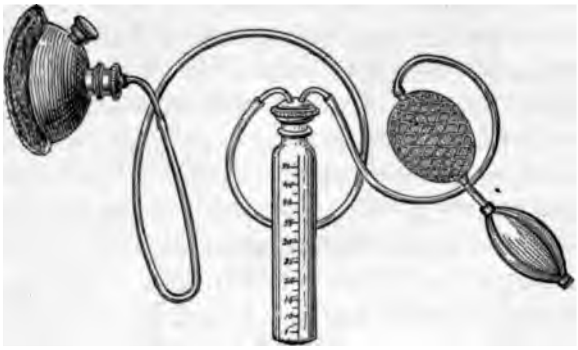

FIG. 16.—Junker's chloroform inhaler.

The same care should be taken as to the cleanliness of the chloroform mask as would be observed with any inhaler. After each anesthesia the metal framework should be boiled and then recovered.

FIG. 17.—Showing the method of administering chloroform (first step).

Administration.—The patient's lips, nose, mouth, and cheeks should be well greased with vaselin or lanolin. The anesthetic is started by holding the mask wet with a few drops of warm chloroform 4 or 5 inches (10 to 12 cm.) from the face (Fig. 17), the patient being told to breathe naturally and regularly. As soon as the patient grows accustomed to the vapor, the chloroform is dropped steadily at a rate of 10 to 30 drops a minute, and the mask is brought nearer the face, being careful, however, not to touch the skin with portions of the mask wet with chloroform (Fig. 18). When given gradually in this way, the struggling is not usually prolonged or violent. The anesthetic should never be poured on suddenly in large quantities; it must always be administered well diluted with air. *In the stage of excitement, chloroform must be given with extreme care;* if the patient struggles, the drug should not be pushed, otherwise, when the patient

FIG. 18.—Showing the method of administering chloroform (second step).

holds his breath, as he will in such cases, a large quantity of the anesthetic is retained in the lungs, and, when he takes a deep breath, a dangerous amount may be inhaled from the already oversaturated mask. Coughing and vomiting mean that the vapor is too strong, and it should be promptly diluted as it should also if the patient's breathing becomes embarrassed. The jaw must be kept well forward if there is the slightest impediment to free respiration from the tongue. When the patient is fully anesthetized, only small quantities of the anesthetic should be administered, just sufficient to keep him under.

With chloroform anesthesia, we have practically the same stages as with ether, but they succeed each other more rapidly, and a dangerous degree of anesthesia is quickly produced unless proper care be taken. The stage of excitement is less marked and shorter than with ether, and the patient presents a more tranquil appearance in every way. It should be the aim of the anesthetist to keep the patient in about the following condition: regular and fairly deep respirations, with only a slight snore; pupils moderately contracted and sluggishly sensitive to light; conjunctival reflex just abolished; full muscular relaxation; and a good color without blueness of the lips or cheeks. The latter is an indication for a weaker vapor and more air or oxygen. With the ordinary chloroform mask, oxygen may be administered by simply inserting the tube leading from the oxygen cylinder under the edge of the mask.

During the entire anesthesia, careful and close watch must be kept over the respirations, the pulse, the condition of the eye reflexes, and the general appearance of the patient. It is only by the constant and undivided attention of the anesthetist that the safety of the patient can be guaranteed. The slightest alteration in the respirations should be taken as a warning, as this is often the precursor to circulatory failure. Very shallow, irregular, or gasping respiration, a weak, thready, or intermittent pulse, sudden and continued dilatation of the pupils in the absence of eye reflexes, and marked duskiness or sudden pallor of the skin, are all indications that a dangerous stage of narcosis has been reached.

The administration of anesthetics by the vapor method has already been described under ether anesthesia (page 33), and will not be repeated here. With chloroform, it is an especially valuable method to employ, as the warm vapor may be administered in a definite strength, and with air or oxygen as desired.

NITROUS OXID ANESTHESIA

Nitrous oxid is a colorless gas, heavier than air, and with no perceptible odor or taste. It is obtained in a liquid form, highly compressed in steel cylinders or containers, from which, when liberated, it escapes as a gas. It has a pleasant odor and a slightly sweetish taste. It has marked anesthetic properties, though the anesthesia is not so profound as that from ether or chloroform. It increases the rate and depth of respiration and accelerates the heart action, at the same time raising blood-pressure. If pushed too far, the respirations cease, though the heart continues to beat for some time. For short operations it is the safest of all the general anesthetics, 1 in 100,000 being the generally accepted death rate.

Anesthesia from nitrous oxid cannot be maintained for more than fifty or sixty seconds without air, on account of the development of symptoms of asphyxia. Used with the proper admixture of air or oxygen, however, an anesthesia for an hour or more may be safely maintained. According to Hewitt, mixtures containing 5 to 7 per cent. of oxygen are best suited for adult males, and mixtures of 7 to 9 per cent. of oxygen are best for females and children. Mixtures of nitrous oxid and air, composed of from 14 to 18 per cent. of the latter for men, and from 18 to 22 per cent. for women, give the next best results.

Nitrous oxid is very rapid in its action, producing complete unconsciousness in from one to two minutes, and is the most agreeable of the general anesthetics to take. The patient comes out of it very quickly, usually in from thirty to sixty seconds, and its use is not followed by nausea and vomiting. The lung, kidney, and heart complications of ether and chloroform are likewise absent.

Suitable Cases.—When used pure, nitrous oxid is suitable only for short procedures lasting about a minute, such as extracting teeth and making incisions for drainage, etc.

With the admixture of air or oxygen in proper quantities to prevent asphyxial symptoms, and administered by an expert, it may be made applicable for anesthesia in some major surgical operations not consuming a great deal of time, as well as in many of the minor ones. It is an excellent anesthetic to employ for the reduction of fractures requiring only a moderate amount of muscular relaxation, and for breaking up adhesions in ankylosed joints. When local anesthesia is contraindicated, it becomes the anesthetic of choice for abscess, felon, empyema, benign tumors, strangulated hernia, varicocele, minor amputations, exploratory operations, etc. Within the last few years the scope of nitrous oxid and oxygen anesthesia has been enormously enlarged, some operators employing it in their work to the exclusion of ether in operations of considerable magnitude upon the biliary passages, kidney, bladder, intestines, and stomach. It should be remembered, however, in connection with some of the above abdominal cases, that often complete relaxation is not obtained under this form of anesthesia.

Nitrous oxid is contraindicated in cases of dilated heart or advanced valvular disease, and in patients with atheroma of the blood-vessels, on account of the danger of cerebral hemorrhage. In children, the mask and formidable appearing apparatus frequently cause such fear as to preclude its use. It is not a suitable anesthetic to employ in patients with narrow or abnormal air passages, or in those suffering from goiter, enlarged tonsils, or adenoids. In operations about the rectum and perineum, it is sometimes unsatisfactory, as the patient may stiffen up or straighten out the limbs, thus interfering with the operator. The same may be said of its use in alcoholics, or strong, robust, or fat individuals, though, according to Gwathmey, by preliminary medication with morphin alone, or with morphin and chloretone, or morphin and hyoscin, any patient can be anesthetized satisfactorily.

Apparatus.—Nitrous oxid may be administered alone or with air by means of any of the usual inhalers for that purpose, such as Hewitt's, Gwathmey's, Bennett's (Fig. 19), etc. In general these consist

FIG. 19.—The Bennett nitrous oxid gas inhaler.

of a metal mask with a pneumatic rubber rim that fits the face accurately so as to exclude air, a gas chamber with inspiratory and expiratory valves or openings, and, attached to the gas chamber, a rubber balloon connected by rubber tubing with the nitrous oxid cylinder. With such apparatus, air may be admitted through the openings provided for that purpose or the inhaler may be removed every two to five inspirations, allowing the patient to get a supply of pure air. Oxygen may likewise be administered by passing the oxygen tube under the rim of the mask.

When a definite amount of oxygen is to be given, a special apparatus, as that of Hewitt (Fig. 20), Gwathmey (Fig. 21), Teter, Cunningham, or Gatch, is essential. With these inhalers any desired combination of nitrous oxid gas and oxygen may be obtained by regulating special switches, which are provided with indicators showing the exact strength of the vapor which the patient receives.

Carbon dioxid, which is valuable as a respiratory stimulant, is provided by rebreathing or by connecting the apparatus with a tank of CO_2.

As with all inhalers, the metal parts should be boiled and the rubbers sterilized in a solution of 1 to 20 carbolic acid after use. Before using, the apparatus should always be tested to see that it works properly.

FIG. 20.—The Hewitt nitrous oxid gas and oxygen inhaler.

Administration.—In giving pure nitrous oxid, the apparatus is properly connected with the supply cylinder, and the rubber balloon is about three-fourths filled with gas. The gas should be turned on slowly, as, at times, when suddenly released, it escapes from the cylinder with a loud noise which might tend to frighten a nervous patient. The face-piece is then tightly applied over the mouth and nose, so that air cannot be drawn in around the rubber rim. The expiratory valve is opened and the patient is told to breathe regularly. After two or three breaths of air, during which the patient becomes accustomed to the apparatus, the gas is allowed to enter the mask by opening the proper stopcock. The patient thus breathes in pure nitrous oxid and expires nitrous oxid and air, so that he constantly receives more nitrous oxid into the lungs. After a few breaths, the expiratory valve is closed and the patient breathes the gas back and forth.

The first few inspirations of gas are soon followed by a change in the color of the face—it becomes dusky, and finally a deep livid hue. There is at first incoherent speech, but this is soon followed by the anesthetic snoring, rapid respiration, and laryngeal stertor. There is usually tremor or twitching of the superficial muscles of the eyes, mouth, neck, etc., and at times complete rigidity and violent jactitations of the limbs. The anesthesia cannot be continued

FIG. 21.—Gwathmey's nitrous oxid gas and oxygen inhaler.

beyond this point without danger of asphyxia. If the mask is removed, there is still a period of surgical anesthesia, lasting about a minute. This is soon followed by a reactionary redness or blush about the face, and a return to normal breathing. By reapplying the mask before the patient comes entirely out, and administering more nitrous oxid, the anesthesia may be considerably prolonged, provided sufficient air is admitted to avoid extreme cyanosis, stertor, and muscular twitching, and yet not so much as to keep the patient insufficiently anesthetized. This may be accomplished by allowing two to five breaths of nitrous oxid to one of air, or the air may be administered in combination with the nitrous oxid through the opening provided on the inhaler for that purpose. A slight duskiness of the countenance, moderate snoring, and regular respiration should be aimed at.

Administered with oxygen, a complete absence of symptoms of asphyxia is secured. An even anesthesia is best obtained with some form of apparatus that accurately regulates the percentage of oxygen. The technic is essentially the same as that employed in giving pure nitrous oxid. The patient first breathes pure air, then the nitrous oxid is turned on, and finally the oxygen. Starting with but a very small proportion of oxygen (2 to 3 per cent.) it may be increased to from 5 to 10 per cent., or more, depending upon the case. Enough

FIG. 22.—Showing the method ot administering nitrous oxid gas.

oxygen should always be given to prevent cyanosis without detracting from the anesthetic effects of the nitrous oxid. There is no doubt that it requires special training for one to become expert in administering this combination. Success depends upon the ability of the anesthetist to provide a combination of gas and oxygen that will produce narcosis without cyanosis. With the proper amount of oxygen, the patient goes under the anesthetic in two to three minutes without any of those unpleasant symptoms seen with pure nitrous oxid, the color of the skin is normal, the breathing becomes regular and slightly snoring, and the pulse may be slightly increased in rate.

Recovery is rapid and is usually unaccompanied by any unpleasant after-effects.

NITROUS OXID AND ETHER SEQUENCE

By this method the patient is thoroughly anesthetized with gas and then a change is slowly made to ether. It is a most valuable method for avoiding the disagreeable effects of the early stages of anesthesia ordinarily encountered when straight ether is administered from the start. A combination of gas and ether carries the patient into a stage of surgical anesthesia very rapidly—usually in about one to three minutes. Much less ether is required both in starting and maintaining narcosis than when ether alone is employed, and, the patient not being saturated with the drug, the after-effects of ether anesthesia are not nearly so frequent or pronounced. It is

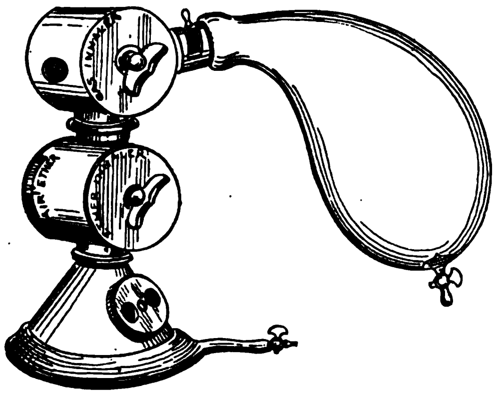

FIG. 23.—The Bennett gas and ether apparatus.

safer than ether given alone by the open or semiopen inhalers, probably because the stage of excitement is absent, and, in the second place, the carbon dioxid content is maintained and the ether vapor is warmed through the constant rebreathing; and, finally, a much smaller amount of the anesthetic is required.

Apparatus.—If desired, the gas may be administered by any of the ordinary nitrous oxid gas inhalers, and the ether by the open or semiopen method, though a combination gas and ether apparatus, such as Clover's, Hewitt's, Bennett's (Fig. 23), Gwathmey's (Fig. 24), or Pedersen's, is preferable and more convenient. These inhalers consist of the usual metal mouth-piece and inflatable rubber rim, inspiratory and expiratory valves, and gas bag. In addition, the inhalers

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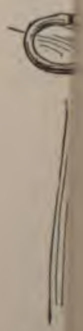

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ether. During this period, if symptoms of asphyxia appear, small quantities of air should be admitted from through the air valve, but not in such amount as to allow to come out. As soon as anesthesia is well established, lly takes less than two minutes, the gas is discontinued inistration of the ether is proceeded with in the usual way a closed cone.

g a combination of gas and ether, care must be taken to ether rather slowly at first. If the patient commences to hold his breath, the ether should be turned on less rapidly, y stopped, until regular breathing is again established. inistered properly, the patient goes under the anesthetic ising quickness, without any discomfort or struggling, and, thesia is once established, but little anesthetic is required in it. Some duskiness of countenance and cyanosis are to ed from the nitrous oxid, and the constant rebreathing of the por, but this may be controlled by a careful regulation of the es.

ETHYL CHLORID ANESTHESIA

yl chlorid is a colorless, very volatile and inflammable liquid. , it has an ethereal odor, and should not be acid to litmus.

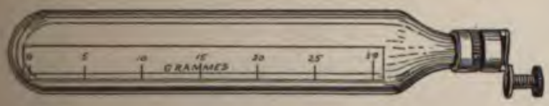


FIG. 25.—Ethyl chlorid tube.

general anesthetic purposes the purest quality of the drug should ed, and only that labelled "for general anesthesia." This can be ined in containers furnished with a spring stopcock, which per- the drug to be administered in a fine stream in any desired quan- (Fig. 25), or in hermetically sealed glass tubes containing about drams (5 c.c.) of the drug. The latter is best suited for the d inhalers, the whole amount being emptied into the inhaler at Ethyl chlorid is decomposed by light and air, hence it should kept in a dark place and in tightly stoppered tubes. Being in- mmable it should not be used near a flame or cautery.

When inhaled, it is very rapidly absorbed and is quickly elimi- d. anesthesi roduced in from thirty seconds to a minute and la three minutes after the withdrawal f the anesthetic. Recovery is not quite so rapid as from nitrous oxid, and after-effects, such as headache, nausea, vomiting, and dizziness, are not at all uncommon. It is not nearly so safe as nitrous oxid, nor so pleasant an anesthetic to take. It has the advantage, however, of not producing cyanosis, and the anesthetic effects are more prolonged; furthermore, it may be administered without special apparatus. It stimulates both the heart and respiration, increasing the rate and the depth of the latter, but it lowers blood-pressure through dilatation of the peripheral vessels.

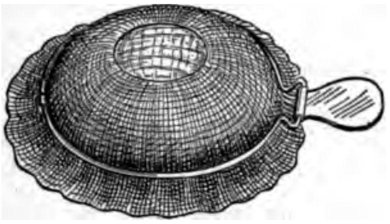


FIG. 26.—Showing the Schimmelbusch mask covered with gauze and oil silk for the administration of ethyl chlorid.

Suitable Cases.—Ethyl chlorid is employed mainly for brief operations or examinations not requiring full muscular relaxation, and as a preliminary to ether to get the patient under rapidly without struggling and excitement. It acts especially well in children on account of its rapidity of action. It should never be immediately followed by chloroform, as both are circulatory depressants. Its use is contra-indicated when there is any respiratory obstruction.

Apparatus.—Owing to its great volatility, ethyl chlorid is most satisfactorily administered by means of a closed inhaler, though the semiopen method may be employed, and is preferred by many as being safer. For the latter, one may employ an Esmarch or Schimmelbusch mask, over the gauze of which is placed some impervious material, as oil silk or rubber tissue, with a small opening through which the drug is sprayed (Fig. 26); or an Allis inhaler may be used, leaving a small opening in the top. Any of the ordinary closed inhalers may be utilized for administering ethyl chlorid by simply spraying the drug into the ether bag.

FIG. 27.—Ware's ethyl chlorid inhaler.

There are a number of inhalers, however, devised especially for this drug and similar anesthetics. Ware's inhaler (Fig. 27) consists of a pliable rubber mouth-piece, to the top of which is fitted a metal chimney. At the point the latter joins the mouth-piece, several layers of gauze are interposed upon which the anesthetic is sprayed through the top of the apparatus. The somnoform inhaler consists of a glass face-piece with an inflatable rubber rim and rubber balloon. The balloon is attached to the mouth-piece by a T-shaped chamber which is provided with a valve and a small opening through which the anesthetic may be sprayed.

Administration.—In administering ethyl chlorid by the closed method, the inhaler is placed over the patient's face during expiration in order to fill the bag, and, as soon as the patient is breathing regularly, from 1 to 1¼ dr. (4 to 5 c.c.) of ethyl chlorid are sprayed into the bag, or, if a special inhaler is used, into the opening provided for the purpose. If the face-piece be tightly applied, so as to prevent the entrance of air, signs of anesthesia appear in from thirty seconds to one minute. As soon as anesthesia is produced, the patient should be allowed to have air.

Full anesthesia is characterized by rapid and slightly stertorous breathing, dilated pupils, absence of the conjunctival reflex, and more or less complete relaxation. There is no cyanosis, though the color of the skin is heightened from the dilatation of the peripheral vessels. The inhaler should now be removed and the operation proceeded with, or else ether is substituted. If the patient recovers too rapidly, more anesthetic may be given, provided a plentiful supply of air is allowed. By an interrupted administration of ethyl chlorid—that is, first securing deep narcosis and then giving air—a prolonged light anesthesia may be obtained, though at times muscular relaxation is not complete and the patient is apt to remain partly conscious. Danger signs from ethyl chlorid anesthesia are gasping, shallow respirations, pupils widely dilated and not reacting to light, and general pallor of the skin.

Administered by the semiopen method, a greater quantity of the drug will be necessary, and somewhat more time will be consumed in getting the patient under than by the closed method. The mask is placed over the face, air being excluded as far as possible by surrounding it with a towel, and the drug is simply sprayed upon the inhaler in a steady stream until anesthesia is produced.

ANESTHETIC MIXTURES

The addition of ether, alcohol, and other drugs to chloroform has been extensively practised for the purpose of modifying the action and avoiding the dangers of the latter. There are a large number of such mixtures, varying both in composition and in the relative proportion of their separate constituents. The A. C. E. mixture is composed of:

Alcohol,	1 part
Chloroform,	2 parts
Ether,	3 parts

A mixture somewhat similar to this, known as the Billroth mixture, contains:

Alcohol,	1 part
Ether,	1 part
Chloroform,	3 parts

The C. E. or Vienna mixture contains:

Chloroform,	1 part
Ether,	3 parts

Schleich's mixture for general anesthesia is composed of ether, chloroform, and petroleum ether. This is furnished in three strengths of solution, one for light narcosis, one for moderate narcosis, and one for deep narcosis.

Anesthol is composed of:

Ethyl chlorid,	17 per cent.
Chloroform,	35.89 per cent.
Ether,	47.10 per cent.

Of these, the A. C. E. mixture, the C. E. mixture, and anesthol, are most used in this country.

In point of safety, mixtures occupy a place between chloroform and ether, the added safety over chloroform depending mainly upon the stimulating effect of the ether. The complications and dangers that may arise during the administration of these mixtures, however, are those met with from chloroform rather than from ether, and, as a general principle, mixtures should be given with as much caution as would be observed in the administration of the most dangerous drug they contain.

Suitable Cases.—When nitrous oxid or ether are considered inadvisable, a mixture of chloroform and ether is the next choice. Thus in children and in persons over sixty, in the fat and plethoric, in cases suffering from chronic lung trouble, as emphysema, bronchitis, etc., in advanced cardiac disease with lack of compensation, in atheroma, in alcoholics, in those with renal disease, and in cerebral operations mixtures are most useful. Being agreeable to take, they are often used as a means of obtaining primary anesthesia to ether when nitrous oxid or ethyl chlorid are unavailable.

Apparatus.—Mixtures containing chloroform should always be given by the open method, and for this purpose some such mask as the Esmarch or Schimmelbusch, previously described (see page 26), should be used.

Administration.—The same general rules and principles that govern the administration of chloroform should be followed in the use of mixtures. They should always be given with the patient in a recumbent position. The inhalation is begun gradually with the admixture of plenty of air. Small quantities of the anesthetic frequently repeated are to be used in preference to a few large doses.

The anesthesia produced by mixtures is only a slight modification of chloroform narcosis. On account of the stimulating effect of the ether, the pulse is fuller and more rapid, respirations are deeper, and the whole appearance of the patient is better than when chloroform alone is used. Dangerous signs, should they appear, are not quite so abrupt as with chloroform and may usually be detected before a serious or hopeless condition supervenes.

SPECIAL METHODS OF ANESTHESIA

Intubation Anesthesia.—In operations about the mouth, such as is required, for instance, in removal of the tongue, repair of a cleft palate, resection of the jaw, etc., the administration of the anesthetic by means of tubes passed into the pharynx through the nose, known as Crile's method, will be found of great service. The advantages are that the anesthetist and inhaler are removed from the seat of operation so that they in no way interfere with the operator, and the anesthetic may be administered continuously, as it is not necessary to delay or stop the operation at frequent intervals in order to get the patient well under, as is the case when the ordinary interrupted form of anesthesia is employed. As the pharynx is packed with gauze, aspiration of mucus or blood from the site of operation is avoided, nor is there vomiting or coughing up of blood that may have collected in the back of the pharynx.

Apparatus.—The apparatus consists of two rubber tubes of a size that will comfortably pass through the nares, each about 8 inches (20 cm.) long, preferably cut at their distal ends at an acute angle, and furnished with side openings. The upper ends of the tubes are connected to the two arms of a Y-shaped glass tube, to the long arm of which is attached by means of a third piece of rubber tubing a funnel lightly packed with gauze.

Technic.—After full anesthesia has been obtained in the usual way, a mouth gag is inserted, the throat is well cleared of mucus by means of small gauze swabs, and the two tubes, well lubricated, are carefully passed through the nares and down to the epiglottis with their pointed ends directed downward and forward. The tongue is then drawn well forward and the whole pharynx is firmly packed with a *single piece* of gauze in such a way that the packing does not obstruct the lateral fenestræ or ends of the tubes (Fig. 28). Care

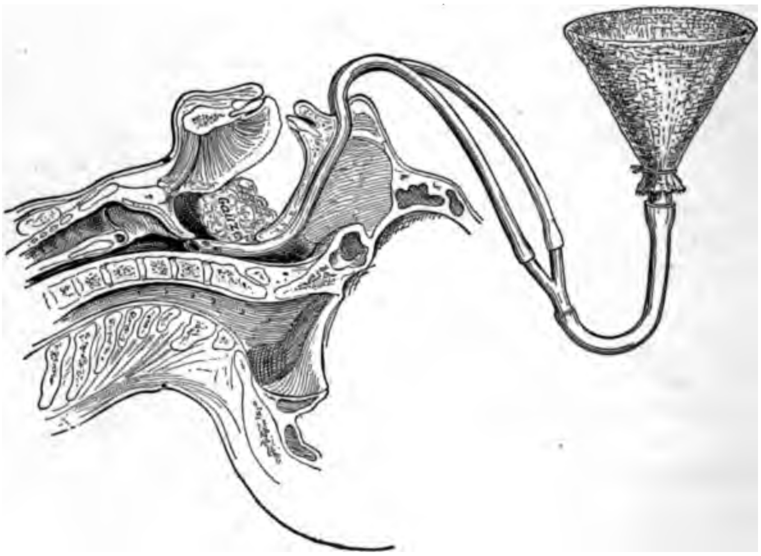


FIG. 28.—Showing the method of inserting the tubes and packing the pharynx for intubation anesthesia.

should be taken at this stage to listen at the ends of the tubes in order to make sure that the patient is breathing properly. If he is not, the gauze should be promptly removed and the pharynx repacked. As soon as regular breathing is established through the tubes, the funnel is connected and the anesthetic is continued by the drop method.

Intratracheal Insufflation Anesthesia.—Intratracheal insufflation anesthesia, first suggested by Meltzer and Auer, consists essentially in the introduction deep into the trachea of a flexible tube with a diameter considerably less than the lumen of the trachea and the forcing of a current of air and ether vapor through the tube, the space between the tube and trachea permitting the return of air from the lungs. This method of anesthesia was originally adopted to supply a positive pulmonary pressure for operations upon the thoracic viscera, the resistance to the return of air through the trachea being sufficient to prevent the lungs from collapsing when the thorax is opened. For this purpose it has largely replaced the various differential pressure chambers.

Intratracheal insufflation is, furthermore, of special value in operations about the mouth, tongue, throat, jaws, and nose as the continuous reflux air current prevents the aspiration of blood, mucus, vomitus, or other foreign matter from the pharynx into the trachea. It is also indicated in cases where normal respiration is interfered with, and in operations about the neck, head, or face it permits the operator to work in an unobstructed field. The easy, even anesthesia produced by this method, the marked absence of shock and post-operative vomiting attending its use, and the fact that the dosage may be accurately regulated has led some surgeons to employ it as a routine in preference to the ordinary inhalation methods.

While some accidents have attended the use of insufflation anesthesia, they have been due to faulty technic. If an approved form of apparatus is used and certain cautions are observed, there is no danger. The apparatus should always be provided with a safety valve to guard against overpressure and there must be no chance of liquid ether entering the tracheal tube. Furthermore, before beginning the insufflation, the operator must assure himself that the tube is in the trachea and not in the esophagus, that the tube is not introduced beyond the bifurcation of the trachea, and that during the insertion of the tube the pharynx and trachea are not injured.

Apparatus.—There are several good intratracheal insufflation machines on the market, such as Elsberg's, Janeway's, and Boothby's, which are elaborate in their completeness. A very simple and inexpensive apparatus (Fig. 29), which answers all purposes, is described by Meltzer (Keen's Surgery, Vol. VI) as follows:

"By means of a glass-blower's foot-bellows (B) air is driven through a system of branching tubes into the intratracheal tube (In.-T). The first branching of the tubes is introduced for the purpose of regulating the interruption of the air-stream. From the right branch a tube is led off laterally, carrying a stopcock (St. 3), which is to be used for the interruptions of the air-current. During the opening of the stopcock a part of the air-current continues through the left tube, thus preventing too great a reduction of the pressure, which is undesirable. By means of a screw-clamp (S.C.)

the amount of air which is to pass through the left tube can be regulated; a narrowing of this tube causes a greater collapse of the lung during the interruption. The second branching of the tubes is introduced for the purpose of regulating the anesthesia. The ether bottle (E) is interpolated in the left branch; the right branch runs uninterrupted outside of the bottle to unite with the part of the left tube which comes from the ether bottle. When the stopcock in the right branch (St. 2) is closed, all the air passes through the ether bottle; when, instead, both stopcocks in the left branch (St. 1 and St. 4) are closed, only pure air reaches the intratracheal tube, and

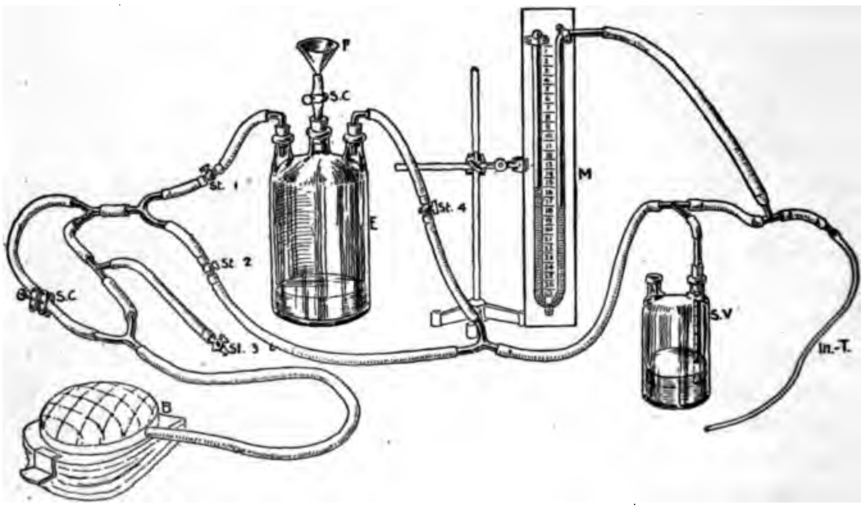


FIG. 29.—Apparatus for intratracheal insufflation anesthesia (Meltzer in Keen's Surgery).

when all three stopcocks are open only one-half of the air is saturated with the anesthetic. By partial closing of the stopcocks various degrees of anesthesia can be obtained. The third opening in the ether bottle carries a tube with a funnel (F) through which the bottle is filled with the anesthetic; the tube is otherwise kept tightly closed by means of a screw-clamp (S.C.). All three rubber stoppers are firmly and permanently wired down to resist various pressures. When the ether bottle is to be refilled during insufflation, both stopcocks on the left side are closed, while the one on the right side is open."

"The tube which connects the anesthesia circle of tubing with the intratracheal tube (In.-T) carries two lateral tubes; one is connected with a manometer (M), which needs no description, and the other leads to a safety valve (S.V.) of a simple construction. To the rubber tubing is attached a graduated glass tube, the lower end of which is immersed under the surface of the mercury in this bottle to a depth corresponding to the pressure which is desired for the intratracheal insufflation. For instance, if the pressure should be not more than 20 mm. of mercury, the glass tube is immersed just 20 mm. below the surface of the mercury. The glass tube is kept in the desired place by means of a rubber ring resting upon the opening of the mercury bottle. This device gives great safety to the working of the method. No matter how strong and irregular the bellows is worked, the intratracheal pressure could never rise above the one arranged for; the surplus of air escapes through the tube from under the mercury."

The tracheal tube should be flexible and elastic, about 14 inches (35 cm.) long, with a mark 10½ inches (27 cm.) from the distal end

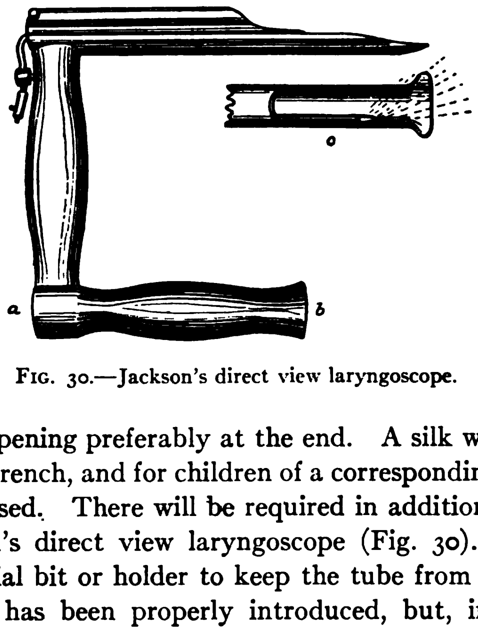


Fig. 30.—Jackson's direct view laryngoscope.

and with the opening preferably at the end. A silk woven catheter, No. 22 to 24 French, and for children of a correspondingly small size, is frequently used. There will be required in addition a mouth-gag and a Jackson's direct view laryngoscope (Fig. 30). Elsberg has devised a special bit or holder to keep the tube from slipping up or down after it has been properly introduced, but, in its absence, adhesive plaster may be employed for this purpose.

Asepsis.—The tracheal tube and the laryngoscope must be sterile.

Preparations of the Patient.—The patient is prepared as for any anesthesia (see page 18) and is given morphin gr. 1/6 (0.0108 gm.) and atropin gr. 1/100 (0.00065 gm.) by hypodermic half an hour before the operation.

Technic.—The patient is first etherized in the usual way and is placed upon the operating-table with his head hanging over the edge in which position it is supported by an assistant (see Fig. 452), the patient's mouth being held open by a mouth-gag. The Jackson laryngoscope is then introduced (for the technic of this see page 449), and, with the epiglottis pulled forward by the beak of the instrument so that a good view of the larynx is obtained, the tracheal catheter, wet in cold water, is inserted. No force should be employed in introducing the catheter, and, as soon as it is well in the larynx, the tubular speculum is removed. The catheter is then pushed forward until it meets a resistance which is generally the right bronchus. The catheter is then withdrawn 2 to 2½ inches (5 to 6 cm.) until the mark on the catheter is level with the patient's teeth. The operator must be certain that the catheter is in the patient's trachea and not in the esophagus. The catheter is finally fixed in place, and, after the apparatus is properly connected, the insufflation of the air and ether vapor is commenced. The vapor at first should be blown in under slight pressure, that is, about 10 mm. of mercury and then under higher pressure—15 to 20 mm. of mercury. The air current should be interrupted 5 to 6 times a minute by opening the vent for that purpose a second or two at a time. The anesthesia is pushed to complete muscular relaxation and abolition of reflexes, and, when the desired degree of narcosis is obtained, the dose of ether should be kept uniform, as the degree of anesthesia from a certain dose is practically stationary. At all times it should be seen that there is a free passage for air, and the tongue should not be allowed to fall back and produce any obstruction. A spasm of the glottis may in some cases be the cause of obstruction; if so, full anesthesia will relieve the condition. The color and respirations of the patient should be carefully watched, and, if the latter become shallow and infrequent, the anesthetic should be diminished.

For ordinary cases, the manometer is kept at 15 to 20 mm. of mercury. In operations on the thoracic viscera, the pressure will depend upon the distention of the lung desired; it should, however, never be higher than 50 mm. of mercury. If the catheter proves too small to keep the lung inflated when the thorax is opened, Meltzer recommends that pressure be made over the middle of the thyroid cartilage every few moments.

At the completion of the operation, the ether is discontinued and pure air is insufflated for a moment or two before the tube is withdrawn in order to remove as much of the anesthetic vapor as possible.

Anesthesia Through a Tracheal Opening.—In some operations upon the tongue, larynx, or pharynx it becomes necessary to administer the anesthetic through an opening in the trachea.

Apparatus.—For this purpose a Hahn or a Trendelenburg cannula is employed. These instruments consist essentially of a metal funnel, covered or filled with gauze upon which the anesthetic is dropped, and connected with a special tracheotomy tube by means of a piece of tubing. The tracheal tube of the Hahn apparatus is

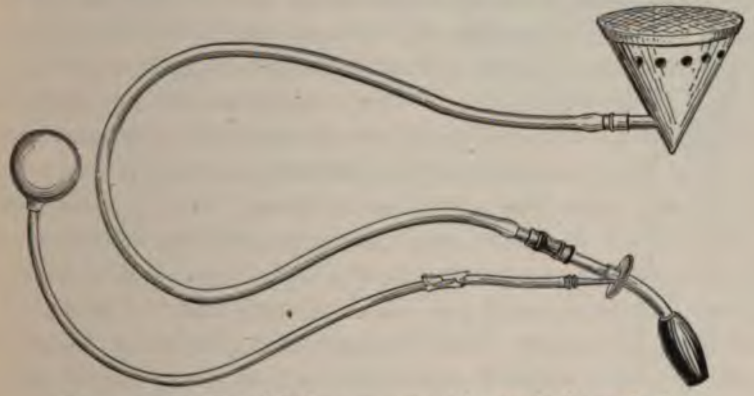


FIG. 31.—The Trendelenburg apparatus for tracheal anesthesia.

surrounded by a flat dried sponge fastened securely in place, which, when wet, swells up and acts as a tampon, preventing blood from descending along the side of the tube. The same result is obtained with the Trendelenburg instrument (Fig. 31) by surrounding the

FIG. 32.—Showing the tracheal cannula in place.

lower portion of the cannula with a delicate air bag, which is gently inflated by compressing an inflating bulb supplied with the apparatus as soon as the tracheotomy tube is in place (Fig. 32).

Technic.—A preliminary tracheotomy is first performed (see page 447). The tracheal tube is then introduced into the opening, care being taken to see that the tamponade is effective, so as to prevent blood from entering the trachea. The tube to convey the anesthetic vapor from the funnel is then attached to the tracheal cannula, and the anesthetic is administered by dropping chloroform on the gauze of the inhaler.

Intravenous General Anesthesia.—Burkhardt in 1909 devised a method of producing general narcosis by administering ether intravenously in normal salt solution. Since then the method has been given a trial by a number of operators abroad and by a few in this country, but it has never become popular. From our present knowledge it is not probable that intravenous etherization will ever supplant the inhalation method as a routine. In certain operations, as those about the face, upper air passages, mouth, tongue, and neck, the absence of a mask near the field of operation and the even and uninterrupted anesthesia that is produced by this method is of undoubted advantage. Furthermore, the stimulating effect of a continuous saline infusion makes the method one of special value in ill-nourished, debilitated, or cachectic subjects On the other hand, there are the dangers of sepsis, thrombosis, embolism, and pulmonary edema if all the details of the technic are not carefully observed. When properly administered it is claimed that the anesthesia is rapidly obtained, that there is seldom any stage of excitement, that pulmonary irritation and nausea are absent, and that the recovery from the anesthesia is prompt and without discomfort. According to Kummell intravenous anesthesia is contraindicated in the presence of arterio-sclerosis, myocarditis, and general plethora.

In the early cases in which this method was employed, an interrupted form of anesthesia was given, that is, a quantity of ether solution sufficient to get the patient under was infused and the flow was then stopped, the infusion being continued when the patient commenced to show signs of coming out. The uneven anesthesia this produced and the fact that some cases of venous thrombosis and pulmonary embolism were reported as a sequel led to the adoption of a continuous infusion as the only safe method.

Apparatus.—An apparatus, such as described by Rood (*British Medical Journal*, Oct. 21, 1911), which will permit a continuous but slow flow of solution is required.[1] The apparatus should consist of (1) a glass reservoir with a capacity of 3 pints (1500 c.c.) supported upon a stand at a height of 8 feet (240 cm.) from the floor, (2) a glass

[1] In this country an apparatus designed by Dr. Honan is manufactured by the Kny Scheerer Co. of New York.

dripping chamber with a capacity of 8 ounces (250 c.c.), and (3) a warming chamber surrounded by a jacket containing water at a temperature of 100°F. (38°C.) (Fig. 33). When the apparatus is working the solution drips from the pipette leading from the reservoir into the indicator, the lower half of which is filled with solution and the upper half with air. A screw pinch cock below the indicator controls the rate of flow, the rate at which the solution drips from the pipette being an index of the rate at which it will enter the vein.

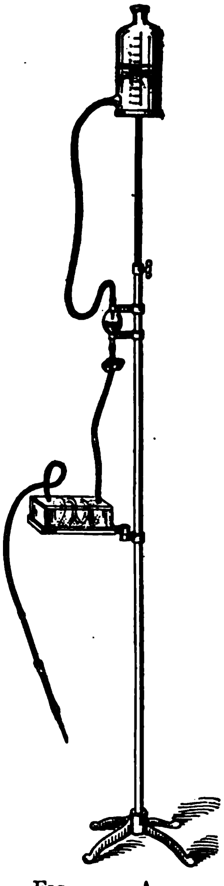


FIG. 33.—Apparatus for intravenous anesthesia.

Instruments.—The operator will require a scalpel, a pair of blunt-pointed scissors, thumb forceps, an aneurysm needle, a needle holder, curved needles with a cutting edge, and No. 2 plain catgut (Fig. 34).

Solutions.—Ether is used in a 5 per cent. solution in normal salt solution by Burkhardt and in a 7.5 per cent. solution by Rood. Hedonal and paraldehyde have also been used with success. Fedoroff employs a 0.75 per cent. solution of hedonal in normal salt solution. The objection to the use of this drug is the length of time the hypnotic effect persists when large amounts are administered. Noel and Souttar (*Annals of Surgery*, January, 1913) first called attention to the anesthetic effects of paraldehyde when given intravenously. Honan and Hassler (*Medical Record*, Feb. 8, 1913) employ paraldehyde 2½ per cent. and ether 3 per cent. in normal salt solution.

Temperature.—The solution should be given at a temperature of about that of the body.

Quantity.—The amount of solution used will depend upon the age and condition of the patient and the length of anesthesia. Usually from 6 to 25 ounces (200 to 800 c.c.) of solution will be required.

Preparations of Patient.—It is advisable to give the patient hypodermically an hour before the operation morphin gr. 1/6 (0.0108 gm.), atropin gr. 1/100 (0.00065 gm.), and scopolamin gr. 1/100 (0.00065 gm.). All clothing should be removed from the arm chosen for the infusion and the arm should be bandaged to a well-padded splint so that the infusion cannula cannot be disturbed by movements of the patient.

Site of Injection.—One of the most prominent veins at the bend of the elbow—preferably the median basilic—is chosen for the infusion.

Asepsis.—The solution must be absolutely sterile. The instruments are sterilized by boiling. The site for the infusion is shaved and the skin is sterilized by painting with tincture of iodin.

Technic.—A tourniquet is placed about the arm above the site of injection. Under infiltration anesthesia with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution the median cephalic or the median basilic vein is exposed through a small incision. The

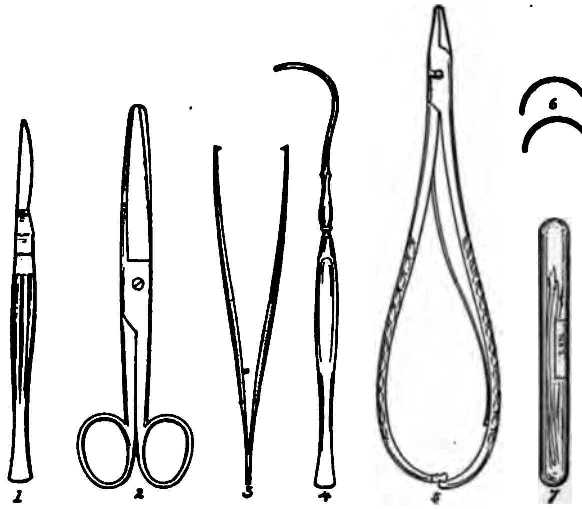


FIG. 34.—Instruments for intravenous anesthesia. 1, Scalpel; 2, blunt-pointed scissors; 3, thumb forceps; 4, aneurysm needle; 5, needle holder; 6, curved needles; 7, No. 2 plain catgut.

distal portion of the vein is ligated, the proximal portion is incised, and the cannula inserted *with the solution flowing* as described under intravenous infusion (page 170). *The constriction is then removed from the arm* and the ether solution is allowed to run, at first fairly rapidly until anesthesia is induced, and then drop by drop, being guided by the depth of anesthesia.

It usually requires from four to ten minutes to induce full anesthesia, using 3 to 6 ounces (100 to 200 c.c.) of solution. After anesthesia is obtained the flow of solution should be at about the rate of 40 to 60 drops per minute. Should edema of the eyelids appear at any time, the infusion should be temporarily stopped.

During the anesthesia the anesthetist must take the same precautions to maintain unobstructed air passages as with inhalation anesthesia.

At the completion of the operation the cannula is removed, the vein ligated with catgut, and the wound sutured. A sterile dressing is then applied. If a large quantity of solution has been infused, it is a wise precaution to have that patient's position in bed changed from time to time, otherwise edema of the lungs or of dependent portions of the body may develop.

Rectal Anesthesia.—It consists in producing narcosis by means of warm ether vapor slowly forced into the rectum. This method was employed in 1847 by Roux. Later, in 1884, it was taken up by Mollière and in this country by Weir and Bull, but it never came into general use. In the early cases colicky pains, diarrhea, bloody stools, and painful distention of the intestine were frequently observed. These symptoms, no doubt, were in many instances due to faulty methods of administering the anesthetic, and with the improved technic of Cunningham and others the method has given better results.

Though it cannot be said to be free from risks, rectal anesthesia has a definite place among the methods of anesthetizing at our disposal. Its greatest field of usefulness is in cases of extreme pulmonary or bronchial involvement and empyema, and in operations about the face, mouth, and larynx, where other means of anesthesia are unsuited. To the former class of cases it is especially suited on account of the absence of pulmonary or bronchial irritation from the ether. While it is true that the greater part of the ether is eliminated from the lungs, the direct irritation of concentrated vapor is overcome, as is shown by the absence of the bronchial secretion, cough, etc. The method also has the advantage of requiring but little ether to induce and maintain anesthesia, and there is practically no stage of excitement or postoperative nausea and vomiting. On the other hand, the induction of narcosis is slow, and, in some cases where the absorptive power of the rectum is limited, sufficient of the drug is not taken into the system to keep the patient under, so that other means of anesthetizing must be utilized. It is not a suitable method to employ in abdominal operations on account of the distention produced, nor should it be used if the intestines are inflamed or their walls weakened.

Apparatus.—A simple apparatus consists of the following: A wash bottle to hold the ether, about 8 inches (20 cm.) high and 4 inches (10 cm.) in diameter, supplied with a tight stopper in which are two perforations. Through one of these openings a glass tube leads to the bottom of the bottle, and through the other a glass tube, cut off flush with the under surface of the stopper, leads out. A double cautery bulb is attached to the afferent tube by a piece of rubber tubing, while to the efferent tube is connected a piece of rubber tubing leading to a plain rectal tube, a glass bulb being interposed between the rectal tube and the rubber tubing to catch any condensed ether vapor and prevent it from entering the rectum. The efferent tube is opened or closed by means of a small pinch cock. In addition, a short rubber exhaust tube is connected to the efferent tube by means of a Y shaped glass tube and is likewise supplied with a

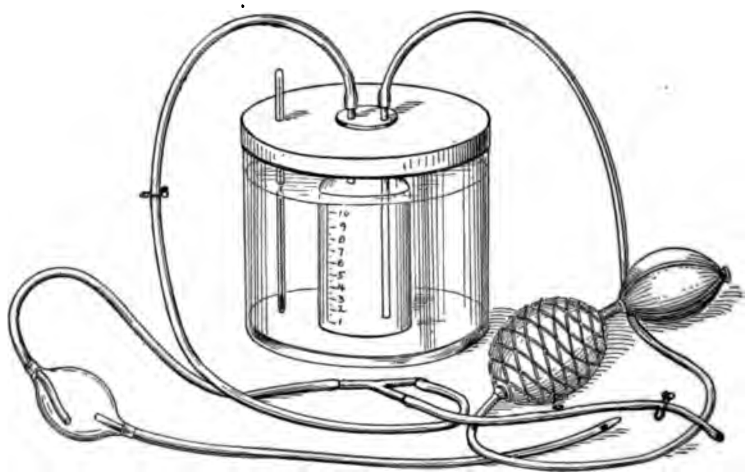


FIG. 35.—Apparatus for rectal anesthesia.

pinch cock. The free end of the exhaust tube is placed in a bottle of water in order to readily recognize the escape of gas from the rectum when the exhaust is opened. Both the afferent and the efferent tubes should be of sufficient length to permit the apparatus to be moved to a distance from the patient if necessary. The ether bottle is surrounded by a metal container holding warm water. This should be kept at a temperature of about 90°F. (32°C.), but not much above, as the ether will boil at 96°F. (35°C.). A thermometer should be provided for the purpose of regulating the temperature. By compressing the cautery bulb air is forced into the ether through the long tube and leaves the apparatus saturated with warm ether vapor.

More elaborate forms of apparatus have been devised, such as

Sutton's, in which oxygen takes the place of air as a vehicle for the ether vapor and the degree of distention of the bowel is controlled by means of a manometer.

Preparation of the Patient.—A thorough cleansing of the bowels is absolutely necessary, otherwise absorption cannot take place and the first essential of the anesthesia is defeated. A cathartic is given to the patient the night before the operation, and on the following morning a colonic irrigation, followed by an ordinary soapsuds enema an hour before the operation, complete the preparations.

Technic.—The patient lies upon the table with one thigh elevated upon a sand-bag so as to afford room to insert the tube, etc. The bottle is filled about two-thirds with ether, leaving one-third of its capacity for vapor, and the apparatus is tested to see that it works properly. The rectal tube, well lubricated, is inserted 8 to 10 inches (20 to 25 cm.) within the bowel, and the ether vapor is forced in by means of gentle compressions of the rubber bulb every five to ten seconds. As the rectum becomes distended, the exhaust tube is opened and the clip on the tube leading from the ether chamber is closed to permit the gases already present to escape, otherwise the absorption of the vapor is interfered with; on complaints of distention, the superfluous vapor must, likewise, be allowed to escape. The exhaust tube must also be opened when violent coughing occurs, otherwise the rectal tube is liable to be expelled.

In from three to five minutes the odor of the drug will be distinguished in the patient's breath, and the patient soon begins to feel drowsy. The breathing, at first rapid, becomes regular and finally slightly stertorous, and the patient then passes into complete surgical narcosis, generally without the preliminary stage of excitement. The time necessary for this varies from five to fifteen minutes, according to the patient and the ability of the bowel to absorb. The anesthetic cannot be pushed, however, for the more the bowel is distended beyond a certain point the less is the absorption. As soon as anesthesia is complete it may be maintained by gently squeezing the bulb every minute or so. The same signs as to the depth of anesthesia, condition of the patient, etc., should guide the anesthetist as in the administration of pulmonary anesthesia, and the same precautions about keeping the tongue and the jaw forward should be observed. At the completion of the anesthesia, the rectal tube is disconnected from the apparatus, and, by gentle abdominal massage of the colon, the vapor remaining unabsorbed is forced out. This should be followed by a cleansing enema.

Oil-ether Colonic Anesthesia.—Gwathmey of New York has developed a method of rectal anesthesia by means of a mixture of olive oil and ether injected into the rectum to which he applies the name "oil-ether colonic anesthesia" (*N. Y. Medical Journal*, Dec. 6, 1913). This form of anesthesia has been used by its originator in a large number of cases and is a most valuable addition to the field of rectal anesthesia. The method is especially useful in operations about the head and neck, though it has been used in a great variety of operations. According to Gwathmey, it is contraindicated in colitis, hemorrhoids, fistula in ano, or other pathological conditions of the lower bowel, and in most cases where ether is contraindicated. Under this form of anesthesia there is complete relaxation, the reflexes remain active, and there is an absence of nausea. For from one to three hours following the anesthesia there is a pain-free period. So far no diarrhea or bloody stools or other untoward effects have been observed.

Apparatus.—The necessary equipment is very simple, consisting of a catheter and funnel for introducing the oil and ether mixture and two small rectal tubes for emptying and irrigating the colon.

Solutions Used.—A mixture of ether in olive oil is employed in the following strengths: For cases over fifteen years of age a 75 per cent. mixture; for children of from six to twelve years of age a 55 to 65 per cent. mixture; and for those under six years of age a 50 per cent. mixture.

Quantity.—One ounce (30 c.c.) of the mixture is administered for each 20 pounds (8 K.) of weight.

Preparations of Patient.—The usual preparations as for any anesthetic are carried out, and the colon is irrigated until the fluid returns clear. For adults a preliminary hypodermic injection of 1/8 to 1/4 gr. (0.0081 to 0.0162 gm.) of morphin and 1/100 gr. (0.00065 gm.) of atropin is given half an hour before operation and at the same time 5 gr. (0.3 gm.) of chloretone in 2 drams (8 c.c.) of olive oil and 2 drams (8 c.c.) of ether is introduced into the rectum. For children preliminary medication is generally omitted, as the weaker solutions are not irritating to the bowel.

Technic.—The anesthetic mixture is introduced into the bowel while the patient is in bed in the Sims position. The small catheter, well lubricated, is inserted a few inches into the rectum and the desired quantity of solution, depending upon the weight of the patient, is slowly poured into the funnel. About five minutes should be consumed in introducing 8 ounces (250 c.c.), the quantity generally required for an adult of ordinary size. The tubes should be left in place until the patient is partially unconscious. In from five to twenty minutes the anesthesia is established. During the anesthesia the anesthetist should keep the air passages free and the jaw well forward and should keep careful watch over the general condition of the patient Should the patient become too deeply under the influence of the anesthetic, shown by cyanosis, shallow, embarrassed or stertorous respirations, a rectal tube is introduced and 2 to 3 ounces (60 to 90 c.c.) of solution are withdrawn.

At the completion of the operation, two small rectal tubes are passed well up in the bowel and the latter is irrigated with cold water soapsuds, the injection being made through one tube while the second one permits the escape of the washings. Two to 3 ounces (60 to 90 c.c.) of olive oil are then injected into the rectum to be retained by the patient, and the tubes are withdrawn.

Scopolamin-morphin Anesthesia.—Hypodermic injections of scopolamin and hyoscin (which is claimed to be chemically the same) have been used quite extensively in combination with morphin to produce anesthesia. From the number of deaths reported from this combination when used in large enough quantities to produce anesthesia unaided, it would appear to be a very dangerous form of anesthesia, and up to the present time it has a higher death percentage than chloroform or ether. In small doses, however, hyoscin and morphin may be used with good results as an adjunct to local or general anesthesia. In such cases they can be given as follows: Hyoscin, gr. 1/100 (0.00065 gm.) and morphin, gr. 1/6 to 1/4 (0.0108 to 0.0162 gm.) by hypodermic, one hour to two hours before operation. This combination is more efficacious than morphin alone, and has the effect of producing a drowsy state and even sleep, which may last five to six hours after the operation. It is contraindicated in patients with heart disease or when there is a tendency to pulmonary edema. In the young and the aged hyoscin and morphin should be used with great caution.

ACCIDENTS DURING ANESTHESIA AND THEIR TREATMENT

The accidents and dangers that may arise during the administration of anesthetics are connected with the respiratory or circulatory systems and include asphyxiation, respiratory paralysis, and cardiac paralysis. Theoretically, the dangers of nitrous oxid, ether, and ethyl chlorid are those to be expected from failure of the respiratory centers, while the accidents from chloroform narcosis are primarily those occurring as the result of the depressing effects of the drug upon the circulation. Practically, however, in severe cases failure of the respiratory center and circulatory paralysis, if not coincident, precede or follow one another in such rapid sequence that it is often impossible to distinguish between the two or to determine which is the primary cause, and treatment must be directed toward both conditions.

Accidents may be avoided in the great majority of cases if proper precautions are taken beforehand in the preparation of the patient and due care is observed in the administration of the anesthetic. These points have already been considered, but it may not be out of place to emphasize by repetition the most important of them. Never allow the patient to have food within three hours of the time of anesthesia. See that all foreign bodies, false teeth, plates, etc., which might fall into the throat and obstruct the respiratory passages are removed beforehand, and that tight bandages or clothing that might constrict the neck or chest are loosened. When relaxation occurs, turn the patient's head to one side to allow mucus and saliva to flow from the mouth, and see that the tongue does not fall back in the throat and act as an obstruction. The anesthetist must devote his entire attention to the anesthesia, taking particular care to watch the respirations, at the same time not forgetting to give due attention to the pulse, the condition of the eye reflexes, and the general appearance of the patient. The assistant chosen for this duty should be a person of large experience in the administration of anesthetics so that he may be competent to interpret danger signs before they proceed too far. If there is any doubt as to the meaning of a sudden change in the patient's condition or of unusual symptoms, it is always better to err on the safe side and allow the patient to partly recover than to induce a deeper, and what may be a dangerous, state of narcosis.

Asphyxiation.—It is characterized by a moderate cyanosis or a marked lividity of color and gasping respirations. It may be only transient, or it may become progressively worse and severe. Such a condition should be promptly treated by removal of the cause which will be found to be some one of the following: coughing, struggling, locking of the jaws, awkward position of the patient, an improper holding of the cone, the so-called "forgetfulness to breathe," falling back of the tongue and epiglottis, obstruction to the air passages by blood, mucus, saliva, or foreign bodies, partial or complete occlusion of the nose from deformities of the bones and nasal growths, or from collapse and falling in of the alæ nasi during inspiration under deep narcosis.

Treatment.—Cyanosis due to coughing or struggling may be overcome by simply removing the inhaler and permitting the patient to get a breath of fresh air. When the position of the patient is

FIG. 36.—Method of holding the jaw forward.

responsible, it should be corrected without delay. If the cyanosis be due to obstruction or partial occlusion of the nares, the mouth should be kept sufficiently open by means of a mouth-gag to permit the entrance of the necessary amount of air. "Forgetting to breathe," is met by removing the inhaler and, after waiting a moment, the patient will in the majority of cases take a breath. If this is not sufficient, a sharp slap upon the sternum with a wet towel or a momentary compression of the sternum is frequently all that is necessary. Failing by these means, the jaws should be held apart and rhythmic traction exerted upon the tongue to excite a reflex inspiration.

FIG. 37.—Showing the method of drawing the tongue and epiglottis forward.

Obstruction caused by the falling back of the tongue and epiglottis is corrected by properly holding the lower jaw forward (Fig. 36), or by traction upon the tongue by means of tongue forceps or a silk suture. An effective temporary means for overcoming obstruction from this cause is to pass the index finger into the mouth over the base of the tongue and hook it forward together with the epiglottis (Fig. 37). In persistent cases the use of a pharyngeal breathing tube is of the greatest aid in obtaining an unobstructed airway. This mechanical device (Fig. 38) consists essentially of a hollow rigid rubber or metal tube curved to conform to the shape of the base of the tongue through which the patient breathes when the tube is placed in the pharynx.

FIG. 38.—Connell's pharyngeal breathing tube.

When the asphyxial symptoms are due to obstruction by collections of fluid in the throat or foreign bodies, the patient's head should be turned to one side, the jaws forced open, and the air passages cleared. Solid bodies may be removed by the finger or forceps. If this is not possible, tracheotomy (page 447) should be performed without hesitation.

FIG. 39.—Artificial respiration (inspiration). Note the assistant's hands ready to make counterpressure over the lower portion of the chest.

In any case of asphyxia, if the cyanosis is severe and grows progressively worse in spite of the above line of treatment, the anesthetic and the operation should be discontinued while artificial respiration, combined with inhalations of oxygen, is carried out. This is effectively performed by a combination of the Sylvester and Howard methods, or by the use of Meltzer's insufflation apparatus or some one of the machines made especially for performing artificial respiration. Any of the methods of artificial respiration are useless, however, as long as there is any obstruction in the air passages, and these should always be first cleared out, as previously directed.

In the absence of special apparatus, artificial respiration is carried out as follows: The foot of the operating-table is raised upon a stool and the patient is slid down so that the head hangs partly over the edge. The anesthetist, standing at the patient's head, takes a firm hold just below the elbows and draws the arms upward and outward until they are very nearly perpendicular above the head (Fig. 39). This thoroughly expands the chest and produces an inspiration. The arms are maintained in this position for

FIG. 40.—Artificial respiration (expiration). The operator brings the patient's arms firmly against the chest while the assistant makes counterpressure.

a second or two, to allow the air to thoroughly expand the lungs. Expiration is produced by the reversal of the above maneuver, bringing the arms downward with firm pressure against the chest wall, while at the same time an assistant, with palms of the hands outstretched over the margins of the ribs and epigastrium, presses upward toward the diaphragm (Fig. 40). This counterpressure prevents the effects of the expiratory maneuver being lost upon the diaphragm and abdominal viscera. After another second or so, the assistant suddenly releases the lower portion of the chest and at the same time elevation of the arms is again performed. The movements producing artificial respiration should be made as nearly as possible at the rate of normal respiration, certainly not over twenty times a minute. As an adjunct to the above, forcible dilatation of the sphincter ani may be performed for the purpose of exciting reflex inspiration.

A favorable response to treatment is denoted by a gradual return of the natural color, at first feeble gasps and then stronger attempts at respiration, and a return of the pulse at the wrist. If, after five or ten minutes, there is no response to the treatment, the prognosis is exceedingly bad, but the artificial respiration should be persisted in for at least half an hour. Deaths from asphyxia alone during anesthesia can be prevented in nearly all cases by following the suggestions and the treatment above described.

Respiratory Paralysis.—This is a more serious condition. In the first stages of anesthesia it may be due to a spasm of the glottis, diaphragm, or respiratory muscles through reflex irritation from overstimulation of the nasal branches of the trigeminal nerve, when large quantities of ether are suddenly poured upon the inhaler or the strength of the drug is too rapidly increased. The patient suddenly stops breathing and becomes cyanosed, but the pupillary reaction remains and the pulse is usually good; and, if artificial respiration be promptly performed, the danger is overcome.

When the condition occurs in the later stages, after deep narcosis, it is the result of too much anesthetic, producing paralysis of the medullary centers, and is a more dangerous condition. The pupils suddenly dilate and fail to respond to light, and the conjunctival reflex is lost; the respirations become progressively weaker and more superficial, and finally stop. The patient has an ashen-gray look, lies in a state of extreme relaxation, and the heart ceases to beat after a few seconds.

Treatment.—This is a condition requiring prompt and energetic treatment. The anesthetic and the operation should be immediately stopped and every effort made to revive the patient. It should be seen that there is no impediment to the free entrance of air into the respiratory passages, and then the foot of the table should be elevated upon a stool, while artificial respiration is performed after the manner above described (page 69).

Cardiac Paralysis.—Syncope may occur during anesthesia from chloroform or ether, but is more apt to be produced by the former. It is the most serious of all the anesthetic accidents. From the fact that a large proportion of the deaths from chloroform anesthesia occur in the early stages, when only a small quantity of the anesthetic has been given, it has been contended that fright, producing vasomotor paralysis, is the cause. There is no doubt that fright or struggling during the early stage of anesthesia is sufficient in some cases to cause dilatation of the heart and vasomotor paralysis, especially if the individual is already affected with degenerative changes in the heart, or is suffering from severe anemia or shock. But fatal syncope has occurred in many cases after only a few inhalations of chloroform, when the patient was in strong physical condition and exhibited no fear of the operation whatever. Such cases and those occurring after full anesthesia has been established can only be ascribed to the toxic action of the drug from sudden overdosage.

When circulatory paralysis occurs, the pulse first becomes weak and irregular, and then feeble and fluttering; the skin becomes pallid, the pupils dilate and remain fixed, and finally the heart stops entirely. Irregular attempts at breathing may continue for a few moments after cessation of the heart-beat. Postmortem examination reveals a heart dilated and overcharged with blood, and general dilatation of the capillaries and veins, especially in the abdomen, showing that the patient has practically bled into his own vessels, and nearly all the blood is withdrawn from the cerebral centers.

Treatment.—The treatment of such a condition should consist in artificial respiration and in adopting means to overcome the cerebral anemia and to empty the engorged heart. In the presence of signs pointing to syncope, the treatment should be instituted promptly, without waiting for cessation of respiration. The foot of the table should be immediately elevated to an angle of 45 degrees, so that the patient is in an exaggerated Trendelenburg position. Children may be inverted by simply holding them by the heels. Combined with position, compression of the limbs and abdomen by means of bandages may be employed to force the blood from the dilated capillaries and splanchnic areas. Artificial respiration and oxygen inhalations should be employed from the start, as already described. Massage of the heart for the purpose of emptying it of the engorged blood should also be practised.

External cardiac massage may be readily carried out with the hand placed over the precordium by elevating and depressing the wrist-joint at about the rate of the normal beat. In abdominal operations the heart may be massaged by grasping it between the thumb and forefinger, through the relaxed diaphragm, and alternately compressing and relaxing it twenty to forty times a minute. Direct cardiac massage can be practised through an incision in the fourth intercostal space and opening the pericardium. This operation has been successfully performed in some seemingly hopeless cases, and is worthy of trial.

Cardiac stimulants, such as strychnin, are of little use until the circulation is reestablished; a hypodermic of some rapid acting drug, however, as adrenalin chlorid, 5 to 20♏ (0.30 to 1.25 c.c.) injected into a vein, camphorated oil, 20♏ (1.25 c.c.), whisky, 20♏ (1.25 c.c.), etc., may be tried with better chances of success. An intravenous infusion of hot salt solution, combined with 15 to 30♏ (1 to 2 c.c.) of a 1 to 1000 solution of adrenalin chlorid injected drop by drop by means of a hypodermic directly into the rubber tube of the infusion apparatus while the solution is flowing, should be given by an assistant while the other means of treatment are being carried out. According to Crile's experiments, an intraarterial infusion of adrenalin in salt solution injected toward the heart (see page 177) has more effect in raising blood-pressure and would be a more rational form of treatment. When there is no improvement within ten or fifteen minutes, the case is usually hopeless.

THE AFTER-EFFECTS OF ANESTHESIA

Vomiting.—This is the most frequent postanesthetic complication. The best way to avoid it is by careful preparation of the patient before anesthesia and a skilful administration of the anesthetic. In some cases, however, it occurs in spite of all that can be done, and may be persistent. That from chloroform is usually more severe and more difficult to treat.

For the ordinary vomiting, inhalations of vinegar, ice in small quantities by mouth, or very hot water in small doses (teaspoonfuls) are the common remedies. The latter is most efficient, serving to dilute the mucus and wash out the stomach contents. Fifteen to 20 gr. (1 to 1.3 gm.) of bicarbonate of soda in a glass of warm water is also recommended. Likewise pure olive oil in ounce doses has been successfully employed. Cerium oxalate, gr. v (0.3 gm.), bismuth subnitrate, gr. v (0.3 gm.), acetanilid in 1 gr. (0.065 gm.) doses every one-half hour until 8 gr. (0.5 gm.) have been taken, morphin, or small doses [1/12 gr. (0.0054 gm.)] of cocain every half hour up to 1 gr. (0.065 gm.) may be used in the more troublesome cases. If the condition becomes persistent and severe, lavage of the stomach (see page 547) should be carried out and repeated as often as necessary. In fact, it is the best means of preventing vomiting in any case, and some surgeons employ it as a routine while the patient is still on the operating-table before becoming conscious.

Respiratory Complications.—These are seen more frequently after ether than chloroform, and include edema of the lungs, bronchitis, bronchopneumonia, and lobar pneumonia. They should be treated along the lines ordinarily followed in such cases. Lung complications are especially liable to follow anesthesia where a diseased condition is already present, as bronchitis, emphysema, or tuberculosis, or in the aged or feeble.

To avoid as far as possible such complications, the mouth, nose, and teeth should be carefully cleansed before anesthesia, the apparatus employed for administering the anesthetic should not be carried from one patient to another without sterilization, and due care should be observed while administering the anesthetic to prevent aspiration of fluids or vomitus. As a further precautionary measure, the patient should always be carefully protected against chilling, both during the anesthesia and while he is being removed to his bed.

Renal Complications.—Temporary albuminuria and casts are not uncommon after both ether and chloroform, and, if a diseased condition of the kidneys be present beforehand, it is much aggravated, though of the two drugs chloroform exerts less of an irritant action. Scanty excretion of urine with actual suppression and hematuria are occasionally seen. Such a condition should be treated by mild diuretics, cathartics, and saline rectal irrigations.

Postoperative Anesthetic Paralyses.—These are mostly peripheral from pressure upon some nerve during the period of unconsciousness, though paralysis of central origin may take place as the result of cerebral embolism or hemorrhage, especially in those with high arterial tension and degenerative changes in the blood-vessels. Peripheral paralysis may affect the arm, leg, or face. Injury to the musculospiral nerve from pressure by the edge of the table if the arm is allowed to hang down, and injury to the brachial plexus from pressure between the clavicle and first rib, or by the head of the humerus when the arms are fastened above the head are the most frequent lesions.

Delayed Poisoning.—Certain of the late deaths occurring after anesthesia, that were formerly supposed to be due to sepsis, shock, fat embolism, etc., are now known to be due to an acid intoxication. This condition, variously designated as cholemia, acidosis, acetonuria, and acid intoxication, most frequently follows chloroform narcosis and is more common among children. The symptoms do not appear until the patient has recovered from the anesthesia developing in from 10 to 150 hours (Bevan and Favill).

The condition is characterized by persistent vomiting, jaundice, sweetish breath, rapid pulse, Cheyne-Stokes respiration, in some cases extreme restlessness and excitability, in others delirium, convulsions, and coma. In some the temperature is exceedingly high, in others it is subnormal. Death in fatal cases occurs within three to five days. At postmortem there is found a condition of fatty degeneration of the kidneys, heart muscle, and liver, most marked in the latter, and at times actual necrosis of the liver is seen. This condition is the result of the destructive action of chloroform upon the cells. The insufficiency of the liver results in the accumulation of toxins, and acetone, diacetic acid, and oxybutyric acid appear in the blood and urine as by-products.

Bicarbonate of soda given by mouth in mild cases, and in salt solution by rectum, by hypodermoclysis, or intravenously in the severer ones, is a most valuable remedy for this condition. For intravenous injection 1½ ounces (45 gm.) of bicarbonate of soda is dissolved in 1 quart (liter) of normal salt solution [salt ʒ ii (8 gm.) to the quart (1000 c.c.) of water], and ½ pint (250 c.c.) is administered every three or four hours until the entire amount is injected. Glucose is also frequently employed. It may be given in doses of ½ to 1 dram (2 to 4 gm.) to children and ½ ounce (15 gm.) to adults by mouth, rectum, or intravenously. In addition, free elimination by the skin should be encouraged, and the bowels should be kept freely open.

THE AFTER-TREATMENT OF CASES OF GENERAL ANESTHESIA

Before moving a patient from the operating-table to his bed, it should be seen that he is well protected and properly wrapped in warm dry blankets. During the process of moving, care should be taken not to elevate the head or chest. The recovery room should be well ventilated, but the patient should be protected from any draughts. The bed should have been previously prepared and well warmed by means of hot-water bags, which are to be removed, however, when the patient is received, unless there is some special indication for their use, as in shock or collapse. Hot-water bags should always be covered with flannel and care should be taken to see that they are not hot enough to burn the patient.

The best position for the patient is flat upon the back, with the head level or a little lower than the body, and with the face turned to one side. If vomiting occurs, the patient should be turned slightly to one side and the vomitus received in a basin, after which the mouth should be wiped out. Frequent rinsing of the mouth with warm water may be practised if the patient is conscious, and will be found to be very grateful. The patient should be watched by an attendant until consciousness returns, for, if left alone, he may choke from mucus or vomited material collecting in the throat, or attempt to sit up, remove his dressings, or in other ways do himself harm. Delirious patients should be gently restrained, but not tied in bed. Inhalations of oxygen or vinegar, and washing the patient's face in cold water, are of aid in arousing to consciousness.

FIG. 41.—The ether bed.

The patient should not be allowed to sit up for at least six hours. Small quantities of hot water or cracked ice are given in the first few hours, but no food is allowed within six hours, and not then unless the patient has stopped vomiting. In cases of collapse, or for patients who are very weak, nutrient or stimulating enemata may be prescribed to sustain the patient until food can be taken. The first food taken by mouth should be liquid in character, consisting of broth, beef tea, or soup. If this is retained, other articles of soft diet should be added, until the ordinary diet is being taken. It is important to have the urine examined for several days after anesthesia, and after the use of chloroform special reference should be paid to detecting the presence of acetone or diacetic acid.

CHAPTER II

LOCAL ANESTHESIA

By local anesthesia is understood the abolition of pain sensation in a chosen region, without the production of unconsciousness. Analgesia is a more correct term to apply to this variety of anesthesia, but usage has so perpetuated the term "local anesthesia" that it will be employed in these pages.

The introduction of cocain by Koller, in 1884 first made possible local anesthesia as it is employed at the present time, previously, compression of the nerve trunks supplying the field of operation by means of a tourniquet, and the application of cold to the part, being the methods most frequently resorted to. A further impetus was given to the development of local anesthesia by the discovery that infiltration with cocain, or similar local anesthetics, into or around a nerve trunk in any part of its course effectually blocked the sensation in the region supplied by that particular nerve peripheral to the point of injection. The introduction by Schleich of the method of infiltrating the tissues with *weak* anesthetic solutions was another important step and one that made possible the safe employment of cocain in really extensive operations.

Through improvement in the technic of the methods of infiltration and nerve blocking much progress has been made in enlarging the field of local anesthesia until it can now be employed with entire success in a large number of major operations, as well as the usual minor ones. Indeed, it is safe to say that fully half the operations performed at the present time under general narcosis could be as satisfactorily carried out under local methods intelligently used.

In the choice between local and general anesthesia for any given case, the question to be decided is whether under local anesthesia pain sensibility can be entirely abolished and, at the same time, sufficient muscular relaxation be obtained to insure the proper performance of the procedures contemplated. If these conditions can be satisfactorily obtained, and if the operator possess the necessary experience and skill in its use, then local anesthesia should be offered to the patient, if for no other reason, simply to avoid the well-known unpleasant after-effects of general narcosis, and to obtain a less disturbed and more rapid recovery, regardless of whether the particular operation be classified as a major or a minor one.

Advantages and Disadvantages of Local Anesthesia.—There are certain advantages peculiar to local anesthesia that should be carefully considered when selecting the anesthetic in any given case. Most important is the absolute safety to the life of the patient when this form of anesthesia is employed with proper precautions. With the substitution of the weak for the old-time strong cocain solutions, and the discovery of the newer less toxic analgesics, together with a knowledge of the amount of these drugs that can be safely used, the dangers of poisoning may be disregarded.

Furthermore, under local anesthesia, shock is lessened, and the depression observed after the use of general narcosis is absent to a marked degree, so that this form of anesthesia becomes the method of choice when an anesthetic is required for those in collapse or with lowered vitality. This is especially true when the nerve-blocking method is employed, for it is well known that cocain or drugs with similar anesthetic properties injected into a nerve effectually blocks the passage of all shock-producing impulses along that particular nerve. As Crile puts it: "As no impulses of any kind can pass either upward or downward, there is no more shock in dividing the tissues, even the nerve trunks thus "blocked," than in dividing the sleeve of the patient's coat." The value of this principle is so well established that the injection of a local anesthetic into nerve trunks supplying a region of operation is frequently performed for the purpose of preventing shock even where general anesthesia is employed, as, for example, the preliminary blocking of the sciatic nerve in hip amputations and the preliminary infiltration of the field of operation, the so-called "anoci-association" of Crile.

Under local anesthesia the postoperative blood changes and the kidney, heart, and lung complications are all avoided, while the unpleasant after-effects that pertain to general anesthesia are reduced to a minimum. The avoidance of vomiting is especially important for the proper healing of wounds, and the prevention of such complications as hernia. A further advantage in operating under local methods is that the most favorable conditions for primary union are obtained, for, as gentleness in handling tissues is essential for the successful employment of this method of anesthesia, the minimum amount of trauma will be inflicted upon the tissues.

Another feature connected with an operation under local anesthesia is that it does away with the necessity for an anesthetist, and often of any kind of an assistant—a very important consideration under some circumstances.

In certain operations—hernia, for example—there is a distinct advantage in having the patient conscious, that he may demonstrate the protrusion by coughing. On the other hand, in some cases consciousness and the knowledge of what is going on is of distinct disadvantage, and in nervous or hysterical individuals it may become a contraindication, depending upon the control the operator has over his patient.

There is no doubt that it requires more time to operate under local than under general anesthesia, and that it necessitates the possession of patience and tact upon the part of the operator. As Matas observes, "it is this tax upon the operator's attention, and the vigilance required to keep the inhibitory powers of the patient under control, and the time consumed in the anesthetizing procedure that will prevent cocain and the local analgesics from gaining ascendency in the crowded amphitheaters of popular teachers where quick and brilliant work is expected by an impatient audience." This inconvenience to which the operator is subjected, coupled with the general unfamiliarity with the proper technic, probably accounts for the fact that the wide scope of local anesthesia is not more generally taken advantage of at the present time.

Suitable Cases.—Besides the minor surgical procedures, such as the incision of an abscess, exploratory puncture, removing small cysts, amputating toes or fingers, performing circumcisions, etc., major operations of any magnitude and extent may be performed, provided the region is capable of being anesthetized by infiltration or nerve blocking.

For the removal of practically all benign growths such as lipomata, wens, cysts, benign tumors of the breast, and for the removal of superficial isolated glands, local anesthesia is quite sufficient. Whether tuberculous glands of the neck should be attempted under local anesthesia will depend upon their extent. If we can be sure there are but one or two superficial glands, it may be readily done, but in the writer's opinion it is rarely possible to define the extent of these operations beforehand, and it is not an uncommon experience in apparently simple cases when the field of operation is thoroughly exposed to find a chain of matted glands requiring deep and wide dissection for their removal. For the same reasons, and because the limits of the disease are not well defined when the tissues are swollen by the infiltrated fluid local anesthesia is not as a rule suitable for the removal of malignant growths.

Amputations of any of the limbs may be performed if the large sensory nerves are properly blocked. By means of a preliminary co-cainization of the sciatic and anterior crural nerves, amputation of the leg has been often painlessly performed when a general anesthetic was contraindicated. The same principle applies to amputations of other limbs.

Many of the operations upon the superficial bones, such as wiring and plating fractures and rib resections, may be painlessly performed if the periosteum as well as the more superficial tissues are rendered insensible by proper infiltration. Thus fractures of the lower jaw, the clavicle, the olecranon, and the patella can readily be operated upon by local methods. The latter operation lends itself especially to local anesthesia on account of the superficial position of the bone and the scarcity of sensory nerves in that region.

For the majority of abdominal operations local anesthesia is not satisfactory. It is not that there is any difficulty in entering the abdominal cavity—this can be very readily done under careful infiltration of the various layers of the abdominal wall—but the trouble is in meeting the various complications that may be present. We know that the abdominal organs are insensible to pain, but the parietal peritoneum is most sensitive, especially if inflamed. The separation of adhesions and procedures that require dragging upon the mesentery are likewise painful. Exploratory operations and procedures, such as colostomy, gastrostomy, gastrotomy, simple drainage of the gall-bladder and appendiceal abscess, suprapubic cystotomy, suture of the intestines following typhoid perforation, appendicostomy, and *some* interval operations for appendicitis, requiring but little intraabdominal manipulation, can be readily performed without a general anesthetic; but when extensive manipulation is required, with the separation of adhesions necessitating more or less pulling upon the mesentery, local anesthesia is contraindicated. Furthermore, in abdominal surgery complete muscular relaxation is usually required to secure the necessary wide retraction, and this cannot always be obtained under local anesthesia.

Local anesthesia is ideal in the operation for inguinal hernia on account of the superficial location of the structures involved and the definite position and course of the sensory nerve trunks supplying the region of operation. Other forms of hernia may be operated upon by employing infiltration alone, but not with the entire satisfaction obtained in the inguinal variety. For strangulated hernia of any variety, local anesthesia should always be the choice. The additional strain of general anesthesia upon these patients, already toxic, frequently produces more depression than they can withstand, and, as there is no need for haste, abundance of time may be taken in attempts at restoration of gut of doubtful vitality, without adding a particle to the shock of the operation.

Tracheotomy, thyroidectomy, the ligation of blood-vessels, the repair of the perineum and cervix, and any of the operations about the scrotum, as those for castration, varicocele, or hydrocele, are all amenable to local anesthesia. Quite extensive operations about the rectum have been performed by some operators under local anesthesia, but for most of the work in this region thorough stretching of the sphincter ani is essential, and this cannot be performed painlessly by this method; for this reason it is unsuitable in the majority of cases. However, simple operative procedures, such as those for fissure, external and thrombotic hemorrhoids, and straight uncomplicated fistulæ are within the scope of local anesthesia.

By a skilful use of local anesthesia in the hands of one thoroughly familiar with the technic of infiltration and nerve blocking, this list may be considerably enlarged. Furthermore, it should not be forgotten that in many operations too painful for local anesthesia alone, the major portion of the operation may be performed under local methods, and then nitrous oxid gas or a small quantity of ether may be administered to tide the patient over the more painful procedures, thus avoiding a prolonged general narcosis.

Those cases in which local anesthesia is impracticable have been already indicated in a general way. In addition, for young children, for those who are greatly excited or hysterical, and for insane or delirious individuals, local anesthesia is generally contraindicated or at best it is very unsatisfactory on account of the difficulty of obtaining the necessary quietude.

Methods of Producing Local Anesthesia.—At the present time two classes of local anesthetics are recognized: (1) Agents which freeze the tissues, and (2) chemical anesthetics or analgesics, of which cocain is a type. Freezing of the tissues has a very limited field of usefulness—practically none in major surgery—and it is upon some of the analgesic agents that we have to rely largely.

The methods of employing anesthetics may be in turn divided into two: (1) Where the drug is used in such a way that the endings of the sensory nerves are paralyzed (terminal anesthesia); and (2) where the drug is brought in contact with a nerve trunk in some part of its course, thereby blocking the sensory conductivity of that particular nerve and rendering the area supplied by it devoid of sensation (regional anesthesia). To the first class belong the topical application of analgesic drugs to mucous membranes, and their injection into the tissues (infiltration anesthesia), though by this latter method a mixture of terminal and regional anesthesia is often produced; while regional anesthesia may be produced by the injection of analgesics *into* a nerve trunk (endoneural infiltration), *about* a nerve trunk (perineural infiltration), into the subarachnoid space (spinal anesthesia), or into the extradural space. Another method of producing local anesthesia, termed venous anesthesia, has lately been introduced by Bier, whereby the analgesic agent is injected into the venous system and is thus brought in contact with the nerve trunks and nerve endings. This is a combination of the terminal and regional methods of anesthesia.

Drugs Employed for Local Anesthesia.—Of the many local anesthetics cocain was the first employed and, being the most powerful of all local anesthetics, holds the most important place. In the early history of its development cocain was used in solutions as strong as 10 and 15 per cent., with the result that frequently a set of dangerous symptoms, and in some cases death, were the sequels. To avoid these untoward effects a number of drugs, as eucain B, tropacocain, stovain, alypin, novocain (procain), acoin, nirvanin, orthoform, anesthesin, subcutin, propasin, quinin and urea hydrochlorid, etc., which are less toxic, but have in varying degrees the same action as cocain, have been introduced as substitutes. Of these eucain B., procain (novocain), and quinin and urea are probably most frequently used.

Cocain.—When applied to the unbroken skin it is without effect, but in contact with mucous membranes it completely deadens sensibility within a few moments. Injected into the tissues, cocain produces anesthesia within the area of contact; when injected into or about a sensory nerve, it is rapidly absorbed and produces complete insensibility in the whole distribution of the nerve peripheral to the point of injection.

Solutions of cocain should always be freshly prepared at the time of operation, as it is well known that they are prone to decompose, and in a short time become capable of producing suppuration. A medium isotonic with the fluids of the body, as normal salt solution, is the best for dissolving the cocain. Such a solution, producing neither swelling of the tissues, as water does, nor shrinkage of the cells, as is the case with the more concentrated saline solutions, has no injurious effects upon the tissues. The effectiveness of the solution is also increased by using it warm.

As solutions of cocain will not stand prolonged boiling, the salt or tablet should be previously sterilized by dry heat. An efficient method is to place the cocain in a small test-tube plugged with cotton, and then to sterilize it by means of dry heat at a temperature of 300° F. for fifteen minutes. Several firms[1] prepare hermetically sealed glass tubes of sterilized salt and cocain according to Bodine's formula, each tube containing 2⅘ gr. (0.18 gm.) of sodium chlorid and 1 gr. (0.065 gm.) of cocain muriate. The contents of one of these tubes dissolved in an ounce (30 c.c.) of sterile water gives approximately a 1 to 500 solution of cocain in normal salt solution. Alkalis render cocain inert. For this reason soda should not be put in the water in which the syringes, needles, and solution glasses are boiled.

Solutions of cocain used in the following strength will be found amply strong for the purpose for which they are recommended. For anesthetizing the skin and for perineural injections, a 1 to 500 (⅕ of 1 per cent.) solution; for deeper infiltration, a 1 to 1000 (1/10 of 1 per cent.) solution; for massive infiltration, a 1 to 3000 (1/30 of 1 per cent.) solution; and for endoneural injections, 10 to 30♏ (0.6 to 2 c.c.) of a 1 to 200 (½ of 1 per cent.) solution are employed. Schleich has three solutions containing a combination of cocain, morphin, and sodium chlorid:

	No. 1, strong	No. 2, medium	No. 3, weak
Cocain hydrochlorate	gr. 3 (0.2 gm.)	gr. 1½ (0.1 gm.)	gr. ⅙ (0.01 gm.
Morphin hydrochlorate	gr. ⅓ (0.02 gm.)	gr. ⅓ (0.02 gm.)	gr. 1/12 (0.00 gm.)
Chlorid of sodium	gr. 3 (0.2 gm.)	gr. 3 (0.2 gm.)	gr. 3 (0.2 gm.)
Distilled sterilized water	oz. 3⅓ (100 c.c.)	oz. 3⅓ (100 c.c.)	oz. 3⅓ (100 c.c.

The strong solution is used for the skin, perineural injections, etc. An ounce (30 c.c.) may be used without risk. Of the medium strength solution, used for ordinary infiltration of the tissues below the skin, 2 ounces (60 c.c.) may be used; while as much as 10 ounces (300 c.c.) of the weaker solution, which is employed for massive infiltration of large areas, may be safely injected. Tablets according

[1] Park, Davis & Co., and Squibbs.

to the Schleich formulæ may be obtained from most pharmacists, with full directions for the preparation of a solution of any given strength. Schleich's solutions find favor with many operators, but personally the writer prefers to administer the morphin separately in a definite dose by hypodermic half an hour before operation.

The addition of adrenalin chlorid to the cocain solution, as advocated by Braun, is of distinct advantage. Adrenalin is a vasoconstrictor and has the same effect in the way of an adjunct to local anesthesia as constriction of the part has, increasing as well as prolonging the anesthetic effects to a marked degree. At the same time, by preventing capillary oozing, it gives a much drier field of operation. With its use there is some danger of secondary hemorrhage if the large blood-vessels are not properly secured, since, owing to its styptic action, even arteries of some size may be prevented from bleeding at the time and so be overlooked. It is a good rule, therefore, to at least clamp any vessel that bleeds, however, slightly, when using adrenalin. From 5 to 10 minims (0.3 to 0.6 c.c.) of the 1 to 1000 solution of adrenalin chlorid is added to the cocain and salt solution before it is to be used.

The high toxicity of cocain has already been referred to. This toxic action is due to the absorption of more of the drug than the tissues can take care of. The amount of the drug that can be injected into the tissues with safety depends upon the strength of the solution as well as the method of injection. To be well within the limits of safety, not more than $\frac{3}{4}$ gr. (0.0486 gm.) of cocain should be allowed to remain unconfined in the tissues, nor should this amount be exceeded when applied to mucous membranes from which rapid absorption takes place. With the weaker cocain solutions (0.2 to 0.1 per cent.) it is rarely necessary to exceed this amount, even in extensive operations. Of course, when a large proportion of the solution escapes, or when the circulation is impeded by constriction, a larger amount may be used with safety.

B-Eucain.—Eucain was one of the first substitutes for cocain. It is claimed to be one-fourth as toxic as cocain; on the other hand the anesthetic effect is slower and less pronounced. It has the advantage over cocain that its solutions may be boiled. Eucain is a vasodilator and the addition of adrenalin to its solutions has not nearly so pronounced an effect as when added to cocain. The drug is generally used in $\frac{1}{2}$ per cent. solution with adrenalin.

Procain.—Procain, one of the more recent and at the present time the most popular substitute for cocain, was introduced in 1905 under the trade-name "novocain." It is estimated to be one-sixth to one-seventh as toxic as cocain, thus permitting the use of fairly large quantities without danger. It is non-irritating to the tissues and is not a vaso-dilator. Like eucain, its solutions are not affected by boiling. It is precipitated from solution by free or carbonated alkalis, so syringes, needles, etc., should be boiled in pure water. Used in conjunction with adrenalin its anesthetic powers are about equal to cocain when injected into the tissues, but is somewhat slower in its action. As a local anesthetic for mucous surfaces it is far inferior to cocain, and has never become popular in nose and throat work. Solutions of this drug, like those of cocain should be isotonic with the body fluids and freshly prepared.

Braun employs four novocain solutions:

	No. I	No. II	No. III	No. IV
Novocain	3¾ gr. (0.25 gm.)	3¾ gr. (0.25 gm.)	1½ gr. (0.1 gm.)	1½ gr. (0.1 gm.)
Normal salt solution	3⅓ oz. (100 c.c.)	1⅔ oz. (50 c.c.)	2½ dr. (10 c.c.)	1¼ dr. (5 c.c.)
Adrenalin 1–1000 or Homorenon 4 per cent.	5 drops	5 drops	5 drops	10 drops

No. IV is employed only for injecting large thick nerves.

Procain is supplied in tablet form and in strengths corresponding to the above.

Quinin and Urea Hydrochlorid.—This combination was introduced into surgery in 1907. So far as known, it has no toxic effects, and the anesthesia produced by it is a protracted one, often lasting four or five days. In its early use solutions of 1 per cent. were employed, but it was found they produced an exudate of fibrin that sometimes interfered with wound healing, so that at the present time the drug is employed in ½ to ¼ per cent. solutions. Upon mucous membranes, solutions of 10 to 20 per cent. may be used. It, however, does not produce a shrinkage of the tissues as cocain does and for this reason is inferior to it in nasal work.

Preparation of the Patient.—The usual preparation of the bowels, etc., recommended as preliminary to general anesthesia, is advisable. There is no need for the patient to fast, however, and a light meal of eggs, coffee, milk, toast, etc., may be allowed, unless the character of the operation contraindicates it. If it seems probable that a general anesthetic will be required to complete the operation, the patient's stomach should, of course, be empty, and the same precautions should be taken as for general anesthesia (see page 18). Apprehensive anticipation on the part of the patient should be prevented as far as possible by reassurances and by a good night's sleep before the operation.

Preliminary medication with morphin is advisable in all cases, where the operation is to be at all extensive, unless some distinct contraindication to its use exists. It serves a threefold purpose: it allays nervousness on the part of the patient and thus removes the psychic element; it somewhat deadens sensibility; and it is the physiological antidote for cocain poisoning. It may be given hypodermically in the dose of 1/6 to 1/4 gr. (0.0108 to 0.0162 gm.) a half hour before operation. In some cases, where the patient is especially nervous or unusual difficulties are expected, morphin 1/4 gr. (0.0162 gm.) combined with 1/100 gr. (0.00065 gm.) of hyoscin may be administered hypodermically two hours before operation.

The Conduction of the Operation.—The successful and satisfactory employment of local anesthesia depends upon an intelligent appreciation of its limitations, upon the experience and skill of the operator, and upon an accurate knowledge of the sensory nerve supply in any given region. These are essential. Much also depends upon the temperament of the operator and upon his method of operating. For this reason, with some operators, the use of local anesthesia will be impossible; with others, it will necessitate a radical change in their operative technic. A nervous fidgety operator, in a hurry to get through his work, will never find much to encourage him in attempts to employ local anesthesia in major surgery.

It is important, in the first place, to make the patient as comfortable as possible upon the operating-table. Operations under local anesthesia consume considerable time, and it is a hardship to keep a conscious patient upon the ordinary hard-topped operating-table for an hour or more. Several thicknesses of blanket, an air mattress, or a layer of soft pillows placed upon the table, will add much to the patient's comfort, as well as to the peace of mind of the operator. The patient should always be recumbent, and a comfortable, relaxed attitude should be assumed, with the arms folded over the chest or clasped above the head. While washing the patient in preparation for the operation, it should be borne in mind that he is conscious and great gentleness should be employed in the process. Care should also be taken not to soak the patient with large quantities of solution and leave him lying in a chilly pool for the remainder of the operation.

With very nervous individuals, it is well to keep the instruments covered from view and to avoid all reference to knives, scissors, etc. In fact, strict silence should be enjoined upon all. The patient's mental attitude can be further influenced to advantage by observing a quiet demeanor in the operating-room, by the avoidance of haste, and by a most careful handling of the tissues. Clean-cut dissection only is allowable in operations under local anesthesia. Rough manipulations, or tearing of the tissues, or unnecessary pulling with retractors by an awkward assistant causes pain by dragging upon structures outside the anesthetized area and is often sufficient to cause restlessness and apprehension on the part of the patient, a state of mind which, if produced in the early part of an operation, rapidly changes to complete demoralization, necessitating the use of a general anesthetic for completion of the operation. Rough wiping of the wound is likewise to be avoided. In fact, in every move and step the aim of the operator should be extreme gentleness. Neglect in observing these small and apparently trivial details is responsible for many of the failures with local anesthesia, and often results in condemnation of the method, though the fault lies with the operator.

THE PRODUCTION OF LOCAL ANESTHESIA BY COLD

The anesthetic properties of intense cold have long been recognized and utilized in minor surgery. The tissues may readily be frozen sufficiently for anesthetic purposes by the application of salt and ice, or by spraying the part with some rapidly evaporating chemical such as ether, rhigoline, or ethyl chlorid. The tissues as a result become first red and then blanched and a superficial anesthesia is produced, which persists but a few minutes. This form of anesthesia has a very small field of usefulness, and is only suitable for small incisions or punctures; even in these cases the method is open to the objection that the tissues become so hard that it is difficult to cut through them at times, and any dissection is out of the question. Furthermore, the thawing out process is attended with more or less pain. Freezing often lowers the vitality of the tissues to such an extent that sloughing results; especially is this so when applied to the tissues of poorly nourished individuals.

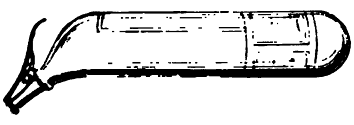


Fig. 42.—Ethyl chlorid spray tube.

Ethyl chlorid is now used almost exclusively for the purpose of freezing, and is both quick and effective. It is obtained in glass tubes with one end drawn out to a fine point and furnished with a spring tip (Fig. 42) or with a screw cap. The method of application is extremely simple. The tube is uncovered and held inverted in the hand at a distance of 12 to 18 inches (30 to 45 cm.) from the surface of the skin. Under the heating influence of the hand the liquid is forced out of the container upon the tissue in a fine jet or spray. Rapid evaporation occurs, and, in about thirty seconds, the skin becomes white and sufficiently frozen to be devoid of sensation.

THE SURFACE APPLICATION OF ANESTHETIC DRUGS

Cocain and other drugs with similar anesthetic action may be applied to mucous surfaces (1) by instillation, as in the eyes, bladder, urethra, etc.; (2) by means of a spray or atomizer, as in the mouth or nose; and (3) upon swabs or compresses, either in solution or in crystals. Only the surface of the mucous membranes is anesthetized in this way, but a number of operations not involving the deeper tissues, such as the removal of polypi or small tumors, and opening of infections may thus be performed.

For operations about the eye, a drop or two of a 2 to 4 per cent. solution of cocain is instilled into the eye every ten minutes until three or four drops have been given.

Local anesthesia of the nasal mucous membrane may be produced by applying a 4 per cent. solution of cocain upon swabs of cotton directly to the part to be anesthetized. Spraying is not so desirable, as the solution is liable to run down into the pharynx through the posterior nares and produce a very unpleasant sensation in the throat, and, at the same time, the amount of solution necessary to produce anesthesia being larger, the danger of poisoning is greater. To increase the effectiveness of the cocain and obtain a bloodless field of operation, a spray of a 1 to 1000 adrenalin solution may be employed after the cocainization.

In the larynx cocain may be applied more freely without danger than is the case when it is applied to the nasal mucous membrane. Small quantities of a 10 per cent. solution may be applied by means of a spray, or, better, applied directly to the desired spot on a swab, with the aid of a laryngeal mirror.

The anterior urethra may be sufficiently anesthetized by filling it with a 0.2 per cent. cocain and adrenalin solution, introduced by means of a urethral syringe. The solution should be confined in the urethra for at least fifteen minutes, by holding the meatus closed. The posterior urethra may be anesthetized by instilling into it a few drops of a 1 per cent. cocain and adrenalin solution or a 2 per cent. procain adrenalin solution by means of an instillation syringe or through a soft rubber catheter.

For the bladder, a 0.1 per cent. cocain and adrenalin solution is sufficient. Five ounces (150 c.c.) of such a solution to which is added twenty drops (1.25 c.c.) of adrenalin is slowly introduced warm by means of a catheter, the bladder having been previously irrigated. The operator should then wait fifteen to twenty minutes for the drug to take effect.

INFILTRATION ANESTHESIA

Infiltration anesthesia was devised by Schleich after a series of careful experiments with salt solutions of different strengths, combined with minute quantities of morphin, cocain, and carbolic acid. From his work has been evolved the weak cocain solution, as used at the present time, which has made possible the safe employment of cocain in really extensive operations.

By infiltration is meant the production of analgesia in a part by edematization of the tissues with weak anesthetic solutions. The fluid is introduced into the tissues, carefully avoiding important vascular structures, without particular reference to the nerve trunks. The resulting anesthesia is partly due to the direct action of the drug upon the nerve endings, partly to the pressure of the fluid, and also to the interference with the blood supply. The anesthesia may be increased and indefinitely prolonged if the circulation be kept stationary by some form of constriction applied to the part, centrally to the seat of injection, or by incorporating in the fluid infiltrated vasoconstrictor drugs like adrenalin. With the infiltration method of anesthesia it is necessary to thoroughly edematize or literally pack the tissues with the anesthetic fluid, for, without this, the weak solution employed would be worthless.

Apparatus.—For the purposes of ordinary infiltration the 60♏ (4 c.c.) or the 10 c.c. (2½ dram) sub-Q syringe is very satisfactory. This syringe has a solid glass barrel and glass piston with asbestos packing, and can be readily sterilized, and is cheap. Several of these syringes should be on hand for the operation, and are to be kept filled in readiness, so that the infiltration may be carried on rapidly without waiting to recharge the same syringe. The needles should be sharp and fine, with a very short bevel, and they should fit the syringe without any leakage at the joint. It will be convenient to have a short needle, 1 inch (2.5 cm.) long, for skin infiltration, and a second one, 2 to 2½ inches (5 to 6 cm.) long, for infiltration of the deeper tissues.

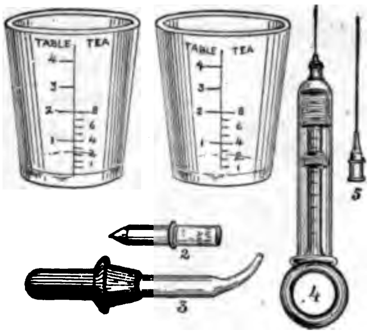


FIG. 43.—Apparatus for infiltration.—1, Medicine glasses for cocain solutions; 2, ampule of sterile cocain and salt crystals; 3, dropper for adrenalin; 4, syringe armed with a short needle; 5, long fine needle for deep infiltration.

For massive infiltration a large syringe or a special apparatus which will allow a continuous and rapid infiltration of the tissues is more satisfactory. The Matas infiltrator (Fig. 44) consists of a heavy glass graduated receptacle for the solution with an air-tight screw cap. Into this cap is fitted a T-tube with two stopcocks, one

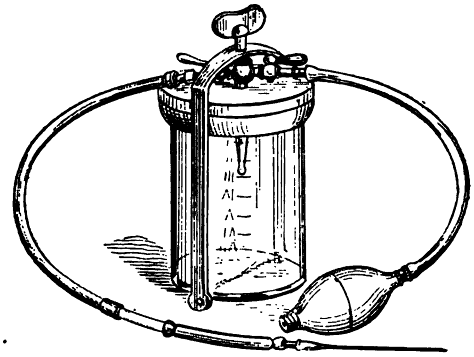


FIG. 44.—The Matas massive infiltrator.

for the introduction of air, and one for the escape of the fluid. A rubber inflating apparatus is attached to the first cock, and to the other is a needle connected by a suitable length of hose. The reservoir is filled about three-fourths full and is then charged with air, and the bulb and tubing are removed. Infiltration is performed by inverting the apparatus and opening the outflow stopcock. Several needles of different lengths, shapes, and sizes are provided with this instrument. The author uses an infiltrator made on much the same principles as the Matas instrument. It consists of a long graduated glass cylinder capable of holding 10 ounces (300 c.c.), with an outlet at the bottom and a rubber stopper fastened in the top by a clamp. A small glass tube connected with an inflating bulb passes through this stopper (Fig. 45). The reservoir is almost filled with the solution, leaving about one quarter for air space, and the instrument is charged with sufficient air to cause the fluid to flow through the needle in a strong stream.

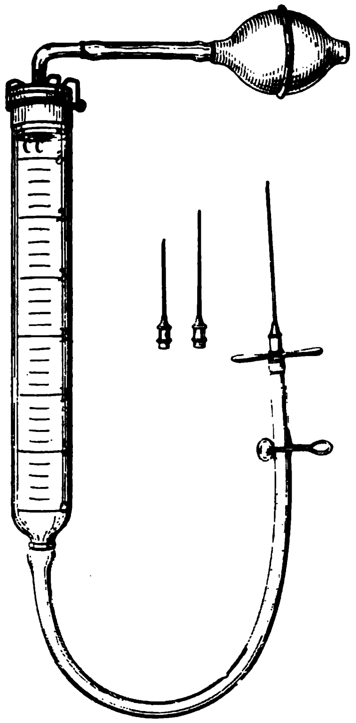


FIG. 45.—The author's apparatus for massive infiltration.

Asepsis.—The syringes, needles, and receptacles in which the solutions are mixed should be boiled in *pure* water without the addition of soda or other alkali.

Technic.—In all cases where an extensive or prolonged operation is contemplated morphin, gr. 1/4 (0.0162 gm.), should be given hypodermically half an hour beforehand, unless contraindicated. For the skin infiltration, a warm 0.2 per cent. solution of cocain and adrenalin or a 1 per cent. procain-adrenalin solution in normal salt solution may be used. The syringe is filled with solution and the needle is shown to the patient with an explanation of just what is intended to be done. This is necessary in order to avoid an often unexpected shock from the first prick of the needle. The needle, *held almost parallel to the surface*, is pushed into the skin just beneath the epidermis—*not beneath the skin*—so as to anesthetize the sensitive end organs. If the needle lies properly, its point will be almost visible immediately below the skin surface. A few drops of solution are injected and the skin becomes blanched and raised into a wheal about the size of a ten-cent piece (Fig. 46). The needle is then reinserted into the *edge of the wheal* and more solution injected in the same manner, until the entire line of the proposed incision is one continuous wheal (Fig. 47). In this way, only the first prick of the needle is felt by the patient.

The subcutaneous tissue, which is in itself insensitive but carries sensitive nerve trunks and blood-vessels, is next very thoroughly

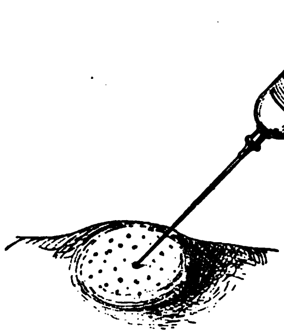


FIG. 46.—Showing the method of infiltrating the skin. The needle is inserted in such a way that, with the injection of a few drops of solution, a wheal the size of a ten-cent piece is produced.

infiltrated, using a longer and somewhat larger needle. For this purpose cocain and adrenalin in a 1 to 1000 solution for ordinary cases and in a 1 to 3000 to 1 to 10000 solution for massive infiltration of large areas or a 1/4 to 1/8 per cent. procain-adrenalin solution may

FIG. 47.—Showing the reinsertion of the needle into the edge of the wheal.

be used. The needle is inserted into the line of the skin cocainization, and the solution is injected in all directions from this point, so as to practically surround the area of proposed incision with anesthetic solution. Special care is taken to thoroughly infiltrate known sensitive regions, as, for instance, in the operation for inguinal hernia about the external ring where the main nerve trunks break up into their terminal filaments. In the case of an operation upon a circumscribed growth, the infiltration is carried out in such a way as to completely encircle the diseased area and isolate it from nerve communication with the surrounding parts. In like manner fascia and

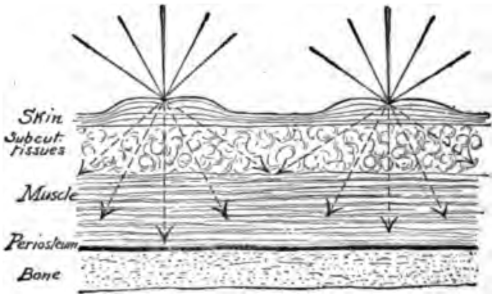


FIG. 48.—Showing the directions in which the needle should be inserted in massive infiltration of deep structures.

muscles, down to or including the periosteum, may be infiltrated in a mass, after the method of Matas (Fig. 48), or each structure separately as it is exposed during the course of the operation. Muscle, tendon, bone, and cartilage have no sensation, but their coverings are extremely sensitive; hence particular care must be taken to in-

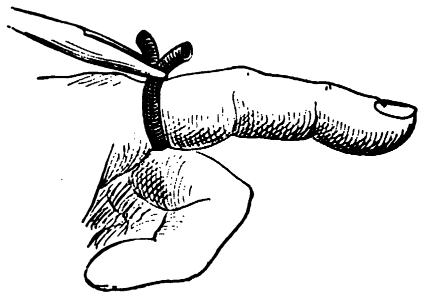


FIG. 49.—Showing the application of a constricting band to the finger in order to prolong and intensify the anesthesia.

filtrate fascia, muscle, and tendon sheaths, periosteum, and joint capsules, and when operating upon joints to anesthetize the synovial membranes by a preliminary instillation of weak cocain solution into the joint before operation. With proper infiltration the whole field is thoroughly edematized and is changed into a tumor-like mass that is perfectly anesthetic.

While the infiltration method is carried out without any attempt to specially anesthetize nerve trunks, the larger ones should nevertheless be injected after the method to be described whenever they are encountered during the operation.

Upon an extremity, more complete and prolonged anesthesia may be obtained if, after infiltration, stasis of the circulation is produced by means of elastic constriction applied centrally to the seat of infiltration (Fig. 49). In such a case, where large quantities of solution are used and remain in the tissues when the operation is completed, it is a wise precaution to loosen the constriction gradually and intermittently, so as not to rapidly flood the system with a large volume of cocain solution.

ENDO- AND PERINEURAL INFILTRATION

The discovery that injections of cocain and similar analgesics into the tissues surrounding a nerve (perineural infiltration) or directly into it (endoneural infiltration) will effectually block the particular nerve and produce anesthesia in the entire area of its distribution has made possible many operations of magnitude, such as those for hernia, amputations, etc. Successful nerve blocking presupposes an accurate knowledge of the course and distribution of the sensory nerves. It may be performed at a distance from the seat of operation by injecting the anesthetic solution around the nerve, or by cutting down and exposing the nerve before injection; or the blocking may be performed by separately injecting each nerve as it is exposed during the course of the operation. The action of the anesthetic is intensified and indefinitely prolonged by arresting the circulation in the injected and anesthetized nerve trunks by means of elastic constriction, as already spoken of under infiltration, and to a lesser degree by the addition of adrenalin to the analgesic solution.

The perineural method of infiltration is more suited to regions supplied by the smaller superficial nerves and to the smaller extremities, as the fingers and toes. For anesthetizing the large nerve trunks with thick sheaths, direct injection of the nerves as they are exposed in the field of operation, or at some point along the course of the nerve central to the seat of operation, will give more certain results. When a region is supplied by several nerves, each will have to be separately isolated and blocked.

Apparatus.—The ordinary 60♏ (4 c.c.) or 10 c.c. (2½ dr.) "Sub-Q" syringe, with a fairly long needle will be found most satisfactory.

Asepsis.—The needles, syringes, and solution glasses are sterilized by boiling in *pure water* without the addition of soda or other alkali.

Technic.—In the perineural method of infiltration the analgesic solution is injected in such a way as to surround the nerve trunk or "envelop the nerve in an anesthetic atmosphere," as Matas expresses it. A spot in the skin from which the nerve can be reached with the hypodermic needle is infiltrated as already described, and through this area the needle is inserted toward the known location of the particular nerve to be anesthetized. The syringe is charged with a 0.2 per cent. solution of cocain and adrenalin or a 1 per cent. procain adrenalin solution and from 15 to 20 drops are injected into the tissues surrounding the nerve. The solution is allowed to become diffused, and then, if the nerve be in an extremity, the part is ex-

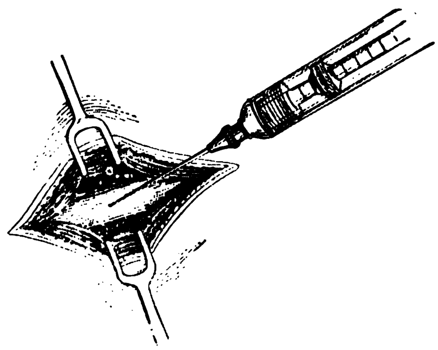


FIG. 50.—Method of infiltrating a large nerve trunk. The anesthetic solution should be injected into the nerve in all directions so that the entire nerve is rendered anesthetic below the point of injection.

sanguinated by elevation and an elastic constriction is applied centrally to intensify and prolong the anesthesia. In a few moments the entire region supplied by the blocked nerve becomes insensible. It may happen that, in regions where constriction is inapplicable, the anesthesia may not be sufficiently lasting for a prolonged operation, and it will be necessary to repeat the injection more than once to maintain the anesthesia.

By the endoneural method, if the nerves are injected in the field of operation, the technic is very simple, the individual nerves being infiltrated with a few drops of a 0.5 per cent. solution of cocain or a 2 per cent. solution of procain as they are exposed. When the injection is made at a point distal to the seat of operation the nerve is first exposed by dissection under infiltration anesthesia and is then thoroughly infiltrated, the fluid being injected into all portions of the nerve so that an entire transverse section is thoroughly blocked (Fig. 50). Other nerves supplying the region of operation are similarly dealt with. The part is then exsanguinated by elevation and an elastic constriction is applied centrally to the point of injection. In a short time all sensation below the seat of injection becomes benumbed, and operations of any magnitude may be performed.

Practical Application of Infiltration, Endo- and Perineural Methods of Anesthesia to Special Localities.—The methods of locally anesthetizing a part just described all have their special indications. The operator should not employ one method to the exclusion of the others, but should make his selection so as to successfully meet the indications in a particular case. In a certain proportion of the cases infiltration alone will suffice; in others, the nerve blocking can be used to better advantage; but in the majority of extensive operations it will be found that a combination of infiltration with endoneural injections is essential to a successful anesthesia in a given region. A brief description of the application of these methods to different regions of the body will furnish some idea as to the scope and capabilities of each.

The Head.—Operations upon the scalp, such as wound suture, the removal of tumors, cysts, etc., and even procedures requiring incision of the periosteum and opening into the brain, may be performed painlessly under a combination of infiltration and perineural anesthesia. An accurate knowledge of the nerve supply of the region is essential, however.

Briefly, the scalp has the following nerve supply (Fig. 51). The small occipital and great occipital nerves supply the posterior part of the scalp as far forward as the vertex. The great auricular nerve supplies the mastoid region, as does also the small occipital. The parietal portion of the scalp receives its supply from the auriculo-temporal and a branch of the temporomalar. The supratrochlear branch of the frontal nerve supplies the integument of the lower part of the forehead on either side of the median line. The supraorbital supplies the cranium over the frontal and parietal bones. Blocking these nerves by cross strips of infiltration at the points where they penetrate the muscular fascia and become subcutaneous (Fig. 52), or performing a thorough circumscribed infiltration around the area of operation, with infiltration of the periosteum, if necessary, renders many cases amenable to local measures which are now performed under general narcosis. Constriction by means of a rubber tourniquet passed around the forehead above the ears and over the occipital protuberance will be found most useful as an aid to anesthesia.

About the lips, chin, nose, cheeks, tongue, mouth, and lower jaw local means of anesthesia are often quite sufficient. Blocking of the mental nerve as it emerges from the mental foramen will render insensitive the region of the chin and the skin and mucous membrane of the lower lip of the same side (see Fig. 52). In like manner the upper lip may be anesthetized by blocking the infraorbital nerves.

FIG. 51.

FIG. 52.

FIG. 51.—The superficial nerves of the scalp and face. 1, Supratrochlear nerve; 2, supraorbital nerve; 3, temporal branch of the temporomalar nerve; 4, auriculotemporal nerve; 5, great auricular nerve; 6, small occipital nerve; 7, great occipital nerve; 8, infratrochlear nerve; 9, infraorbital nerve; 10, nasal nerve; 11, mental nerve.

FIG. 52.—Showing the area of anesthesia after blocking the supratrochlear, supraorbital, and mental nerves. The dots indicate the points for infiltration.

The inferior dental nerve is readily reached for blocking as it enters the inferior dental foramen at the outer side of the spine of Spix. This point lies near the median line of the internal surface of the ramus of the jaw about half an inch (1 cm.) above the upper surface of the last molar tooth (Fig. 53). The lower jaw may be thus anesthetized and teeth may be painlessly extracted. The lingual nerve may be perineurally infiltrated at about the same point, as it lies close to the inferior dental. The floor of the mouth and the tongue are thus rendered insensitive, and quite extensive operations may be performed. Infiltration alone, however, is often sufficient in the smaller operations about the lips and mouth.

Blocking of the branches of the trifacial nerve at their points of exit from the base of the skull gives a wide area of anesthesia and permits the painless performance of very extensive operations in the region supplied by these nerves, such as removal of the tongue, resection of the upper and lower jaws, operations upon the orbit, etc. As early as 1900 Matas reported a resection of both upper jaws after cocainization of the second division of the fifth nerve. More recently Braun and others have reported extensive operations

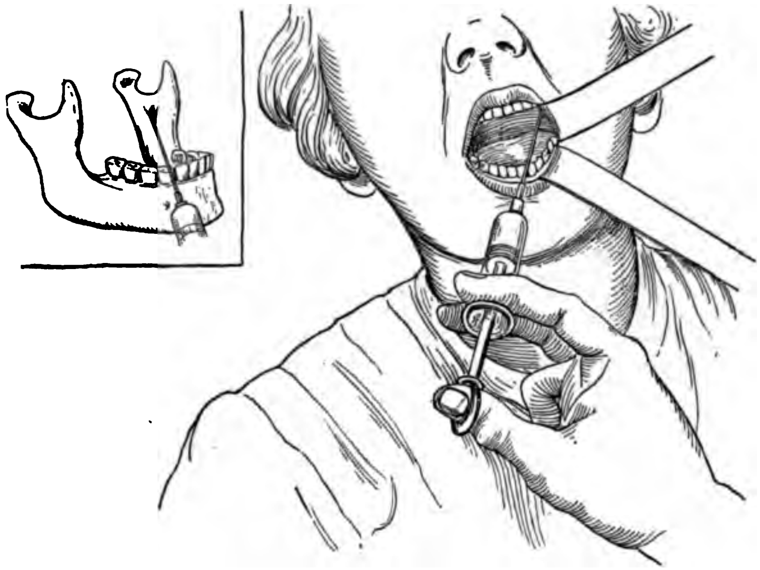


FIG. 53.—Showing the method of blocking the inferior dental nerve.

performed by similar methods. The technic of reaching these nerves is similar to that employed by Schlösser, Patrick, and others in the use of alcoholic injections for trifacial neuralgia (see page 228).

The Neck.—Operations upon the neck for the removal of benign growths, isolated freely movable glands, or for the ligation of vessels are performed by infiltration of the lines of incision combined with massive infiltration of the surrounding tissues. As already mentioned, thyroidectomy and tracheotomy may be carried out by following the same principles. In superficial operations upon the anterior and posterior triangles, perineural blocking by a strip of infiltration, or direct injection of the superficial branches of the cervical plexus as they escape from the posterior border of the sternomastoid muscle at or about its middle will be of great aid (Fig. 55). Operations upon the larynx may be performed under infiltration anesthesia combined with blocking of the superior laryngeal nerve at the tip of the greater cornu of the hyoid bone.

The Thorax.—Exploratory punctures, aspiration of the pericardium and pleura, rib resection for empyema, and the removal of benign growths from the breast may all be satisfactorily performed under infiltration. In the operation of rib resection the infiltration should be carried out layer by layer, including the periosteum. Perineural blocking of the intercostal nerves as they pass between the

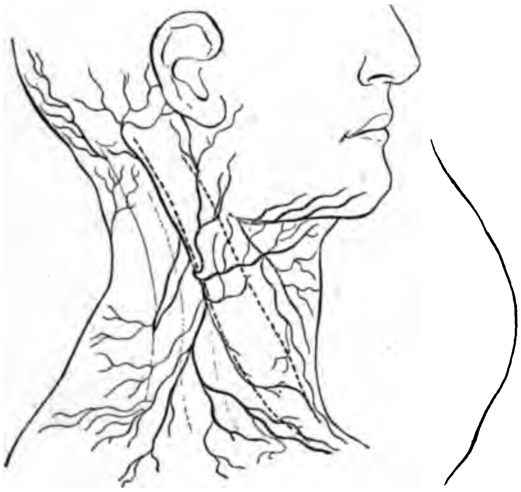


FIG. 54. FIG. 55.

FIG. 54.—The superficial cervical plexus. The dotted lines indicate the course of the sternomastoid muscle.

FIG. 55.—Showing the area of anesthesia after blocking the superficial cervical plexus. The dots indicate the points for infiltration.

intercostal muscles in the upper portion of the intercostal space or endoneural injection of each nerve as it is exposed, will assist in rendering the operation painless where more than one rib is to be resected. For a perineural injection the needle is inserted close to the lower margin of the rib about one and one-fifth inches (3 cm.) from the median line and is pushed in for a distance of 1 3/5 to 2 in. (4 to 5 cm.) when it strikes the bone. An attempt is next made to guide the needle below the lower edge of the rib. The injection is then commenced and is continued as the needle is carried inward and toward the median line well into the subcostal angle for a distance of 1/4 to 1/2 an inch (6 to 12 mm.). As many of the other intercostal nerves as may be necessary are similarly blocked. After the periosteum over the rib is incised and reflected, the rib may be exsected without pain. The parietal pleura, like the peritoneum, is very sensitive and requires infiltration before incision.

The Upper Extremity.—Almost any operation may be performed in this region under a skilful use of local anesthesia. The brachial plexus may be anesthetized by exposing it under infiltration anesthesia above the clavicle (Fig. 56) and blocking each branch separately by direct injection with a 0.5 per cent. solution of cocain or a 2 per cent. solution of procain, or by a perineural injection after the method of Kulenkampff. His technic is as follows: The patient is placed in the sitting position and the subclavian artery is located by palpation. This is usually at a point where, if the external jugular vein were extended, it would strike the clavicle. The needle is

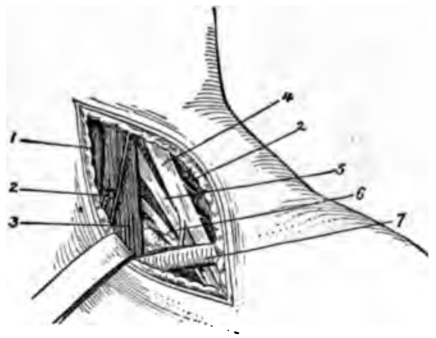


Fig. 56.—Exposure of the brachial plexus for infiltration. 1, External jugular vein; 2, transversalis colli artery; 3, scalenus anticus muscle; 4, fifth cervical root; 5, sixth cervical root; 6, seventh cervical root; 7, clavicle.

nserted just outside this point immediately above the clavicle in an oblique direction slightly back and downward in a line which, if carried back, would strike the spines of the 2d or 3d dorsal vertebra. At a distance of about 1 1/5 inches (3 cm.) the needle should reach the nerve trunks. Paresthesia throughout the arm and motor phenomena indicate when this has been accomplished.[1] If the needle strikes the first rib it has been introduced too far. Kulenkampff injects 2 1/2 drams (10 c.c.) of a 2 per cent. solution of novocain (procain) and adrenalin. In 10 to 30 minutes all sensation in the area below the point of injection is destroyed, and amputations or other

[1] Injury to the phrenic nerve with embarrassed respiration and diminished breath sounds has been reported following perineural injection of the brachial plexus, so that care should be taken to determine the presence of paresthesia before making the injection and not to anesthetize both sides at the same time.

operations may be performed at any level below the seat of injection. In shoulder-girdle amputations, however, infiltration of the lines of incision also should be performed in order to block small branches from the cervical plexus, *i.e.*, the supraacromial and suprascapular nerves.

Operations upon the forearm require blocking of the median, ulnar, and musculospiral nerves. This may be accomplished by blocking the brachial plexus as already described, by directly injecting all three nerves after exposure under infiltration anesthesia in the upper portion of the arm, or by separately exposing and blocking each nerve just above the elbow. In following the latter method, the median

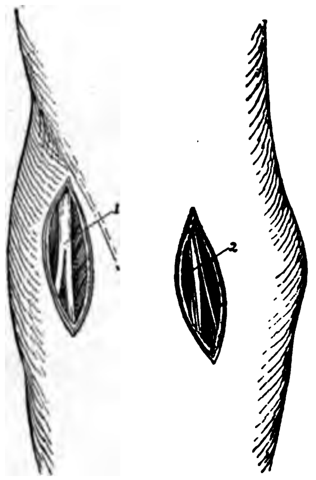


FIG. 57.

FIG. 58.

FIG. 57.—Exposure of the musculospiral and median nerves at the elbow. 1, Musculospiral nerve; 2, median nerve.

FIG. 58.—Exposure of the ulnar nerve just above the internal condyle.

nerve is exposed by an incision across the elbow to the inner side of the biceps muscle, the brachial artery lying just external to it; the ulnar, in the groove between the internal condyle and the olecranon; and the musculospiral, between the biceps tendon and the supinator longus muscle. Blocking each nerve with a 0.5 per cent. solution of cocain or a 2 per cent. solution of procain produces complete insensibility of the extremity below the point of injection excepting the skin and subcutaneous tissues of the upper central portion of the forearm, supplied by the musculocutaneous and internal cutaneous nerves. A circular area of subcutaneous infiltration at the elbow, however, as advised by Matas, abolishes any remaining sensibility in this region (Fig. 59).

Just above the wrist, the median, ulnar, and radial nerves are available for perineural injection. The median is reached by introducing the needle to the ulnar side of the tendon of the palmaris longus and inserting it obliquely for a distance of ½ to ¾ inch (1 to 2 cm.) in the direction of the radius. The ulnar nerve may be

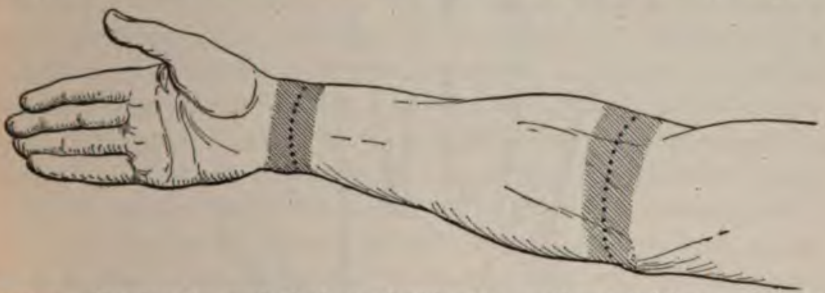


FIG. 59.—Showing the method of anesthetizing the small superficial nerves by circular strips of subcutaneous infiltration.

anesthetized perineurally a little above the head of the ulna by inserting the needle to a depth of about ⅘ inch (2 cm.) between the ulna and the tendon of the flexor carpi ulnaris. The radial nerve and its branches are best caught by a cross strip of subcutaneous infiltra-

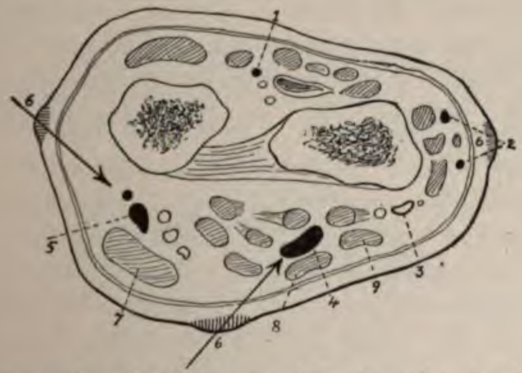


FIG. 60.—Cross-section of the forearm above the wrist showing the direction of the needle for perineural infiltration of the ulnar and median nerves. (After Braun.) 1, Interosseous nerve; 2, radial nerve; 3, radial artery; 4, median nerve; 5, ulnar nerve; 6, areas of skin infiltration; 7, flexor carpi ulnaris tendon; 8 palmaris longus tendon; 9, flexor carpi radialis tendon.

tion just above the styloid process of the radius (Fig. 60). Perineural injection alone for operations upon the wrist is not satisfactory, as this region is also supplied by small branches given off from these nerves higher up. A circular strip of subcutaneous infiltration above the wrist, however, will render the anesthesia complete (see Fig. 59).

In thin individuals, massive circular infiltration alone is generally sufficient to produce anesthesia below the site of injection.

Anesthesia of the fingers is obtained by infiltrating two points in the skin on the dorsal surface near the base of each finger (Fig. 61).

FIG. 61.—Points for inserting the needle in perineural infiltration of the digital nerves.

Through these points the needle is inserted toward each of the four digital nerves, and the anesthetic solution injected (Fig. 62). All nerve communication is thus blocked and the finger may be incised, amputated, etc., without pain. By injecting in the known location

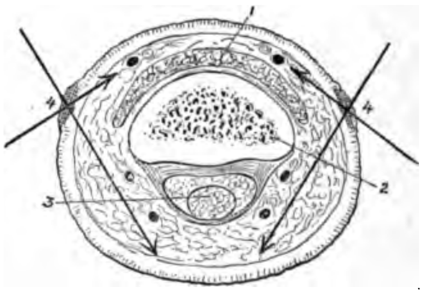


FIG. 62.—Cross-section of the finger showing the direction of the needle for perineural infiltration of the digital nerves. (After Braun.) 1, Extensor tendons; 2, bone; 3, flexor tendons; 4, areas of skin infiltration.

of the digital nerves as they pass between the metacarpal bones, the bases of the fingers and even the metacarpals may be anesthetized.

The Abdomen.—The abdomen may be opened in any region by simple infiltration, combined with endoneural injection of nerves as they are exposed. The skin, the subcutaneous tissues, the fasciæ, the muscular layers, and the peritoneum should be separately infiltrated, layer by layer. More perfect anesthesia may be obtained by combining with the infiltration a paravertebral injection of the nerves supplying the field of operation after the method of Kappis. For work about the kidney or upper abdomen the last five thoracic and upper two lumbar nerves should be blocked. The technic is as follows: The needle is inserted about 1 3/5 in. (3.5 cm.) from the median line on a level with the lower border of the rib and is inserted for a distance of 1 3/5 to 2 in. (4 to 5 cm.) when the bone should be reached. The needle is then made to pass beneath the lower border of the rib and the injection is begun. The solution is slowly injected while the needle is pushed onward for a distance of 1/4 to 1/2 in. (6 to 12 mm.) slightly toward the median line into the subcostal angle. The same method is employed for the lumbar nerves, the transverse processes of the vertebræ being the guides instead of the ribs. The limitations of local anesthesia in abdominal surgery have already been considered (page 79).

Hernia.—While operations for hernia of any variety may be carried out under local anesthesia, the inguinal will be found especially suited to this method of anesthesia, the umbilical and femoral varieties less so.

For inguinal hernia a combination of infiltration and endoneural injection is possible on account of the anatomical arrangement of the inguinal region, which is supplied by three fairly large nerve trunks having a rather constant course—namely, the iliohypogastric, the ilioinguinal, and the genitocrural. The iliohypogastric will be found in the upper angle of the hernial incision after reflecting the aponeurosis of the external oblique, usually running downward and inward on a line drawn from about the anterior-superior spine to a point an inch (2.5 cm.) above the external ring. The ilioinguinal will usually be found in the line of incision just beneath the aponeurosis of the external oblique, and on a lower level than the iliohypogastric, running downward in the long axis of the hernia (Fig. 63). It may even lie as far out as Poupart's ligament. This nerve is often smaller than the iliohypogastric, and in some cases it may be absent, in which event its place is taken by the genitocrural. The genitocrural will be found after reflecting the aponeurosis of the external oblique lying among the structures of the cord, and frequently it lies behind the cord. Infiltration anesthesia is employed until the aponeurosis of the external oblique is reflected, when the above nerves are separately blocked. In performing the infiltration, special care should be taken to inject plenty of solution in the region of the external ring where the nerves break up into their terminal filaments. After the nerves are properly blocked, the remainder of the operation may be painlessly performed without the use of additional anesthesia, though it is better to infiltrate about the neck of the sac before ligating and removing that structure. Omentum may be amputated, adhesions within the sac separated, and gut resected if necessary, without pain.

Femoral hernia may be operated on under simple infiltration of the skin, subcutaneous tissues, and sac; or, preferably, by a combi-

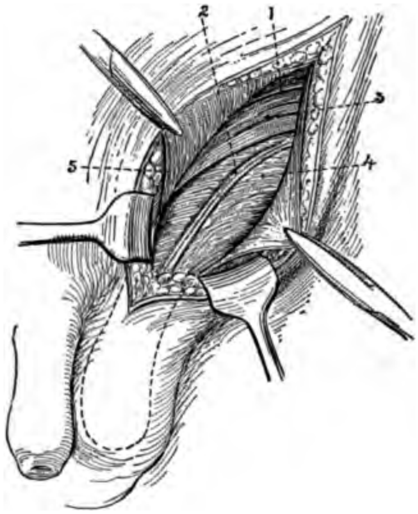


FIG. 63.—Showing the nerve supply of the inguinal region. (After Cushing.) 1, Iliohypogastric nerve; 2, ilioinguinal nerve; 3, conjoined tendon; 4, cremaster muscle; 5, aponeurosis of the external oblique incised and edges reflected.

nation of infiltration and endoneural injection. If this latter method is employed, the incision is placed so as to expose in addition the external abdominal ring. The aponeurosis of the external oblique is thus exposed and is incised for a short distance, so that the ilio-inguinal and genitocrural nerves may be identified and injected. Blocking of these nerves, combined with infiltration, renders the field of operation more nearly anesthetic than infiltration alone.

In operations for umbilical and ventral hernias, the infiltration method is employed. The structures are separately injected, as would be done for an abdominal operation, taking special care to thoroughly infiltrate about the neck of the sac.

The Scrotum.—Any of the operations about the scrotum and testicles, such as those for varicocele, hydrocele, castration, etc., may be carried out by perineural injection around the cord as it

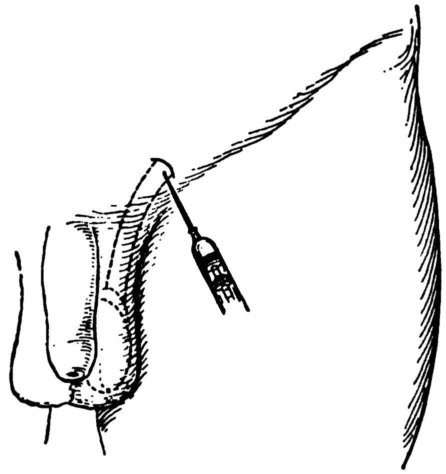


FIG. 64.—Showing the method of infiltrating about the cord in operations upon the testicle.

escapes from the external ring (Fig. 64), combined with infiltration along the site of incision.

Penis and Urethra.—Circumcision may be performed by infiltrating the skin and mucous membranes along the lines of proposed

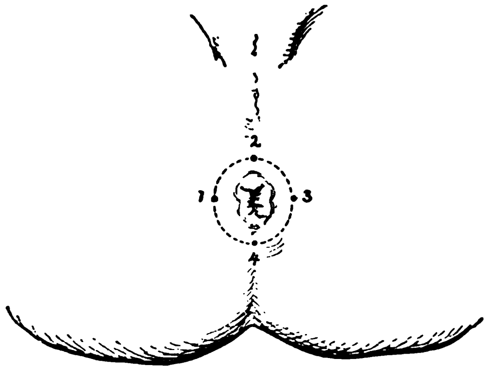


FIG. 65.—Points for injection in infiltration about the anus.

incision, being careful to infiltrate the frenum thoroughly. More extensive operations upon the pendulus portion may be performed by subcutaneous infiltration of a ring about the base of the penis, carefully injecting the solution around each of the dorsal nerves. External urethrotomy may be performed under infiltration combined with topical anesthesia of the mucous membrane (see page 87).

Rectum and Anus.—The limitations of local anesthesia in rectal operations have been previously pointed out. For the removal of external hemorrhoids, skin tabs, etc., injecting a small amount of anesthetic solution into the base of the growth is sufficient. When it is necessary to stretch the sphincter, anesthesia may be obtained in the following manner: Four wheals are made in the skin—in front, behind, and at the sides (Fig. 65)—and through these points the hypodermic needle, guided by a finger in the rectum, is carried up along the bowel and the sphincter is thoroughly infiltrated.

Lower Extremity.—Blocking of the anterior crural, the external cutaneous, and the sciatic nerves, combined with a circular strip of

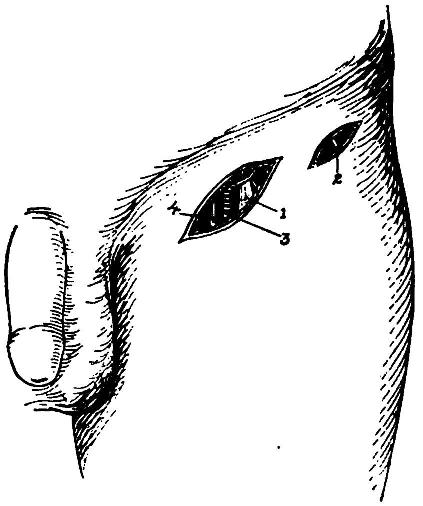


FIG. 66.—Exposure of the anterior crural and external cutaneous nerves for injection. 1, Anterior crural nerve; 2, external cutaneous nerve; 3, femoral artery; 4, femoral vein.

subcutaneous infiltration, completely blocks all sensation in the lower extremity below the level of the "block," and amputations can thus be performed as high as the lower and middle thirds of the thigh. Above this point, however, the nerve supply is complicated and it will be necessary to massively infiltrate along the line of incision as well as to "block" the nerve trunks already mentioned. The external cutaneous nerve may be reached for injection by an incision so placed as to expose the nerve as it emerges from under the anterior superior spine (Fig. 66), or it may be blocked by a perineural injection, the needle being inserted just to the inner side of the anterior superior spine. Skin grafting may be readily performed by blocking the nerve after the manner just described and taking the grafts from the outer side of the thigh. The anterior crural nerve may be exposed by an incision placed about ½ inch (1 cm.) external to the center of Poupart's ligament. The nerve will be found just external to the femoral artery. The sciatic nerve may be reached for perineural injection by inserting the needle at a point where a horizontal line through the tip of the great trochanter cuts a vertical line through the outer margin of the tuberosity of the ischium. A needle about 3 inches (8 cm.) long is required. It is introduced directly backward until bone is reached and is then withdrawn for a distance of 1/25 inch (1 mm.). After injection of the anesthetic solution about

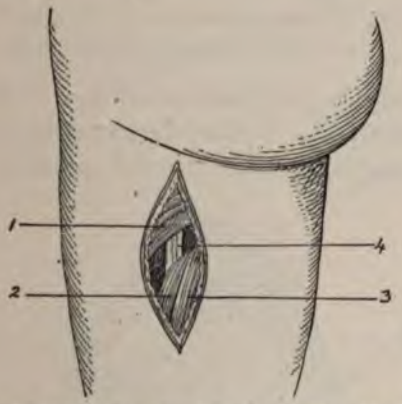


FIG. 67.—Exposure of the sciatic nerve in the upper part of the thigh for injection. 1, Gluteus maximus muscle; 2, biceps muscle; 3, semitendinosus muscle; 4, sciatic nerve.

½ an hour is required for complete anesthesia. The sciatic may also be blocked after exposure under infiltration anesthesia at the lower border of the gluteus maximus muscle, or at the upper border of the popliteal space. In the former case, an incision 3 to 4 inches (7.5 to 10 cm.) long is made between the tuberosity of the ischium and the great trochanter, with its center over the lower margin of the gluteus maximus muscles. By retracting the gluteus maximus upward and the ham-string muscles inward, the nerve will be found lying under the outer edge of the biceps muscle (Fig. 67). In the upper portion of the popliteal space the nerve may be exposed by a vertical incision in the mid-line; it will be found lying between the biceps and semimembranosus muscles. It should be injected before it divides, or else both the internal and external popliteal nerves are to be blocked.

In operations below the tubercle of the tibia, it is unnecessary to block the anterior crural and external cutaneous; blocking the sciatic in the popliteal space and the external saphenous as it passes to the inner and posterior aspect of the knee-joint is sufficient (Fig. 68).

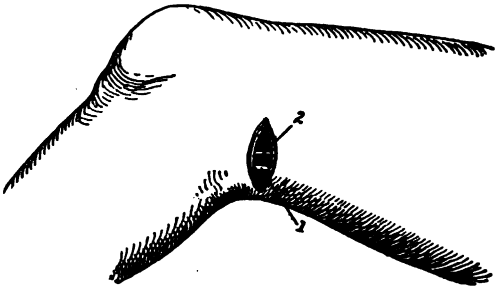


FIG. 68.—Exposure of the internal saphenous nerve for injection. 1, Internal saphenous nerve; 2, internal saphenous vein.

Below the knee, the large nerves are not available for injection until the ankle is reached. Behind the ankle the posterior tibial may be perineurally injected by inserting the needle on the inner side of

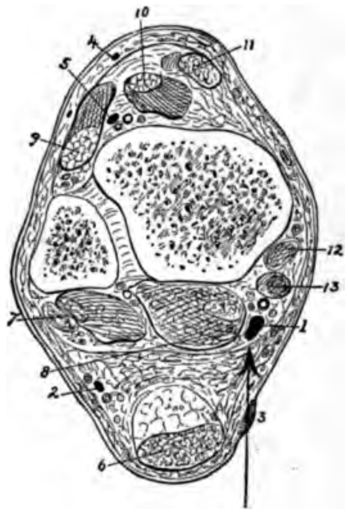


FIG. 69.—Cross-section of the leg above the ankle-joint, showing the direction of the needle for perineural infiltration of the posterior tibial nerve. (After Braun.) 1, Posterior tibial nerve; 2, external saphenous nerve; 3, area of skin infiltration; 4, musculocutaneous nerve; 5, anterior tibial nerve; 6, tendo achillis; 7, peronei muscles; 8, flexor longus hallucis; 9, extensor longus digitorum; 10, extensor longus hallucis; 11, tibialis anticus; 12, tibialis posticus; 13, flexor longus digitorum.

the tendo achillis directly forward almost to the posterior surface of the tibia (Fig. 69). The anterior tibial may be likewise perineurally injected by inserting the needle on the dorsum of the ankle between the tendons of the tibialis anticus and the extensor longus hallucis and the innermost tendon of the extensor longus digitorum. By a circular strip of subcutaneous infiltration, the remainder of the sensory nerve supply may be blocked and complete anesthesia of the foot may be obtained.

In anesthetizing the digits and metatarsals, the same principles already described for the hand are applicable. Amputations of toes, operations for ingrowing toe-nail, osteotomy for hallux valgus, etc., may be readily performed under perineural injection of the proper nerves.

Operations upon Inflamed Tissues under Local Anesthesia.—Upon the extremities some of the methods of endoneural or peri-

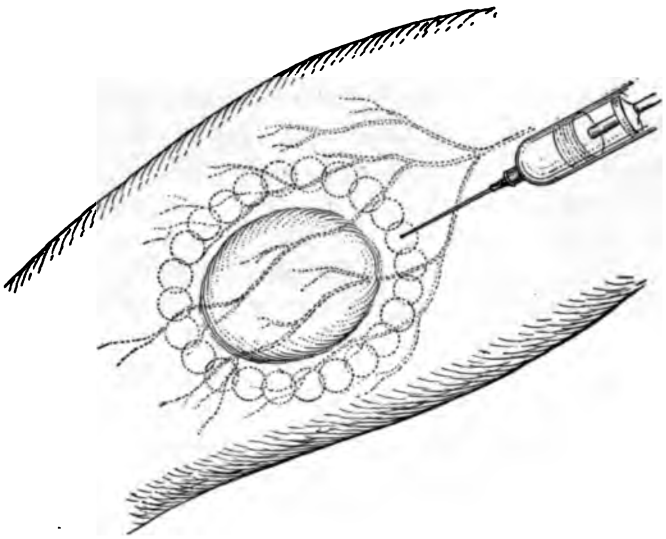


FIG. 70.—Showing the method of anesthetizing an inflamed area.

neural blocking of the nerves supplying the region affected gives most satisfaction. Where these methods are not applicable infiltration anesthesia may be employed if care is taken not to inject the solution directly into the inflamed tissues. An attempt should be made to surround the diseased area with the anesthetic solution, making the injections through healthy skin into the subcutaneous tissues (Fig. 70), thus cutting off all sensory communication with the surrounding parts. Infiltration of the inflamed tissues should be avoided as any increase in distention of the already swollen structures causes intense pain and in some cases seems to lower the resistance to such an extent that cellulitis results.

BIER'S VENOUS ANESTHESIA

The idea of using the blood vessels for the purpose of diffusing local anesthetics through the tissues for surgical operations orginated with Bier, who described the method before the 37th German Surgical Congress in 1908. Previous to this the first record of the injection of local anesthetics into the circulation was in 1886, soon after the introduction of cocain, when Alms injected cocaine experimentally into the iliac artery of a frog and obtained complete anesthesia of the lower limb. Venous anesthesia consists essentially in rendering the limb bloodless and, after isolating the field of operation from the circulation by means of tourinquets applied above and below the area to be anesthetized, injecting the anesthetic solution into one of the veins between the two tourniquets. What is termed "direct anesthesia" rapidly develops between the two bandages; while somewhat later, after the anesthetic solution has had time to act upon and paralyze the nerve trunks within the isolated area, the anesthesia extends to the entire limb beyond the bandage. This is termed "indirect anesthesia."

While venous anesthesia is suitable for any operation upon an extremity which will permit of ischemia of the limb, it is not intended that it should supplant the ordinary methods of local anesthesia which are sufficient for the superficial tissues; its special field is for major operations, such as amputations, resection of joints, and operations upon bones, muscles, tendons, etc. It is especially indicated in cases with heart and lung complications which are poor risks for general anesthesia; and for cases of severe traumatism of the limbs with the patient deeply shocked it is invaluable. According to its originator, diabetic and senile gangrene and arteriosclerosis are contraindications to its use.

Apparatus.—A syringe, such as the Sub-Q or the Janet, with a capacity of about 3 ounces (90 c.c.), Bier's special cannula, a short heavy piece of rubber tubing for connecting the syringe with the cannula, a small medicine glass, a small syringe and fine needle for infiltrating the site of operation, a glass graduate for the vein solution, and three rubber bandages, each 2½ inches (6 cm.) wide and 6 feet (180 cm.) long (Fig. 71), will be required.

Bier's cannulæ are 1/16 inch (1.5 mm.) in diameter for children and 1/14 to 1/12 inch (1.75 to 2 mm.) in diameter for adults. The distal end of the cannula is provided with grooves into which fit the ligatures with which it is tied in the vein, and at the other end there is a stopcock and a bayonet connection (Fig. 72). In the absence of a special cannula, an ordinary infusion cannula may be used, an artery clamp applied to the rubber tubing acting as a stopcock.

Instruments.—Instruments necessary for an ordinary infusion are required; namely, a scalpel, mouse-toothed thumb forceps, a pair of blunt-pointed scissors, an aneurysm needle, needle holder, two

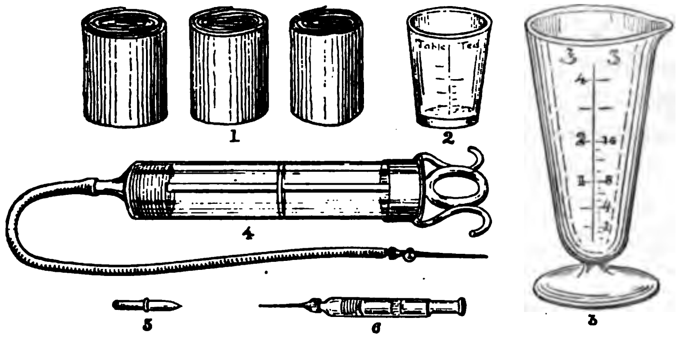


FIG. 71.—Apparatus for venous anesthesia. 1, Rubber tourniquets; 2, medicine glass; 3, glass graduate; 4, large glass syringe and Bier's cannula; 5, ampule of anesthetic; 6, syringe for preliminary infiltration of the skin at the site of operation.

curved needles with a cutting-edge, No. 2 plain catgut, and a few artery clamps (Fig. 73).

Solution.—Bier employs a 0.5 per cent. solution of novocain (procain) in normal salt solution.

Quantity Used.—From 5 drams to 2 ounces (20 to 60 c.c.) of solution are ordinarily injected, depending upon the extent of the area

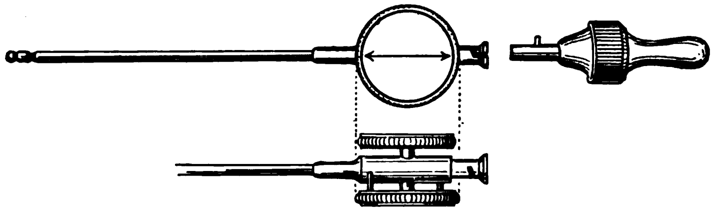


FIG. 72.—Enlarged view of Bier's cannula for venous anesthesia.

to be injected. The quantity employed should not, however, exceed 2⅔ ounces (80 c.c.).

Site of Injection.—The vein selected for the injection should preferably be one of the larger main subcutaneous veins which follow a definite course, rather than a tributary. Likewise veins imbedded in scar tissue are to be avoided. For the arm, the basilic vein and for the leg the internal saphenous vein is usually chosen.

Asepsis.—The limb is sterilized by painting with tincture of iodin. The instruments are boiled, and the operator's hands cleansed as for any operation.

Technic.—Before rendering the limb bloodless, it is well to make a small scratch with a scalpel in the skin over the vein in order to mark its site, as it is sometimes a difficult matter to recognize an empty vein in bloodless tissues. The limb is then elevated and rendered ischemic by the application of an Esmarch bandage applied from the extremity of the limb up to a point well above the site of injection. Some care should be taken in applying this bandage as it is necessary that the veins be thoroughly emptied. A tourniquet

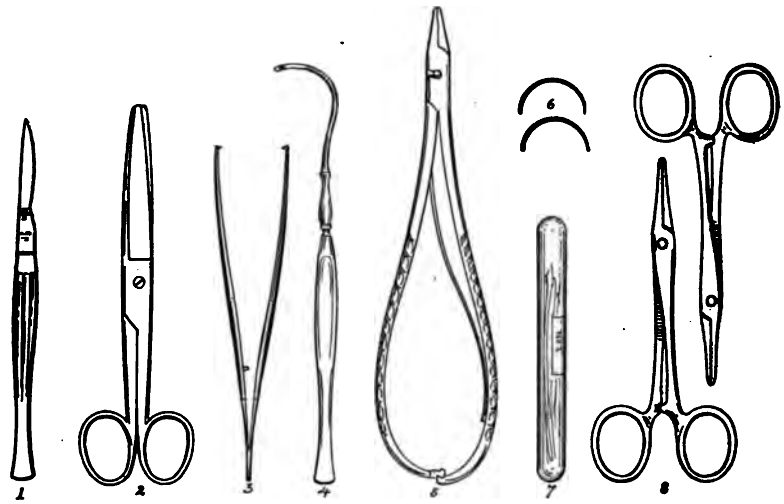


FIG. 73.—Instruments for venous anesthesia. 1, Scalpel; 2, blunt-pointed scissors; 3, thumb forceps; 4, aneurysm needle; 5, needle holder; 6, curved needles; 7, No. 2 plain catgut; 8, artery clamps.

is then applied at the upper limit of the bandage used to exsanguinate the part by wrapping a soft rubber bandage about the limb in broad bands so as not to cause the patient any unnecessary discomfort, and the first bandage is removed for a distance of 4 to 10 inches (10 to 25 cm.). At this point a second tourniquet is applied and the remaining portion of the Esmarch is entirely removed (Fig. 74). The appearance of the limb after the removal of the expulsion bandage is important. Mottling or cyanosis of the skin indicates that the veins have not been completely emptied, whereas, if the expulsion bandage has been properly applied, the skin will appear perfectly white and there will be a segment of the limb lying between the two bandages in which the vessels are entirely empty of blood.

When the operation is near an extremity only one tourniquet need be employed. It should not be placed, however, higher than the middle of the forearm or leg. Under infiltration anesthesia with a 0.2 per cent. solution of cocain or a 1 per cent. solution of procain, one of the main subcutaneous veins, previously selected, is exposed by a small transverse incision in the proximal part of the isolated area. The vein is opened by cutting with scissors, its proximal end is tied off, and the cannula is secured in its distal end. Any small veins that may be cut are securely clamped to prevent leakage of the solution. The anesthetic is then injected under considerable pressure toward the periphery,[1] *i.e.*, against the valves of the veins, until the superficial veins swell and the whole segment between the two bandages becomes paler than before. The stopcock is then closed and the syringe removed, the cannula being left in place for further injection if necessary.

FIG. 74.—Bier's venous anesthesia. Showing the application of the bandages and the site of injection +.

In this way the anesthetic solution is distributed through the tissues between the two tourniquets and is brought in contact with the nerve trunks and nerve endings of the whole area. Direct anesthesia follows between the bandages in three to five minutes, and indirect anesthesia beyond the distal bandage is observed in six to twenty minutes. If the proximal bandage causes pain, as is sometimes the case, a second one may now be placed immediately below it on the anesthetized area and the first one may be removed. As a rule, some motor paralysis occurs in the anesthetized area, but it soon disappears after removal of the bandages. Anesthesia persists as long as the bandages remain in place and rapidly disappears after their removal, so it is necessary that the operation, including hemostasis and suturing, be completed before the bandages are removed. If difficulty is experienced in recognizing cut vessels, saline may be injected into the cannula and it will spurt from the open

[1] Bier in a later communication (*Edinburg Medical Journal*, Aug., 1910) states that the injection may also be made centrally, opening the vein close to the distal bandage.

ends. The danger of poisoning from absorption of the drug employed for anesthesia may be disregarded. This apparent danger was formerly guarded against by washing out the veins with saline at the end of the operation. This precaution is now regarded as unnecessary, for, according to Bier, the anesthetic quickly goes through the vein wall and the greater portion of it becomes bound up in the tissues, returning to the circulation very gradually.

Variations in Technic.—Following Bier's lead, others have injected local anesthetics into the arterial system instead of into a vein. Thus Goyanes (quoted in *Centralblatt für Chirurgie*, 1909, Vol. XXVI) describes a method of regional anesthesia by the injection of the anesthetic solution into an artery. Two to 3 ounces (50 to 100 c.c.) of a 0.5 per cent. solution of novocain (procain) in normal salt solution, colored with a few drops of concentrated methylene blue solution so that the operator may note the penetration of the tissues by the anesthetic, are slowly injected by means of a *fine* needle inserted obliquely into the vessel between Esmarch bandages in a manner very similar to the method of Bier.

Ransohoff (*Annals of Surgery*, April, 1910) describes a method of terminal arterial anesthesia obtained by injecting cocain solution into an artery supplying the area of operation. He reports two cases in which the method was employed, as well as a number of experiments upon animals which would seem to show that it is a safe and efficient procedure in suitable cases. He recommends this method as being especially applicable to operations upon the upper extremity where the brachial, ulnar, or radial artery may be exposed without difficulty and in operations upon the foot or ankle after exposure of the anterior tibial artery.

Ransohoff's technic is as follows: "The main artery supplying the part to be anesthetized is exposed under infiltration anesthesia. An Esmarch strap is now bound about the limb some distance above the point of proposed injection into the artery. The Esmarch should be used as in the Bier hyperemic treatment; that is, snug enough to constrict the veins, but not so tight as to interfere with the arterial circulation. From 4 to 8 c.c. (1 to 2 dr.) of a 0.5 per cent. solution of cocain in normal salt solution should be injected into the artery in the direction of the blood stream. The needle used should be as fine as possible. After anesthesia is complete, the Esmarch may be tightened if perfect hemostasis is desired."

It is claimed that the cocain thus introduced is carried by the capillaries to the individual nerve endings and the solution is diffused through the capillary walls into the surrounding tissues so that little, if any, solution is returned to the general circulation.

It has not been shown that arterial anesthesia possesses any advantages over venous anesthesia, and the arterial method is far more difficult to carry out and on account of the deep situation of the vessels which have to be exposed for the purpose of making the infection.

SPINAL ANESTHESIA

This form of anesthesia is produced by injecting weak solutions of drugs having local analgesic properties into the subarachnoid space. Cocainization of the spinal cord was first suggested by Corning in 1885. Bier, in 1899, improved upon the method and made it practicable for surgical purposes.

The enthusiasm with which spinal anesthesia was first received has, however, proved unwarranted by practical results. The mortality is higher than from ether or chloroform, and it is not absolutely certain that permanent harm to the cord may not result. Certainly, cases have been reported which would suggest such a possibility. In a certain percentage of the cases anesthesia does not develop or is incomplete, and at times most unpleasant symptoms accompany the anesthesia; headache, nausea, vomiting, sweating, chills, rise of temperature, or collapse are by no means rare. Spinal anesthesia has a place in surgery, without doubt, but it should be reserved for those exceptional cases in which general anesthesia is contraindicated or other methods of local anesthesia are impracticable. Recent syphilitic infections, diseases of the brain and spinal cord, marked curvature of the spine, and cases of general septicemia are contraindications to spinal anesthesia.

Injections have been made in all portions of the cord, but for practical surgical purposes they are now limited to the lumbar region. The danger of inducing respiratory paralysis is too great to warrant the introduction of analgesics into the higher regions of the cord.

Solutions Used.—All the various local anesthetics have been used, but at the present time stovain and tropacocain are the drugs most frequently employed for spinal anesthesia.

Cocain is now generally discarded for some of the less dangerous substitutes. If employed, it may be used in a 2 per cent. solution in normal salt solution, 10 to 40♏ (0.6 to 2.5 c.c.) of such a solution, containing between 1/5 and 1 gr. (0.01296 and 0.065 gm.) of cocain, are injected. The addition of a few drops of a 1 to 1000 solution of adrenalin chlorid to the cocain is said to be of great benefit, preventing the rapid diffusion of the anesthetic, and many of the unpleasant after-effects.

Stovain is less toxic than cocain and is very highly recommended by many authorities. A 5 per cent. solution is used, the dose being 3/4 to 1 gr. (0.0486 to 0.065 gm.).

Procain (novocain) is also frequently employed. It is about seven times less poisonous than cocain. A 5 per cent. solution in normal salt solution is employed. The ordinary dose is from 3/4 to 1 1/2 gr. (0.0486 to 0.0974 gm.).

Tropacocain is another substitute for cocain frequently used, and the anesthesia is more lasting. It is given in a dose of from 1/2 to 1 gr. (0.0324 to 0.065 gm.) in a 5 per cent. solution.

At the present time many operators employ solutions with a higher or a lower specific gravity than the cerebrospinal fluid, so that when the solution is injected it will either fall or rise. To render the solution lighter or more diffusible alcohol is added. Babcock (*J. A. M. A.*, Oct. 11, 1913) gives the following formulæ for light solutions:

		(Approximately)
A. Stovain,	0.08 gm.	1 1/4 gr.
Lactic acid,	0.04 c.c.	2/3 gr.
Absolute alcohol,	0.2 c.c.	3 minims
Distilled water,	1.8 c.c.	30 minims
B. Tropacocain,	0.1 gm.	1 1/2 gr.
Absolute alcohol,	0.2 c.c.	3 minims
Distilled water,	1.8 c.c.	30 minims
C. Novocain (procain),	0.16 gm.	2 1/2 gr.
Absolute alcohol,	0.2 c.c.	3 minims
Distilledwater,	1.8 c.c.	30 minims

One to 1.5 c.c. (16 to 25 minims) of these mixtures is given as the adult dose

Barker employs the following solution:

Stovain,	five parts
Glucose,	five parts
Distilled water,	ninety parts (all by weight).

This solution is heavier than the cerebrospinal fluid, having a specific gravity of 1023 against 1007 for the cerebrospinal fluid, and sinks to the lowest level of the canal. It is, therefore, possible to obtain an anesthesia at any level by adjusting the patient's position by the aid of pillows so that the desired vertebra lies at the lowest level.

The injection of a solution of Epsom salt has been advocated by Meltzer, Haubold, and others. Sixteen minims (1 c.c.) of a 25 per cent. solution are given for every 25 pounds (10 K.) of body weight. Three to four hours after the injection paralysis and analgesia in the legs and pelvic regions appear and persist for from eight to fourteen hours. It is claimed that overdosage endangers life from respiratory paralysis.

Apparatus.—A special stylet needle and an appropriate syringe with a capacity of about 1¼ drams (5 c.c.) should be provided. The needle should be of platinum or nickel, 1/25 inch (1 mm.) in diameter, and about 3¾ inches (9.5 cm.) long. The stylet must be ground to a point with the needle and should fit the latter accurately at the point, to avoid carrying in fragments of tissue as it traverses the flesh. It is important that the point of the needle be not too long—the more

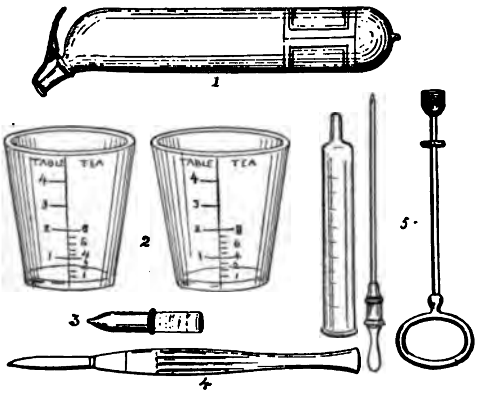


FIG. 75.—Apparatus for spinal anesthesia. 1, Ethyl chlorid; 2, medicine glasses, one for receiving the spinal fluid and the other for the anesthetic solution; 3, ampule containing the anesthetic; 4, scalpel; 5, syringe and trocar.

transversely it is ground the better. With a short-pointed needle the liability of injecting only a portion of the solution into the canal and part outside the subarachnoid space is quite remote. In addition, a scalpel for making the preliminary puncture and sterilized medicine glasses for holding the solution to be injected should be provided (Fig. 75).

Location of the Puncture.—Any of the spaces between the second lumbar and the first sacral vertebra is available for the puncture, but the usual site is between the third and fourth, or the fourth and fifth lumbar vertebra (Fig. 76). The spaces may be identified by counting down from the seventh cervical vertebra. If this is difficult on account of excess of fat, the fourth lumbar spinous process may be readily located, and from it the other vertebræ, by passing a line between the highest points of the iliac crests. Such a line passes through the tip of the spinous process of the fourth lumbar vertebra (Fig. 77). Puncture in the mid-line is generally practised, as it

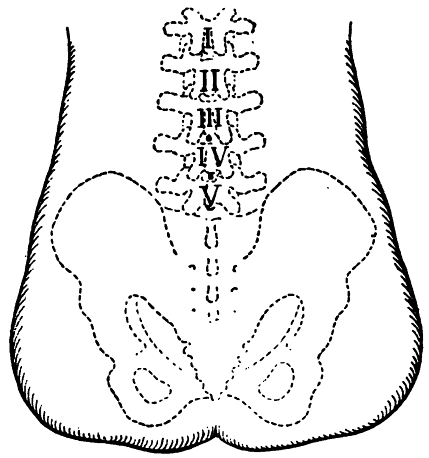


FIG. 76.—Points for injecting the anesthetic solution in spinal anesthesia.

insures the solution being more evenly distributed on both sides of the cord and lessens the chance of a one-sided analgesia. A point between the two spines in the mid-line is chosen, and starting from

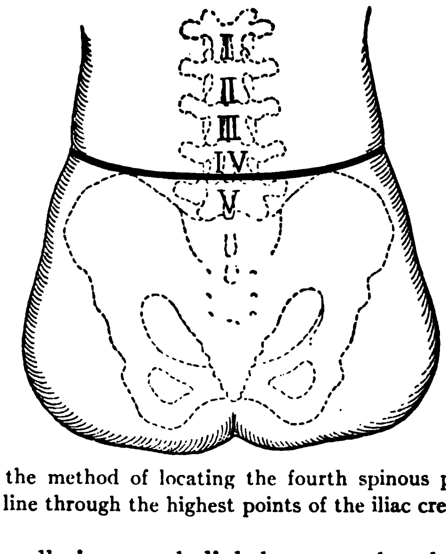


FIG. 77.—Showing the method of locating the fourth spinous process by passing a line through the highest points of the iliac crests.

this point the needle is passed slightly upward and forward between the spinous processes. The average space available for the puncture between the bones in the lumbar portion of the cord is $\frac{18}{25}$ to $\frac{4}{5}$

inch (18 to 20 mm.) in the transverse, and ⅜ to ⅝ inch (10 to 5 mm.) in the vertical diameter.

Preparation of the Patient.—This should be the same as for an operation under general anesthesia (see page 18). If the operation

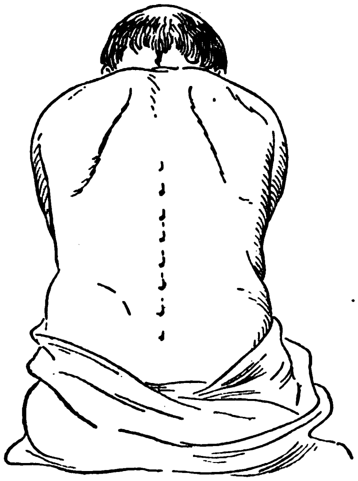


FIG. 78.—Sitting position for spinal puncture.

is to be a prolonged one, morphin gr. ¼ (0.0162 gm.) should be given hypodermically half an hour beforehand.

Position of the Patient.—The body of the patient is curved well forward so as to widen the intervertebral spaces as much as possible. For this purpose the patient sits up, leaning well forward, with his

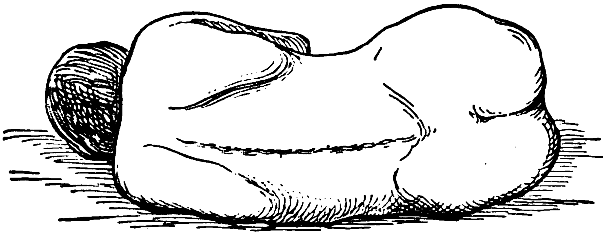


FIG. 79.—Lateral position for spinal puncture.

back to the operator (Fig. 78), or else lies upon one side with the back in the form of an arch (Fig. 79).

Asepsis.—The operation should be performed with the greatest aseptic care. The needle and syringe should always be boiled in plain water, the solution injected must be sterile, and the operator's hands and site of operation should be prepared with all the care that would be observed in any operation.

Technic.—The spot chosen for the puncture is anesthetized with ethyl chlorid or by infiltration with a few drops of cocain, and a small puncture is made in the skin with a scalpel (Fig. 80), to lessen the danger of carrying in infection with the needle. The operator then identifies with his finger a point in the mid-line between the two spinous processes bounding the space for the puncture, and inserts the needle armed with its stylet in a slightly upward and forward direction until it enters the subarachnoid space (Fig. 81). Lessened resistance, followed by the escape of the fluid from the needle, determines

Fig. 80.—Spinal anesthesia. First step, nicking the skin at the site of puncture.

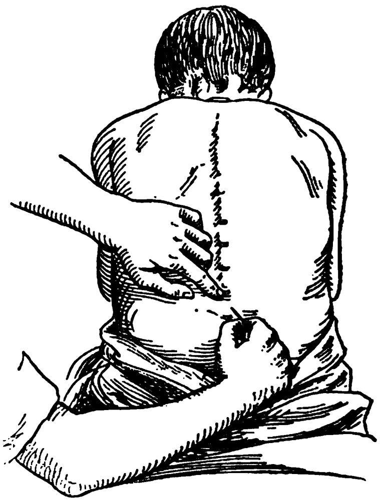


Fig. 81.—Spinal anesthesia. Second step, inserting the needle.

when this is accomplished. The distance necessary to be traversed varies from 1 to 1½ inches (2.5 to 4 cm.) in a child, 2½ to 3 inches (6 to 7.5) in an adult. In inserting the needle, if it strikes bone, it should be withdrawn slightly and its direction changed. The cerebrospinal fluid should gush out with some force on removal of the stylet and should be clear. If only a few drops escape or the fluid is reddish in color it indicates that the needle is not properly inserted, and a new puncture should be made. A quantity of cerebrospinal fluid, corresponding to the amount of anesthetic to be injected, should be allowed to escape before the analgesic solution is introduced (Fig. 83). This will vary from 10 to 40♏ (0.6 to 2.5 c.c.), according to the strength of the solution to be used. As soon as the desired quantity of cerebrospinal fluid has escaped, the flow is stopped by placing a finger over the end of the needle, and the syringe, filled with the proper amount of solution, is attached. Some operators prefer to dissolve the analgesic agent in the cerebrospinal fluid withdrawn and reinject the solution thus formed. The solution should always be slowly introduced (Fig. 84). The needle is then withdrawn and the puncture sealed with collodion and cotton, or is dressed with a piece of gauze held in place by adhesive plaster. If a heavy solution is employed and the operator desires a low anesthesia only, the patient is kept in the upright position for a few moments after the injection to allow the solution to gravitate downward, but, if a light solution is used, the patient's head must be *immediately* lowered to prevent its rapid spread upward.

FIG. 82.—Showing the direction of the needle in entering the spinal canal.

As the solution comes in contact with the nerve roots it blocks

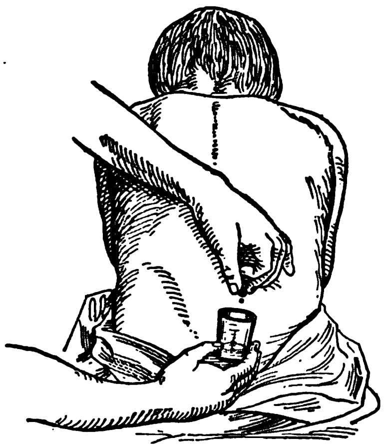


FIG. 83.—Spinal anesthesia. Third step, allowing the cerebrospinal fluid to escape.

FIG. 84.—Spinal anesthesia. Fourth step, injecting the anesthetic solution.

their conductivity, and in from ten to fifteen minutes loss of sensation, often accompanied by muscular paralysis, takes place. The anesthesia becomes marked first in the anal and perineal regions, and then in the lower extremities, being limited above, as a rule, to a zone not higher than the waist line. With a successful injection, any operation about the lower extremities, the anus, perineum, or pelvis may be readily performed. The anesthesia thus obtained persists for two hours or longer.

Following the operation the patient is kept recumbent in bed with the upper part of his body slightly raised and is not permitted to sit upright for twenty-four hours.

SACRAL OR EPIDURAL ANESTHESIA

The idea of anesthetizing the sacral nerves by injecting drugs into the extra-dural space through the lower end of the sacral canal originated with Cathelin. Later the method was employed in obstetrics for the purpose of obtaining painless deliveries, but it never came into general use. More recently sacral anesthesia has been revived and the technic improved by Läwen and others to such an extent that the method is now of recognized value in operations upon the genital and anal regions below the level of the fifth lumbar nerve.

The injection into the sacral canal of normal salt solution alone or in combination with drugs has also been employed extensively as a therapeutic measure for eneuresis and pelvic neuralgias and neuroses.

Like spinal anesthesia, the sacral method fails in a certain proportion of cases even in the hands of those skilled in its use, and in some cases only partial anesthesia is obtained. Most of the failures are met with in very stout individuals. In a successful case the anesthesia usually lasts for from ¾ to an hour. The anesthesia is not accompanied by unpleasant symptoms, such as headache and vomiting, that are sometimes observed in spinal anesthesia, though a transient pallor, acceleration of the pulse, and a fall in blood-pressure may occur.

Anatomy.—Upon the dorsal surface of the sacrum in the median line may be recognized the spinous processes of the three or four upper vertebræ, the fourth spine sometimes, and the fifth spine always being absent through failure of the lamina to coalesce. A triangular gap, known as the hiatus sacralis, is thus formed through which a needle may be readily passed into the sacral canal. The lower margins of this opening are prolonged downward as two tubercles, the sacral cornua (Fig. 85).

The sacral canal contains the lower end of the cauda equina, the filum terminale, and the spinal dura. The latter extends to the level of the second sacral vertebra or to within 2½ inches (6 cm.) of the hiatus (Fig. 86).

Instruments.—The instruments required are the same as for spinal anesthesia (page 117), except a larger syringe—one with a capacity of about 5 drams (20 c.c.)—will be found preferable.

Solutions Used.—Cocain, procain, and quinin and urea have all been used for sacral anesthesia, but procain is the drug generally employed. It is claimed that the addition of sodium bicarbonate to

FIG. 85.—The posterior surface of the sacrum, showing the hiatus sacralis.

FIG. 86.—Showing the interior of the sacral canal.

the procain solution adds to the anesthetic effect. The solution is made up as follows:

Sodium bicarb., puriss.,	0.25 gm. (3¾ gr.)
Sodium chlorid,	0.5 gm. (8 gr.)
Procain,	1 gm. (15 gr.)

This is dissolved in 100 c.c. (3⅓ ounces) of cold sterile distilled water, and is sterilized by boiling. When it has cooled, 5 drops of a 1 to 1000 adrenalin chlorid solution are added The quantity of procain used at a dose is from 0.4 to 0.6 gm. (6 to 9 gr.).

Preparation of Patient.—The patient is given by hypodermic half an hour before the operation morphin gr. ⅙ (0.0108 gm.) and atropin gr. 1/100 (0.00065 gm.). To this may be added scopolamin gr. 1/100 (0.00065 gm.), if the operation is especially difficult or prolonged.

Position of Patient.—The patient should be in the Sims position.

Site of Puncture.—The puncture is made in the median line through the lower end of the sacral canal. The opening is identified by palpating the spinous processes of the sacrum downward until it is felt that they divide in a fork-like manner, forming the boundaries of a triangular area, the hiatus.

Asepsis.—The instruments are sterilized by boiling in plain water, the solution is boiled, and the operator's hands are cleansed as for any operation. The patient's skin at the site of proposed puncture is painted with tincture of iodin.

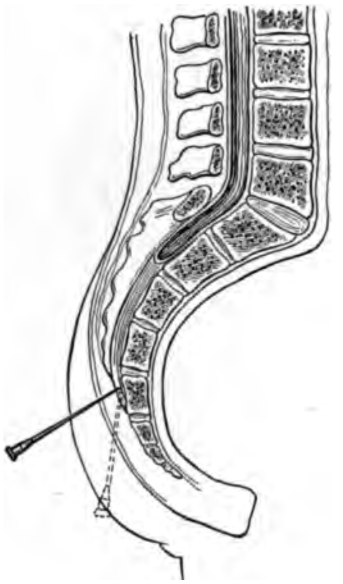


FIG. 87.—Direction taken by the needle in entering the sacral canal.

Technic.—The point of proposed puncture is located and the skin is infiltrated with a 0.2 per cent. solution of cocain or a 1 per cent. solution of procain. A small nick is then made in the skin, and the needle, with the trocar in place, is inserted at an angle of about 45 degrees until it strikes the bone forming the anterior wall of the canal (Fig. 87). The trocar is then withdrawn, and the direction of the needle is changed to correspond with the direction of the sacral canal. It is then pushed into the canal for a distance of about an inch (2.5 cm.). the needle is in the canal its point may be freely moved about, and, upon making a test injection with normal salt solution, the solution can be injected with ease. If difficulty is met in inserting the needle, the sacral opening may be first exposed by an incision under infiltration anesthesia.

A little blood may flow from the needle, due to injury to some small veins, and may be disregarded, but, if the bleeding is profuse, or if blood escapes in spurts, the injection should be abandoned; the same is true if clear fluid escapes from the needle indicating that the dura has been punctured. The anesthetic solution should be injected very slowly, and, when the desired quantity has been introduced, the needle is removed and the point of puncture is sealed with collodion and cotton. The patient is then brought into position for operation, and in from 3 to 5 minutes the anesthesia is complete.

PARASACRAL ANESTHESIA

Another method of securing anesthesia for operations in the region of the perineum is the parasacral blocking of the sacral nerves as they emerge from the sacral foramina. When properly performed, paralysis of the sphincter ani is produced, and the prostatic urethra and the bladder are anesthetized. The anesthesia is thus sufficient for vaginal, prostatic, and rectal operations, but does not extend sufficiently high for operations involving the uterus and adnexa. The anesthesia is more certain than that following an epidural sacral injection and is without after effects.

Anatomy.—Examination of the anterior surface of the sacrum shows that the distance between the adjoining sacral foramina from the 5th to the 2nd measures ¾ of an inch (2 cm.) and between the 2nd and 1st one inch (2.5 cm.), and that a straight line between the 5th and 1st sacral foramina will pass directly over the intervening foramina. Such a line starts at the lower free margin of the sacrum ¾ of an inch (2 cm.) from the median line and diverges slightly, about ⅛ of an inch (0.3 cm.), as it passes up to the 1st sacral foramen.

Viewed laterally, the anterior surface of the sacrum is practically flat between the 5th and 2nd sacral foramina, but from the 2nd to the 1st it is curved anteriorily.

The sacral foramina may thus be readily reached by a needle and the nerves blocked as high as the 2nd sacral by passing a needle upward in a straight line with a slight outward divergence from a point ¾ of an inch (2 cm.) from the median line on the lower edge of the sacrum. The needle cannot be advanced further without striking bone, owing to the forward curve of the sacrum, and to reach the 1st sacral foramen and nerve, the point of the needle must first be elevated about half an inch (1 cm.) and then inserted along the same line as before an inch (2.5 cm.) further.

Instruments.—A syringe with a capacity of 5 drams (20 c.c.), a fairly fine needle 5 inches (12 cm.) long, and a glass graduate with a capacity of 3 ounces (100 c.c.) will be required.

Solution.—A 1 per cent. procain-adrenalin solution in normal salt solution is employed.

Quantity.—For blocking the nerves on both sides about 3 ounces (100 c.c.) of solution will be required.

Preparation of the Patient.—The patient's rectum should empty. Half an hour before the operation the patient is given m phine gr. 1/6 (0.0108 gm.) and atropin gr. 1/100 (0.00065 g hypodermically.

Position of Patient.—The patient should be in the lithoto position.

Site of Puncture.—The needle is inserted into the tissues a point 3/4 of an inch (2 cm.) from the median line on the right a left of the sacro-coccygeal articulation.

Asepsis.—The instruments are sterilized by boiling in pla water, the solution is boiled and the operator's hands are prepared for any surgical operation. The skin at the points of puncture painted with tincture of iodin.

Technic.—If a fairly fine needle is employed, preliminary an thesia of the skin at the point of proposed puncture may be di pensed with. Braun's technic for bloc ing the nerves is as follows: The needle inserted on a level with the sacro-cocc geal point 3/4 of an inch (2 cm.) from t median line parallel to the anterior su face of the sacrum. The lower edge the sacrum is sought for, and from th point the needle is passed 2½ to 3 inch (6 to 7 cm.) along the inner surface of t sacrum on a line diverging slightly fro the midline until bone is reached. Th will be at the 2nd sacral foramen. Fi drams (20 c.c.) of the anesthetic soluti is injected as the needle is withdra from the 2nd to the 5th sacral foramina. With the needle withdra to the lower edge of the sacrum its direction is changed by elev ing its point toward the innominate line, and it is again insert nearly parallel to the mid-line to a depth of 3½ to 4 inches (9 10 cm.) from the edge of the sacrum, when it should strike bone the 1st sacral foramen. Here 5 drams (20 c.c.) more solution is jected. Finally 1¼ drams (5 c.c.) of the solution is injected tween the rectum and coccyx. The same procedure is carried on the opposite side.

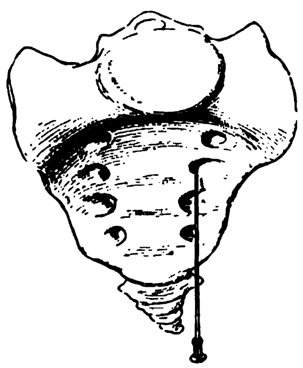


Fig. 88.—Method of inserting the needle for parasacral anesthesia (Warbasse).

If the rectum is empty and the needle is kept in close cont with the sacrum while it is being inserted, there is little dange injuring the bowel, but, as a precaution, the index finger may inserted into the rectum as a guide.

CHAPTER III

SPHYGMOMANOMETRY

Sphygmomanometry is the instrumental estimation of arterial blood-pressure. The determination of blood-pressure has become a subject of such practical importance that both physicians and surgeons should be familiar with the technic. In certain cases it is often of the greatest value not only in making a diagnosis, but for purposes of prognosis and as a guide to the treatment. It is especially important in surgical work in determining the fitness of a subject for anesthesia (see also page 20) and during an operation in revealing impending danger from shock or cardiac weakness. For the latter purposes it should be employed as a routine in all serious operations likely to be attended by shock or considerable hemorrhage.

In studying blood-pressure two measurements are made, namely, the systolic and the diastolic pressure, and from these readings the pulse pressure and the mean pressure are determined. The systolic pressure is the maximum pressure caused by the systole of the heart; diastolic pressure is the minimum pressure in the artery. The pulse pressure is the difference between the systolic and the diastolic pressure, while the mean pressure is the arithmetic mean of the systolic and diastolic pressures; for example, if the systolic pressure is estimated at 145 mm. and the diastolic pressure at 105 mm., the mean pressure would be 125 mm.

The instrument employed for estimating blood-pressure consists essentially of a hollow rubber band for compression of an artery, connected with a manometer and inflating bulb. The amount of pressure necessary to obliterate the pulse distal to the point of constriction measured in millimeters of mercury represents the systolic blood-pressure. The diastolic pressure is obtained by gradually releasing the air from the compression band after the pulse has been obliterated and noting the oscillations of the column of mercury in the manometer, the base line of the greatest oscillation representing the diastolic pressure. Both systolic and diastolic pressure should be taken when it is possible, but of the two the determination of the systolic pressure is of most importance, as pathological conditions affect it more than the diastolic.

The average normal systolic pressure obtained with the wide cm.) armlet, according to Janeway, is as follows:

For children up to two years,	75–90 mm. of mercury
For children over two years,	90–110 mm. of mercury
For adults,	100–130 mm. of mercury

In females the pressure is about 10 mm. less than in males. Af middle life the pressure generally reads higher—often as high as : mm. A systolic pressure between 145 and 90 mm. in an adult m therefore, be considered within the limits of health. If, on repea examinations, the pressure registers above or below these limits should be viewed with suspicion. A pressure above 200 mm considered very high and below 70 mm. very low, while below 4 40 mm. the pulse can rarely be recognized. The diastolic press normally registers 25 to 40 mm. less than the systolic. If the dif ence between the two is less than 20 mm. or more than 50 mm. indicates, in the first instance, an abnormally small pulse, and, in latter case, an abnormally large pulse.

As blood-pressure is dependent upon the quantity and velocity the blood entering the circulation with the contraction of the ventricle, the elasticity of the arterial walls, the volume of blooc the circulation, and on the resistance in the peripheral vessels, it be readily seen that it may be subject to considerable variatior health and may be modified by many circumstances. Anyth which increases one or other of these factors will raise the blood-p sure and *vice versa*. Thus a recent meal, fear, anxiety, self-conscic ness, mental application, pain, drugs which act upon the vascı system, such as camphor, caffein, strychnin, digitalis, adrenalin, e increase blood-pressure. Cold causes a rise in blood-press through its constricting effect upon the peripheral vessels; warn has the opposite effect. Smoking likewise increases it if it ha stimulating effect, but causes it to fall if it depresses. Exercise the same effect, that is, it increases pressure unless it is carried exhaustion, when the pressure falls. The posture of the individ also modifies the pressure reading, it being 10 to 15 mm. higher w the person standing than when lying down. Likewise, the press is generally higher in the afternoon. The size of the encircling ba is also important, the narrow bands giving a higher reading than broad ones. Furthermore, as the estimation of pressure depends the tactile sense of the individual palpating the pulse, the press readings in the same patient will vary somewhat with differ observers. Therefore, to avoid these sources of error and obt readings of value for comparison, the determination of pressure should always be made by the same observer, under the same conditions, at the same time of day, with the patient in the same position, and at rest mentally and physically, and employing the same size armlet.

Instruments.—There have been a number of excellent sphygmomanometers devised, such as the Riva-Rocci, Stanton, Erlanger, Janeway, Hill and Barnard, Faught, Rogers, etc. A few of these will be described.

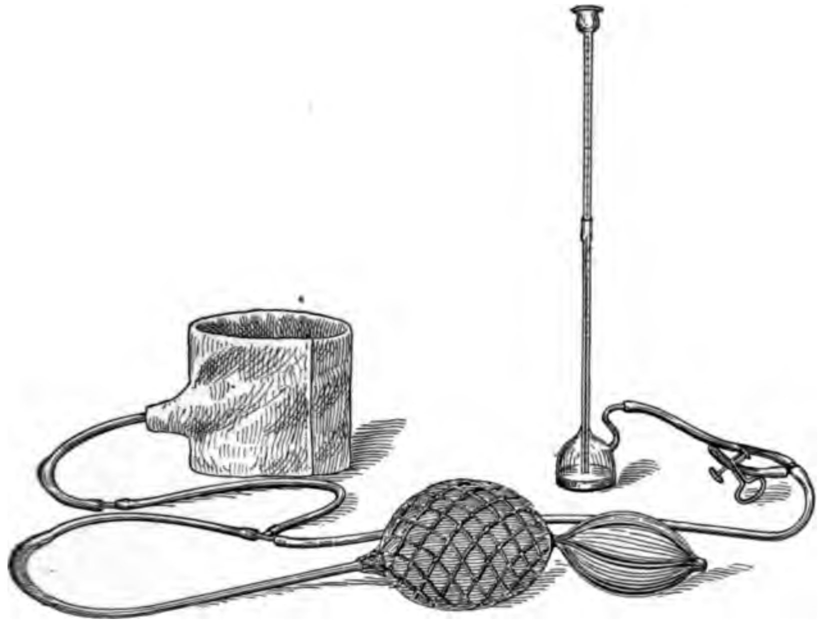


Fig. 89.—The Riva-Rocci Sphygmomanometer.

The Riva-Rocci sphygmomanometer (Fig. 89), as modified by Cook, consists of a portable manometer with a jointed tube and scale reading up to 320 mm. The armlet consists of a rubber bag 4½ inches (11.5 cm.) wide by 16 inches (40 cm.) long, covered with canvas, and supplied with hooks and eyes for fastening it in place. A Richardson double inflating bulb is connected with the armlet, and also with the manometer by means of a glass T-tube and rubber tubing. A second glass T-tube is inserted in the rubber tubing near the manometer, to the long arm of which is attached a short rubber tube supplied with a pinchcock, for the purpose of releasing the pressure.

Stanton's instrument (Fig. 90) consists of a rubber compression armlet 4½ inches (11.5 cm.) wide by 16 inches (40 cm.) long, in-

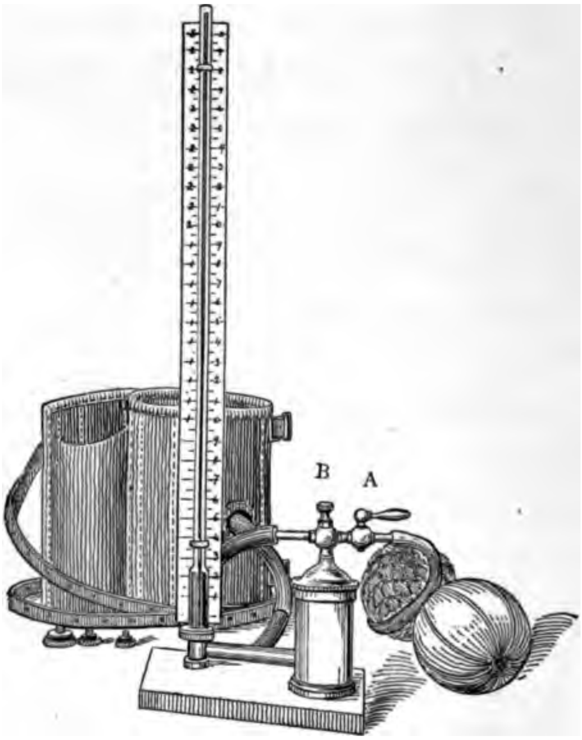


FIG. 90.—Stanton's Sphygmomanometer.

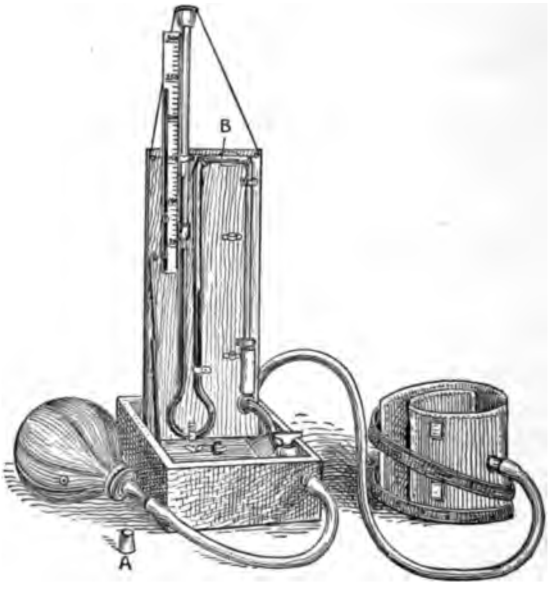


FIG. 91.—Janeway's Sphygmomanometer.

closed in a cuff of leather or thick canvas reinforced by tin strips. In the center of the cuff is cemented a glass tube ¼ inch (6 mm.) in diameter. The manometer consists of a metal cistern connected by a metal tube with a glass mercury tube having a scale registering to 300 mm. The metal cistern is provided with a screw cap having a T-shaped metal tube, one arm of which is connected with the armlet and the other with the inflating apparatus, which consists of a double inflating bulb. At the top of the metal cistern is a screw valve "B" for the gradual release of pressure, and on the arm connected with the inflating apparatus is a stopcock "A" to shut off the inflation.

Janeway's instrument (Fig. 91) consists of a U-shaped manometer with a sliding scale, connected with a cistern, to one side of which is attached the armlet and to the other a Politzer bag for the purpose of

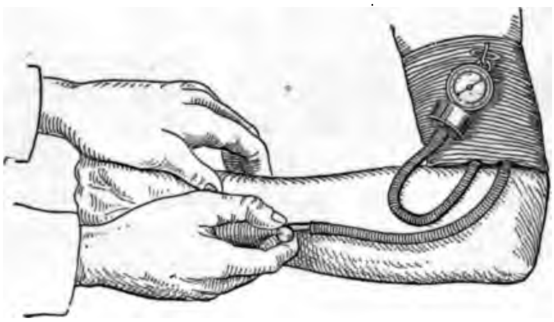


FIG. 92.—Rogers' Sphygmomanometer.

inflation. The armlet is a closed rubber bag measuring 4¾ inches (12 cm.) in width and 18 inches (45 cm.) in length, inclosed in a leather cuff that is fastened to the limb by means of two straps. A stopcock containing a needle valve for the release of pressure is interposed between the cistern and inflating bag. The instrument is unassembled for packing in its case as follows: The scale is slid down and the upper part of the manometer is removed and placed in rings provided for this purpose on the lid. The open end of the manometer is plugged by a small cork "A" and the other end is closed automatically when the lid is shut by a block which compresses the rubber "B." The inflation bulb is removed, and, as the box shuts, the stopcock slips under a spring "C."

Rogers' Sphygmomanometer (Fig. 92) registers blood-pressure by means of an aneroid scale. The instrument consists of a rubber armlet connected by two tubes with a gage and an inflating bulb. The dial registers from 0 to 260 mm. of mercury. Upon the tube leading from the inflating bulb is placed a valve for releasing the air from the armlet. The readings obtained by this instrument correspond very closely to the figures obtained with the mercury instruments, and the instrument has an advantage over the latter in its simplicity and ease of operation.

Whatever form of instrument is employed, a wide armlet (4½ to 4¾ inches (11.5 to 12 cm.)) should be used.

Site of Application.—The compression band may be applied to the arm or the thigh, the former being preferable.

Position of Patient.—The patient should be recumbent with the part subjected to pressure on a level with the heart.

Technic (*Riva-Rocci Instrument*).—The armlet is fastened about the arm midway between the shoulder and elbow by passing the open end of the cuff beneath the band on the closed end and hooking it in place. The manometer is placed upon a table near by, and care is taken to see that the upper portion of the mercury tube is fitted securely in the top of the lower one and that the mercury is at the zero point. The inflating bulb is then properly connected with the armlet and manometer, and the pinchcock is closed. The examiner, with the fingers of one hand palpating the patient's pulse, gradually inflates the armlet by squeezing the bulb with the other hand until the pressure obliterates the pulse, when the height of the mercury is noted. The mercury is then allowed to drop slowly until the pulse just reappears which represents the systolic pressure. For the sake of greater accuracy, this maneuver is repeated by squeezing and relaxing the reservoir bulb.

Stanton's Instrument.—The armlet is buckled in place and is connected with the manometer, the scale of which is adjusted so that the mercury registers zero. With the valve "B" closed and cock "A" open, and with the fingers of the operator on the patient's pulse, the armlet is slowly inflated until the pressure causes the pulse to disappear. The inflation cock "A" is then closed and valve "B" is gradually opened until the pulse just reappears. The height of the mercury when this occurs represents the systolic pressure. The pressure is further slowly reduced a few millimeters at a time, and, as the mercury falls, its column oscillates up and down, increasing in size until a maximum is reached and then diminishing. The base-line of the maximum oscillations represents the diastolic pressure, which is normally 25 to 40 mm. below the systolic pressure.

Janeway's Instrument.—The armlet is properly secured about the limb as described above and the scale is so adjusted that the level of the two columns of mercury is at zero. With the fingers on the radial pulse the armlet is gradually inflated by compressing the bulb, until the pulse disappears. Then, by slowly releasing the bulb until the pulse just returns, the systolic pressure is estimated. In cases of very high pressure, it may be necessary to employ more than one bulb full of air to obliterate the pulse. In such a case, the stopcock is closed, and, after the bag is refilled, the cock is opened again and the pressure raised as high as described. The diastolic pressure is obtained in the same manner as described under the technic with the Stanton sphygmomanometer.

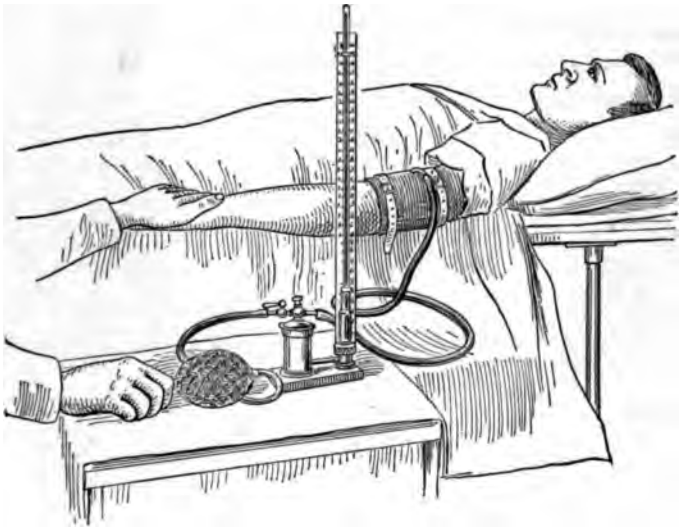


FIG. 93.—Technic of sphygmomanometry with the Stanton instrument.

Rogers' Instrument.—The compression band is applied about the arm like a bandage and is secured by slipping the free end under the last turn. The aneroid gage is hung from a hook on the outer aspect of the armlet and the gage and inflating bulb are properly connected. To measure the systolic pressure the cuff is inflated until the radial pulse is obliterated, and the pressure in the cuff is raised 1 to 2 mm. higher. Air is then allowed to escape slowly from the armlet until the radial pulse beats just reappears. The figure on the dial at which the hand points at this moment represents the systolic pressure. The diastolic pressure is obtained by allowing air to escape from the armlet very slowly until the dial shows a maximum range of oscillations. The valve is then quickly closed and the minimum oscillation is taken as the diastolic pressure.

The Auscultatory Method of determining systolic and diastolic pressure is carried out by the aid of a stethoscope instead of by palpation. The cuff is applied and the pulse obliterated in the usual way. The operator then places a stethoscope over the brachial artery below the cuff and listens for the reappearance of the first sound (Fig. 94). The height of the column of mercury when this occurs represents the systolic pressure. If the armlet be further deflated there will still be heard murmurs which rapidly disappear when the mercury drops 30 to 45 mm. below the systolic reading. The point at which all sounds disappear represents the diastolic pressure.

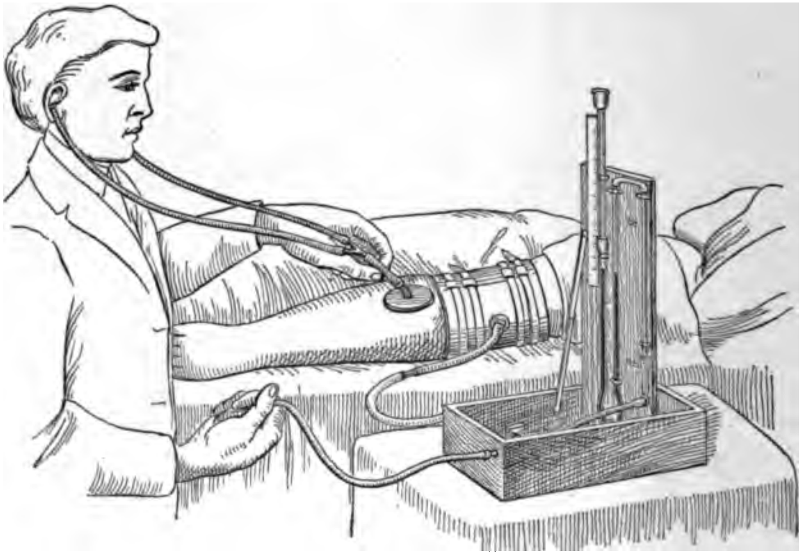


FIG. 94.—Sphygmomanometer by the auscultatory method.

With this method the systolic pressure is recorded at a slightly higher and the diastolic pressure at a lower reading than by the palpation method, and as a result the pulse pressure will be also higher.

Variations of Blood-pressure in Disease.—*Pain* of all kinds causes an increase in the peripheral resistance, and a rise in pressure. Thus, in conditions attended with severe pain, as in acute biliary or renal colic, during labor, in acute peritonitis, etc., the blood-pressure is elevated. If, however, the patient is already in a weakened state or is suffering from shock, the addition of pain may cause a fall in pressure.

Wasting diseases, or cachetic conditions, as cancer, tuberculosis, etc., are as a rule accompanied by low pressure. In tuberculosis, if the pressure is normal or increased, it is looked upon as a good prognostic sign.

In infectious diseases low pressure is the rule. In typhoid fever a rapid drop is indicative of hemorrhage; if perforation occurs, there is a sudden rise in pressure.

Toxic conditions, such as lead poisoning, acute gout, uremia, eclampsia, exophthalmic goiter, etc., are accompanied by increased pressure through reflex vasomotor stimulation.

Renal Affections.—Acute nephritis may or may not produce elevation of pressure. The same is true of chronic parenchymatous nephritis, but in the chronic interstitial variety high pressure is the rule. In any variety, with the onset of uremic symptoms, the blood-pressure rises, but falls as improvement in the condition sets in.

Cardiovascular Diseases.—In valvular lesions pressure may or may not be elevated; in fact, the results of blood-pressure observations in this class of cases are too varied to be of value. In primary myocarditis the blood-pressure is low, but when secondary to arterial or kidney disease it may be high. In arteriosclerosis the pressure is generally elevated, especially with hypertrophy of the left ventricle. Arteriosclerosis may exist, however, without elevation of pressure, and, if cardiac muscle insufficiency be present, the pressure may be below the normal.

Acute Peritonitis.—In the early stages, the pressure is abnormally high. A sharp rise may precede all other symptoms in the beginning of peritonitis from typhoid, appendicular, or other forms of perforation.

Head or Brain Injuries.—Blood-pressure is increased in compression of the brain from depressed bone, extra- or subdural clots, abscess, tumors, fracture of the base, apoplexy, etc., in proportion to the degree of intracranial tension. In acute compression from hemorrhage a high and rising blood-pressure indicates an increase in the bleeding and a progressive failure of the circulation in the medulla. When the paralytic stage of compression appears, the pressure falls. Low pressure is also found in concussion of the brain.

Hemorrhage.—The loss of considerable blood results in a rapid fall of pressure.

In shock and collapse a fall in blood-pressure is uniformly present. According to Crile, in shock, the fall in pressure is gradual, while the term "collapse" should be limited to those conditions in which there is a sudden fall in blood-pressure due to hemorrhage, injuries of the vasomotor centers, or to cardiac failure.

In Surgical Operations.—Ether causes a rise or else has no effect; even in large quantities, it rarely causes a fall. Chloroform, on the other hand, causes a fall in pressure. Nitrous oxid as a rule causes an increase in pressure.

Superficial cutting operations cause a rise through irritation of the peripheral nerves—irritation of the larger nerve trunks causing a greater rise. Opening the abdominal cavity likewise produces a rise followed by a fall, the degree depending upon the length of exposure of the viscera to the air, the amount of handling, separation of adhesions, and sponging.

Under local anesthesia alterations in blood-pressure are less marked than when the same procedures are carried out under general anesthesia.

CHAPTER IV

TRANSFUSION AND THE INJECTION OF HUMAN BLOOD SERUM

TRANSFUSION

The term transfusion, as commonly used, is applied to the transference of blood from the vessels of a healthy individual (the donor) to those of the patient (the recipient), while the term infusion is restricted to cases in which other media than blood are so introduced.

There is good evidence from records of cases that transfusion has been practised for many centuries, but it was not until Lower, in 1665, and Denys, in 1667, published their results that the operation was used to any great extent. After this, it was employed for such a variety of purposes and so extravagant were the claims of its exponents that the French government prohibited its use, and it soon fell into disrepute. Early in the nineteenth century the operation was revived, and it became a recognized means of supplying the body with fluids to replace that lost from excessive hemorrhage, notably that occurring after childbirth.

The transfusion was either performed directly by means of glass cannulæ tied in the blood-vessels and joined by rubber tubing, or else indirectly, the blood being drawn from the donor, and, after first being defibrinated by whipping, the serum resulting was injected into the veins of the recipient. Frequently the blood of dissimilar species, such as sheep's blood, was employed. There were many accidents resulting from the use of alien blood, and from the employment of transfusion in an improper class of cases, to say nothing of the dangers of infection and of embolism to which the patient was exposed by the methods used, so that the results were variable and uncertain, and in some cases even fatal.

As the subject became more thoroughly studied and better understood, it was recognized that the blood of dissimilar species, through its faculty for breaking up the red blood-corpuscles, was impracticable and dangerous for the purpose of introduction into the human circulation, and that direct transfusion from artery to vein or vein to vein only was permissible. Furthermore, it was contended by many that transfusion was a failure outside of increasing the volume of fluid in the circulation, as the blood elements did not retain their vitality, and quickly died in the vessels of the receiver. Added to this, the uncertainty of blood-vessel anastomosis as formerly practised and the fact that transfusion required the use of material and instruments often difficult to procure in an emergency, materially limited the usefulness of the operation, and it became less and less used. Finally, with the introduction of infusions of normal salt solution as a substitute, transfusion practically became extinct.

During the past fifteen years, largely through the work of Carrel, Crile, and others in this country, transfusion was revived, and with the development of improved methods of blood-vessel anastomosis it became a practical operation, the value of which in certain cases even outside of hemorrhage and shock is well established, both experimentally and clinically. More recently still attention has been again focused upon indirect transfusion through improvements in the syringe cannula method by Lindeman, Unger, and others, and the use of paraffin coated tubes. Success with these methods, however, depends upon the ability of the operator to transfer the blood from the donor to the recipient before coagulation takes place. A further step in simplifying indirect transfusion was the addition to the blood of sodium citrate, which prevents coagulation and at the same time does not alter the normal properties of the blood. The development of this method was largely the work of Weil and Lewisohn, and at the present time, owing to its simplicity, transfusion of citrated blood enjoys the widest popularity and is the method of choice.

Indications and Contraindications.—The principal indication for transfusion is severe hemorrhage. Crile has shown that if performed early enough it is a specific remedy. Experimentally he has successfully treated every degree of hemorrhage; dogs were even bled to the last drop that would flow and were then successfully transfused. Transfusion is also indicated in pathologic hemorrhage, where the coagulability of the blood is deficient, as in hemophilia, hemorrhage of the new born, cholemia, hemorrhage from the bowels, etc. In these cases the condition of the patient has been at least improved by the operation and in most cases the hemorrhage has been controlled, though more than one transfusion may be required before permanent improvement is noted.

For shock, transfusion is at times of the greatest value. It exerts far greater influence on blood-pressure than does saline solution. Both will raise blood-pressure, but the latter will not maintain the rise in pressure. Transfusion, on the other hand, frequently raises the blood-pressure above normal and will sustain it at a high level for a number of hours.

For illuminating-gas poisoning, where chemical changes occur which prevent the blood cells from giving up carbon dioxid and combining with oxygen, venesection followed by transfusion is the best treatment.

In secondary anemia transfusion has given good results where the cause has been removed. In pernicious anemia transfusion causes temporary improvement, but it is extremely doubtful if it effects a cure. For acute leukemia it seems to be of no value.

In pellagra marked improvement and some cures have followed the transfusion of blood from healthy donors or healed pellagrins, but it has not proved as valuable a remedy in this disease as was first thought. The beneficial effects are probably the result of an increased resistance on the part of the patient, due to the restoration of the blood to a more normal condition. For the same action, transfusion is indicated in subacute forms of sepsis associated with anemia, emaciation, and devitalized tissues such as is frequently seen in war surgery in patients with large suppurating wounds and infected compound fractures. Repeated transfusions of small amounts of blood is of undoubted value in this class of cases for the purpose of increasing their resistance.

Transfusion has been employed in many other conditions, such as tuberculosis, acute suppuration, acute infectious diseases, etc., but the results have not been encouraging. It is contra-indicated in patients with organic heart disease as there is danger of overtaxing the heart by a sudden increase in the amount of fluids in the circulation.

Selection of the Donor.—A young, healthy, vigorous adult should be selected to supply the blood as the value of a transfusion depends to a large extent upon the type of donor. The subject should preferably be from among the relatives of the patient—a close blood relation, as a brother or sister, if possible. It is essential that the donor be free from arterio-sclerosis, organic heart disease, malaria, syphilis, etc., and a thorough physical examination, including a Wassermann reaction, should be made to determine his fitness.

Hemolysis.—Of the greatest importance is the selection of a donor whose blood is compatible with the blood of the recipient. Unless the delay is considered more dangerous than the risk of hemolysis, the blood of the donor and recipient should always be tested for hemolysis. An exception to this is in the case of a new born infant, as it has been shown by Cherry and Langrock that the mother is always a safe donor.

Moss' work on grouping the blood according to the power of agglutination has proved of great practical value in transfusion. He found that every individual may be arbitrarily classified in one of four groups according to the ability of his serum to agglutinate the corpuscles of other individuals, and according to the ability of his corpuscles to be agglutinated by the sera of other individuals. Agglutination may occur independently of hemolysis, but if agglutination is absent hemolysis never occurs; hence, from the agglutination reaction it is possible to determine whether hemolysis will occur.

Moss classifies the four groups as follows:

Group I.—Serum agglutinates no corpuscles.
Corpuscles agglutinated by sera of Groups II, III, and IV.

Group II.—Serum agglutinates corpuscles of Groups I, and III.
Corpuscles agglutinated by sera of Groups III, and IV.

Group III.—Serum agglutinates corpuscles of Groups I and II.
Corpuscles agglutinated by sera of Groups II and IV.

Group IV.—Serum agglutinates corpuscles of Groups I, II and III. Corpuscles are not agglutinated by any serum.

The above may be conveniently tabulated as follows:

	Serum of Group I	II	III	IV
Corpuscles of Group I	o	+	+	+
Corpuscles of Group II	o	o	+	+
Corpuscles of Group III	o	+	o	+
Corpuscles of Group IV	o	o	o	o

(+ = Agglutination)
(o = No agglutination or hemolysis)

It has been estimated that 5 per cent. of all individuals belong to Group I; 40 per cent. to Group II; 10 per cent. to Group III; and 45 per cent. to Group IV.

While it is preferable that the donor and recipient belong to the same group, it is not imperative, and, in the case of patients belonging to the less common groups I and III, this is often difficult. The important thing is to choose a donor *whose corpuscles are not agglutinated or hemolyzed by the serum of the recipient.* The fact that the donor's serum may agglutinate or hemolyze the patient's corpuscles may be disregarded, as the high dilution of the donor's serum that results when it is added to the blood volume of the recipient, prevents any harmful action. The groups, whose blood may be safely mixed, is shown by the following table:

If the recipient belongs to Group I, the donor may be selected from Groups I, II, III, or IV.

If the recipient belongs to Group II, the donor may be selected from Groups II or IV.

If the recipient belongs to Group III, the donor may be selected from Groups III or IV.

If the recipient belongs to Group IV, the donor should be from Group IV.

Members of Group I are thus termed universal recipients, as the serum of this group does not agglutinate the corpuscles of any of the other groups, while members of Group IV are termed universal donors as their blood may be transfused with safety into any patient.

Method of Determining Blood Groups.—Vincent (*Journal of the American Medical Association*, April 27, 1918), describes a rapid and simple method of determining blood groups by testing the individual's blood against known citrated sera[1] of Groups II and III. Citrated sera are employed to avoid coagulation of the fresh blood which is mixed with the sera in making the test, otherwise the reaction might be confusing.

The technic is as follows: A drop of the Group II serum is placed upon one half of a clean glass slide and a drop of Group III serum upon the other half. The lobe of the ear of the individual to be tested is then punctured, and by means of glass rods about 1/3 of a drop of the blood is added to each serum, thoroughly mixing the blood and serum. Separate glass rods should be used for each transfer of blood so that there will be no mixing of the two sera, and care must be taken to make the transfer before the blood coagulates.

The red cells at first show a uniform suspension in the serum which persists if there is no agglutination. Agglutination, if it occurs, is recognized by the formation of masses of agglutinated cells, and can be distinguished by the naked eye. The reaction usually occurs in about a minute. If there is any doubt as to the reaction, the slide

[1] The serum is prepared by collecting 5 drams (20 c.c.) of blood from individuals of Groups II and III, under aseptic precautions. The serum resulting from each, when the blood has coagulated and the clot contracted, is drawn off by means of separate pipettes into sterile flasks, and sufficient sodium citrate is added to each serum to give a 1.5 per cent. citrated serum. Tricresol 0.25 per cent. is also added to each bottle of serum as a preservative.

should be examined under the microscope. Rouleaux formation sometimes occurs and must not be mistaken for agglutination.

According to the reactions obtained, it is possible to determine to which of the four groups the individual belongs. The accompanying illustrations (Fig. 95) readily explain the reactions.

Quantity of Blood Transfused.—The quantity of blood transfused will vary according to the age of the patient and the condition for which the transfusion is performed. Between 20 and 25 ounces (600 and 750 c.c.) of blood for an adult, and from 2½ to 5 ounces (75 to 150 c.c.) for an infant is an average dose.

In direct transfusion it is impossible to estimate the exact amount of blood transfused and the guides should be the the condition of

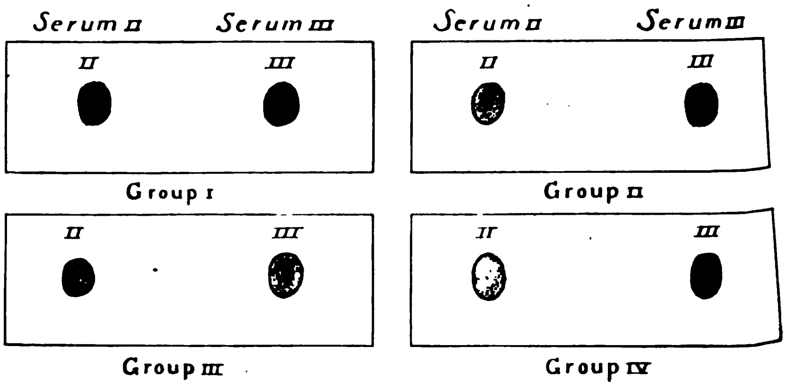


FIG. 95.—Agglutination test as seen macroscopically.

the donor and the recipient; the amount should also vary according to the condition for which the transfusion is performed. Twenty to forty-five minutes' flow in a good anastomosis is usually sufficient. As soon as the donor shows signs of loss of blood—indicated by a gradual pallor about the nose and ears, deepening of the lines of expression, sighing or irregular respiration, etc.—the transfusion must be immediately stopped. If it is carried too far, the donor goes into a state of collapse, and a condition is produced in him similar to that for the relief of which the operation was performed. Furthermore, transfusion of excessive amounts of blood may cause serious damage to the viscera of the recipient, and even death. Acute dilatation of the heart, manifested by dyspnea, cyanosis, cough, pain over the precordium, and falling blood-pressure, is the most frequent sequel to overtransfusion. Should such a complication ensue, the transfusion must be immediately stopped, the patient should be placed in a reverse Trendelenburg position with the feet lowered, and external massage of the heart (page 71) performed to assist in emptying it.

Rapidity of Flow.—The rate with which the blood is injected into the recipient or flows from the donor to the recipient should be carefully regulated, for fear of overcharging the heart and producing an acute cardiac dilatation. In direct transfusion this may be determined by noting the strength of the pulsation in the veins. If too strong, the flow may be controlled by partially compressing the lumen of the artery by means of the fingers.

Repetition of Transfusion.—The blood picture and the general condition of the patient will indicate the need for repetition of a transfusion. Often repeated transfusions of moderate amounts of blood give better results than a single large transfusion. Intervals of seven days may be taken as an average for repeated transfusions, and the same donor should not be employed more frequently than this.

DIRECT ARTERY TO VEIN TRANSFUSION

An anastomosis between the artery of the donor and the vein of the recipient may be effected by means of the special tubes of Crile, or some of the modifications of these tubes, or by means of the direct suture method of Carrel. Crile's method is without doubt the more rapidly and easily performed of the two. It consists essentially of slipping the tube over the vein, turning the free end of the vein back over the outer surface of the tube, and then drawing the artery over this venous cuff. By this method the intimæ of the vessels are brought into apposition and there is no foreign substance in contact with the stream of blood, thus lessening the chance of thrombosis. Anastomosis by direct suture, while it brings about the same result, is difficult to perform except by one accustomed to blood-vessel suture. In addition, there is frequently a contraction of the vessels at the point of suture, and thrombosis is more likely to occur.

Instruments.—There will be required a scalpel, an ordinary pair of blunt-pointed scissors, a small pair of curved scissors, thumb forceps, very fine tissue forceps, two small Crile clamps, mosquito hemostats, and transfusion cannulæ. If direct suture is employed, instead of the Crile tubes, there will be needed several No. 16 cambric needles and fine strands of silk (Fig. 96). The silk should be thoroughly impregnated with vaselin and should be threaded into the needles before the operation is begun.

The tube devised by Crile is of German silver and is provided w a small handle and with two grooves upon the outer surface of the cannula portion into which fit the ligatures holding the vein a artery in place (Fig. 98). At least four sizes of these tubes should

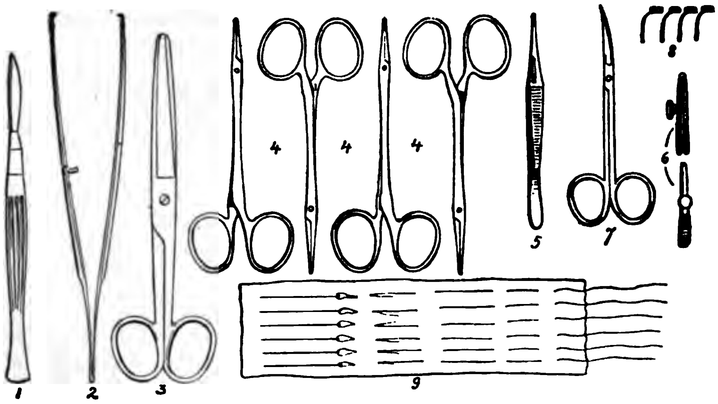


FIG. 96.—Instruments for transfusion. 1, Scalpel; 2, thumb forceps; 3, bl pointed scissors; 4, mosquito hemostats; 5, fine tissue forceps 6, Crile clamps; 7, s pair of curved scissors; 8, Crile cannulæ; 9, needles threaded with fine strands of

at hand, and the largest size that can be used without injury to arterial coats by undue stretching should be employed.

Position of the Donor and Recipient.—The donor should lie u an operating-table of a type that will permit his head to be quic

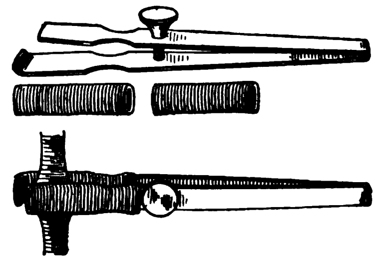


FIG. 97.—Enlarged view of Crile's clamps. (After Fowler.) 1, Clamp without rubbers; 2, rubber tubes to fit on jaws of clamps; 3, clamp applied to artery.

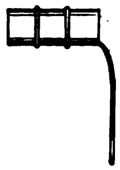


FIG. 98.—Enlarged vie Crile's cannula.

lowered if he becomes faint while the operation is in progress. recipient is placed upon a second table, with the head turned the opposite direction. Both tables should be provided with c ions or a layer of pillows, so that the patients will be comfort during the operation. Between the two operating-tables is placed a small square table upon which the arms of the donor and recipient rest during the operation. The operator is seated upon a stool in front of this table, and his assistant opposite (Fig. 99).

Asepsis.—The strictest asepsis must be observed during the entire operation. The instruments are boiled, and the hands of the operator are prepared in the usual way. The forearms of the donor and the recipient should be sterilized by painting with tincture of iodin.

Anesthesia.—The operation is performed under local anesthesia, employing a 0.2 per cent. solution of cocain or a 1 per cent. solution

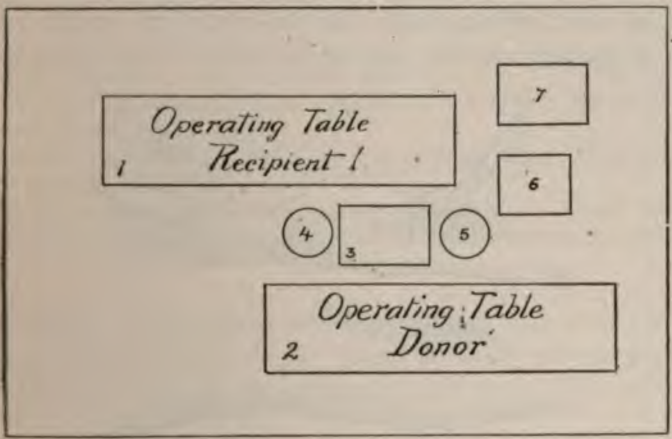


FIG. 99.—Arrangement of the operating-tables for a transfusion. (After Crile.) 1, Table for recipient; 2, table for donor; 3, table for arms of recipient and donor; 4 and 5, stools for operator and assistant; 6, instrument table; 7, table for dressings, etc.

of procain for the skin and a 0.1 per cent. cocain solution or a 0.5 per cent. solution of procain for deeper infiltration.

Technic by Crile's Method.—The radial artery of the donor and any of the superficial veins in front of the elbow of the recipient are chosen for making the anastomosis—in a child the popliteal vein may be utilized. Both the donor and the recipient are given 1/4 gr. (0.0162 gm.) of morphin hypodermically half an hour before the operation unless it is contraindicated.

The area of incision is anesthetized, and about 1 1/2 inches (4 cm.) of the radial artery is exposed and dissected free. Any branches are avoided if possible; if they cannot be avoided, they may be tied off with fine silk and cut close to the trunk. A Crile clamp is gently applied as high as possible to the proximal end of the artery, or, in the absence of a special clamp, a piece of tape may be placed around the artery and clamped sufficiently tight to compress the vessel and shut off the circulation. The distal end of the artery is then ligated and the vessel is cut. The adventitia is pulled over the end of the vessel and is snipped off as clean as possible. The field of operation is now covered with a compress well soaked with hot saline solution. The vein of the recipient is then exposed in the same manner, and about 1½ inches (4 cm.) of it is freed from the surrounding tissues. The distal end of the vein is ligated, and to the proximal end is applied a Crile clamp (Fig. 100), or a narrow piece of tape fastened as described above. The vessel is divided and the adventitia is snipped off after pulling it out over the end of the vessel. A Crile cannula of appropriate size, held in an artery clamp, is pushed over

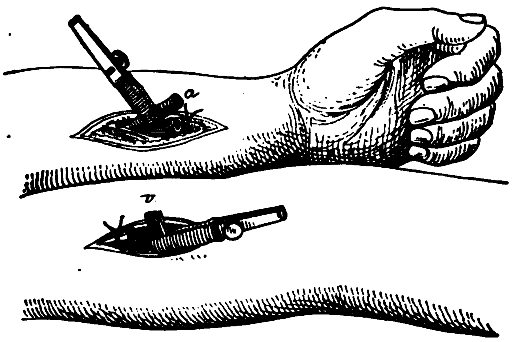


FIG. 100.—Transfusion by Crile's method. First step, exposure of the vein and artery with Crile's clamps applied.

the vein. A suture inserted in the edge of the vein, as shown in Fig. 101, aids in drawing the latter through the cannula. The projecting portion of the vein is seized by three mosquito clamps and is turned back as a cuff (Fig. 102), and is tied in the second groove of the cannula. The forearms of the donor and the recipient are then placed so that the hand of the donor is directed toward the elbow of the recipient. The cuffed portion of the vein is lubricated with sterile vaselin, three mosquito forceps are applied to the edges of the artery, and it is gradually drawn down over the cuffed vein (Fig. 103) and is tied in place by a silk ligature which fits into the first groove on the cannula. The clamp is removed from the vein first. The clamp upon the artery is then very gradually opened, allowing the blood to flow into the vein of the recipient (Fig. 104). At the completion of the operation the vessels are ligated, the tube is excised and the skin incision is sutured and dressed with sterile gauze.

In performing the operation there are several precautions to be observed. The vessels to be anastomosed must be handled with the

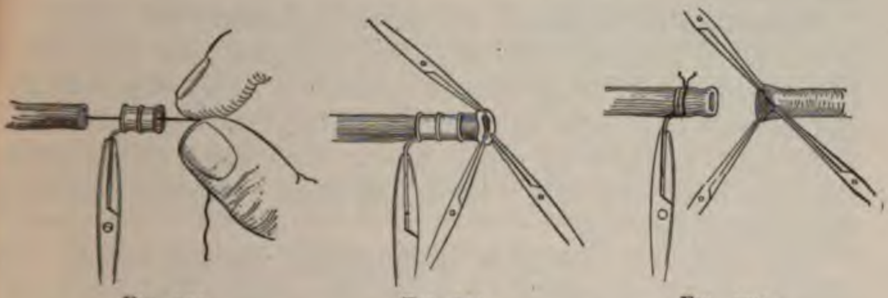


FIG. 101. FIG. 102. FIG. 103.

FIG. 101.—Transfusion by Crile's method. (After Crile.) Second step, drawing the vein through the cannula.

FIG. 102.—Transfusion by Crile's method. (After Crile.) Third step, method of cuffing back the vein.

FIG. 103.—Transfusion by Crile's method. (After Crile.) Fourth step, showing the vein cuffed back over the cannula and the method of drawing the artery over the vein.

greatest care. They should never be bruised with artery clamps or picked up with toothed forceps. Some difficulty may be experienced from retraction of the vessels when they are cut. This may be over-

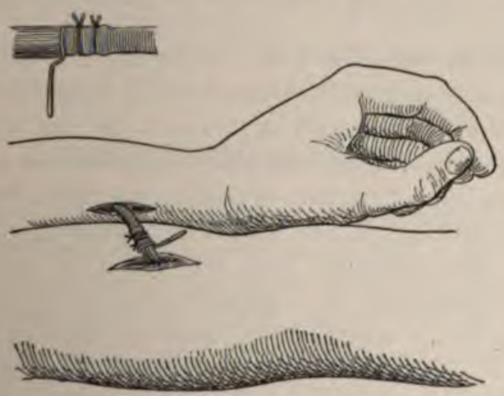


FIG. 104.—Transfusion by Crile's method. Fifth step, showing the anastomosis completed.

come to a great extent by keeping them constantly moistened with hot saline solution. In the case of a contracted artery, Crile advises that it be dilated by gently inserting a fine pair of closed artery clamps covered with vaselin and using it as one would a glove stretcher. Care should be taken that the anastomosis be made without undue tension, and that the cannula be placed accurately in the long axis of the vein and artery, otherwise the flow will be more or less impeded.

Variations in Technic.—Brewer has simplified Crile's method of making an anastomosis by employing long glass tubes lined with paraffin (Fig. 105). These tubes are about 2½ inches (6 cm.) long, and are made small at the end to be inserted into the artery and large at the end over which the vein is drawn. Each end is slightly bulbous, and is provided with a sulcus into which the ligature holding the vessel in place falls.

The tubes are thoroughly sterilized and are then dipped in melted paraffin, shaken out, and allowed to cool. The vein and artery are exposed and isolated in the usual way and two Crile clamps

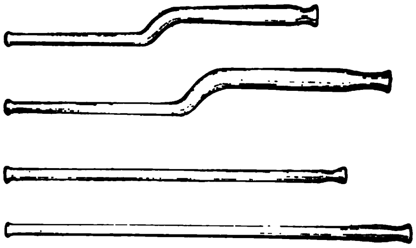


FIG. 105.—Brewer's glass tubes lined with paraffin for transfusion.

are applied as shown in Fig. 100. The artery is drawn over one end of the tube and is secured by a ligature. A longitudinal or a transverse cut is made in the wall of the vein (see Fig. 131), and, after loosening the arterial clamp sufficiently to permit the tube to fill with blood, the distal end of the tube is quickly inserted into the vein in the manner shown in Fig. 132, and is secured in place by a ligature. The clamps are then removed and the blood is allowed to flow.

Elsberg (*Journal of the American Medical Association*, March 13, 1909) describes a very practical cannula that does away with the necessity for the Crile clamps. His method of performing the anastomosis differs from the Crile method in several points. "The cannula (Fig. 106) is built on the principle of a monkey wrench, and can be enlarged or narrowed to any size desired by means of a screw at its end. The smallest lumen obtainable is about equal to that of the smallest Crile cannula, and the largest greater than the lumen of any radial artery. The instrument is cone-shaped at its tip, a short distance from which is a ridge with four small pin points which are directed backward. The lumen of the cannula at its base is larger than at its tip."

In using this instrument, after first exposing and separating the artery from the surrounding tissues in the usual manner, the cannula is widely opened and is placed around the artery before the latter is cut. The cannula is then screwed together, thereby shutting off the arterial flow. The distal end of the artery is next ligated at about ½ inch (1 cm.) from the end of the cannula, and three fine silk traction sutures or small tenacula are passed through the artery at equidistant points on its circumference a short distance from the ligature. The artery is then cut close to the ligature, and the end is cuffed back by drawing upon the traction stitches or tenacula and is caught in the teeth upon the clamp. The vein of the recipient is then exposed and two ligatures are applied, the distal one being tied (see Fig. 130).

FIG. 106.—Elsberg's transfusion cannula.

The vein is opened by means of a small transverse slit in the same manner as for an intravenous infusion (see Fig. 131), and the cannula with the cuffed artery is inserted into the vein and tied securely in place by means of the loose ligature. The cannula is then screwed open and the blood is allowed to flow, the rapidity of flow being controlled by the extent to which the cannula is opened.

INDIRECT TRANSFUSION

In indirect transfusion the blood, instead of passing directly from the vessels of the donor into those of the recipient, is withdrawn into a syringe or receptacle and is then injected into the vessels of the recipient. Its success depends upon making the transfer of blood from the donor to the recipient without coagulation taking place. This may be accomplished by: (1) making the transfer with such rapidity that the blood has not time to clot; (2) coating the receptacle through which the blood flows with paraffin, and (3) mixing with the blood sodium citrate, which prevents coagulation.

Transfusion by some of the indirect methods is preferred at the present time to direct transfusion for the reason that it is simpler, and requires less skill in its performance and at the same time is quite as effective; furthermore, indirect transfusion has this advantage, that the quantity of blood transfused may be accurately measured.

Indirect Transfusion by the Syringe Method of Lindeman. In 1892 von Ziemssen reported having performed transfusions by means of venous puncture upon the donor and recipient and withdrawing syringesful of blood from the donor and injecting them into the recipient. The method did not receive much attention, however, until 1913 when Lindeman improved upon it and made it suitable for transfusing large quantities of blood by using numerous syringes and special cannulæ with which injury to the interior of the vein during manipulation of the syringes was avoided. Two operators and an assistant are necessary; and they should be specially trained, as success with the method depends upon dexterity and speed in handling the syringes to avoid clotting of the blood. For this reason the syringe method is sometimes disappointing in the hands of those of limited experience.

As no skin incision is made, the only discomfort to the donor and recipient is from the puncture of the skin by the needles entering the veins. The same vein may thus be utilized for subsequent transfusions if desired.

Apparatus.—There will be required (1) two sets of cannulæ—one for the donor and one for the recipient, (2) two tourniquets, (3) twelve record syringes with a capacity of 5 drams (20 cc.) each, and (4) three basins for rinsing the syringes—two for sterile water and one for saline solution.

The cannulæ consist of three to each set, which telescope one within the other. The innermost cannula is of small calibre and sharp pointed. It closely fits cannula No. 2, which in turn fits No. 3. The distal ends of cannulæ No. 2 and 3 are smooth and rounded so as not to injure the intima of the veins. On the proximal end of cannulæ No. 1 and 2 are stationary thumb screws. The proximal end of No. 3 is made to fit a record syringe.

Asepsis.—Before using, the syringes are cleaned in peroxide of hydrogen, then washed in a 10 per cent. sodium carbonate solution, rinsed, and sterilized with the cannulæ in 95 per cent. alcohol. The arms of donor and recipient are sterilized by painting with iodine and the hands of the operators and assistant are prepared as for any operation.

Technic.—A tourniquet is placed about the arm of the recipient and a cannula, lined with a thin coating of liquid petrolatum, is inserted into the vein held almost parallel with the skin surface. As soon as the first joint "A" enters the vein, cannula No. 1 is withdrawn ½ an inch (1 cm.). This prevents any injury to the vein wall from a sharp pointed cannula and leaves No. 2 only, in contact with the vein. Cannula No. 3 is now inserted ¾ of an inch (2 cm., into the vein and No. 1 and 2 are removed. If the vein has been successfully entered blood quickly flows from the cannula. When this occurs, the tourniquet is removed, and a syringe containing warm saline solution is attached to the cannula and the solution is slowly injected. In the same manner the cannula is inserted into the vein of the donor and an empty syringe attached. A syringeful of blood is now rapidly withdrawn from the donor and is passed by the assistant to the operator on the recipient, who, after removing

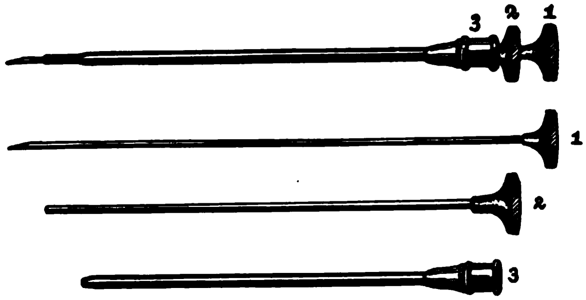


FIG. 107.—Lindeman's cannula assembled and separated.

the saline syringe, attaches the one containing blood and quickly injects the contents of the syringe into the recipient. While this is being done, the operator on the donor attaches another syringe and fills it with blood. Syringesful of blood are rapidly withdrawn from the donor and injected into the recipient until the desired quantity has been transferred. A little saline solution is injected through the cannula of the recipient to keep it free of blood and prevent clotting every 2d, 3d, 4th, or 5th syringeful of blood according to the speed of flow from the donor.

Syringes are not used a second time without being thoroughly cleaned. This is done by a nurse who rinses the syringes through two basins of sterile water and then in saline solution. It is emphasized by the author of this method that only syringes and cannulæ with bright polished surfaces should be used.

Unger's Instrument for Syringe Transfusion.—Unger (*Jour. Amer. Med. Assoc.*, Feb. 13, 1915) describes a cock for use in the

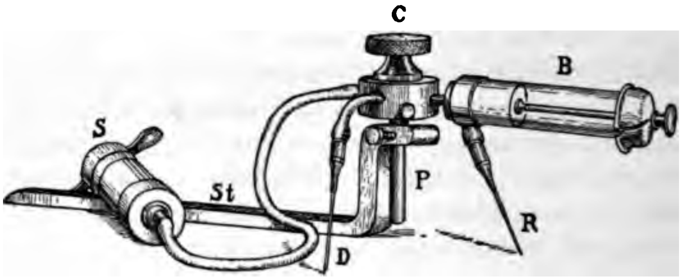


FIG. 108.—Unger's instrument for syringe transfusion.

B. Blood syringe connected to blood outlet, C. stop-cock, D. donor's cannula, P. pedestal by which the stop-cock is raised or turned, R. recipient's cannula, S. saline syringe connected to saline outlet, and St. stand.

syringe cannula method of transfusion whereby the number of syringes is reduced to two, the handling of the cannulæ necessitated by fre-

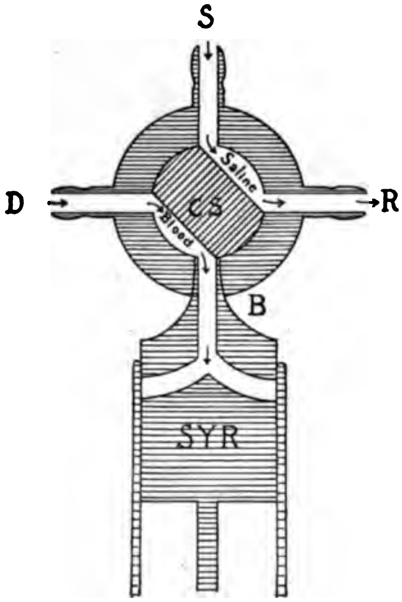


FIG. 109.

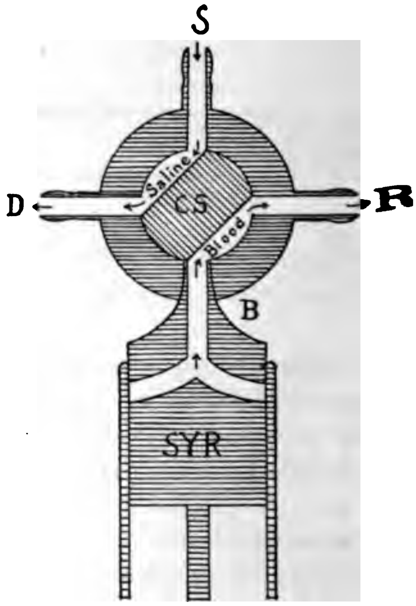


FIG. 110.

FIG. 109.—Unger's instrument. Donor's position (After Unger *Journal of American Medical Association*, July 17, 1916.)

FIG. 110.—Unger's instrument. Recipient's position. (After Unger, *Journal of American Medical Association*, July 17, 1916.)

quent changing of syringes is avoided, and clotting is prevented by regular flushing of the apparatus with saline solution. With this

blood may be withdrawn from the donor and injected
cipient without making any disconnections.
trument (Fig. 108) has four outlets: (1) blood outlet (B), ıtlet (S), (3), recipient outlet (R), and (4) donor outlet (D). (20 c.c.) Record syringe is attached to B and through it ›irated and injected, while to S a second syringe for saline by means of a piece of rubber tubing. To R and D ıt's and donor's cannulæ are connected by means of two ubber tubes 1¾ inches (4 cm.) long. The cock is arranged ırough an arc of 45 degrees. When rotated so that the ge operates upon the donor, saline ected into the recipient (Fig. 109), blood is being injected into the re- ıe solution may be injected into the . 110).

Transfusion by Paraffined Tubes. ll known, coagulation of blood is y retarded when the blood is col- receptacle lined with paraffin, and ne to fill a container of moderate ıe donor's blood and empty it into ıt before coagulation occurs if the ›t shaken. Among the numerous performing transfusion by this ay be mentioned the paraffined David and Curtis, Kimpton and l Vincent.

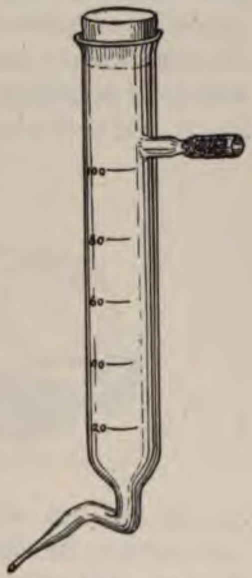


FIG. 111.—Kimpton-Brown indirect transfusion tube.

in their use requires most careful of the tubes, as it is essential that ion of the apparatus with which comes in contact be completely a thin, smooth lining of paraffin to avoid clotting.

us.—The tubes of Kimpton and Brown consist of glass ith a capacity of 5 to 8 ounces (150 to 250 c.c.) closed at nd by a cork. A cannula leads from the bottom of the ›wnwards and then at right angles to the axis of the From the last bend the cannula measures 2 to 3 inches m.) and gradually tapers to a point 1/12 to 1/8 of an inch) in diameter. A side tube opens into the cylinder on the s the cannula a little below the cork, to which a cautery ched (Fig. 111). The apparatus of David and Curtis consists of a 3 ounce (100 c.c.) glass syringe with rubber tube and two-way valve and a double cannula tipped glass bulb of 13 ounces (400 c.c.) capacity (Fig. 112).

Vincent's apparatus is very similar to Kimpton's and Brown's except that the lower end has a ground glass joint which fits a needle and thus permits its use without preliminary exposure of the veins.

Preparation of the Tubes.—Paraffining the tubes must be done under rigid asepsis. A mixture of stearin 1 part, paraffin 2 parts, and vaseline 2 parts is sterilized in an autoclave or by boiling, and the glass tubes are likewise sterilized in an autoclave. The paraffin mixture is melted in a water bath, and after first moderately heating the tube equally over an alcohol flame, the cork is removed and about 1½ ounces (50 c.c.) of the melted paraffin mixture is poured into it and is allowed to run over the entire interior of the tube, in-

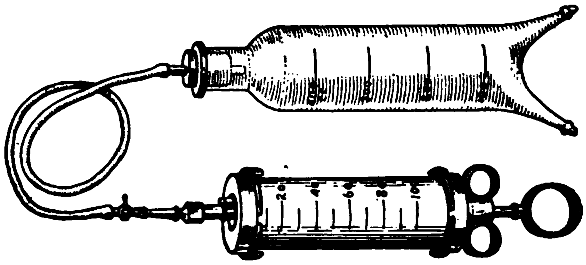


FIG. 112.—David and Curtis apparatus for indirect transfusion.

cluding the cork which has been replaced in the tube, forming a uniform coat, and some of it is allowed to escape through the cannula. The tube is then turned so that the excess of paraffin runs back and out of the side opening. In the David and Curtis apparatus the excess of paraffin is drained off through the cannula tips. The junction of the cork and glass is finally sealed with paraffin on the outside. The tubes are then wrapped up in a sterile towel and are ready for use.

Another method of coating the tubes is described by Alton (*Journal of the American Medical Association*, Aug. 16, 1919.) The tubes are sterilized by dry heat and are then rinsed out with a small amount of alcohol and then ether. A mixture of paraffin with melting point of 53° C. 1 part and ether 80 parts is sterilized in an autoclave and an ounce (30 c.c.) of this is poured into the tube, and the tube is shaken and rolled so that the entire inner surface is coated with the solution. A small amount of the solution is allowed to escape through the cannula to coat its interior, the excess solution being emptied out. As the ether evaporates it leaves a thin even coating of paraffin. It is advisable to wait several hours for the paraffin to harden before using the tubes.

Asepsis.—Syringes and rubber portions of the apparatus are sterilized by boiling. The arms of the donor and recipient are sterilized by painting with tincture of iodin and the hands of the operator and his assistant are prepared as for any operation.

Technic with the Kimpton and Brown Apparatus.—A tourniquet is placed upon the donor's arm with sufficient tension to produce venous obstruction, but not obliterate the pulse. Under local anesthesia with a 0.5 per cent. procain-adrenalin solution one of the prominent veins at the bend of the elbow is then exposed through an incision 1 inch (2.5 cm.) long. The vein is tied proximally and

FIG. 113.—Method of holding the filled tube in carrying to the recipient.

a ligature is placed around it distally, but is not tied. This ligature, held taut by an assistant, acts as a clamp and the vein is opened. The vein of the recipient is similarly exposed without using a tourniquet and is tied off distally, the proximal ligature being used as a clamp. The vein is then opened, and, with the tube held upright, the cannula is inserted into the donor's vein, and the tube fills with blood under the venous pressure, which may be augmented by having the donor open and close his hand. When filled, the tube is taken to the recipient in a horizontal position with the side opening uppermost (Fig. 113) and the cannula is inserted into the vein of the recipient with the tube held upright. A cautery bulb is attached to the side opening of the tube and enough pressure is made on the cautery bulb to empty the tube. The cannula is withdrawn while there is still a little blood left in it. More tubes may be filled and emptied in this manner, utilizing the same veins. At the conclusion of the transfusion the veins are ligated, the incisions closed with a few stitches, and a sterile dressing is applied.

Transfusion of Citrated Blood.—The development of the method of transfusing blood to which sodium citrate is added to prevent coagulation is mainly the result of experimental work by Weil and Lewisohn. It was found that citration of blood to 0.2 per cent. was sufficient to prevent coagulation, and that the trans-

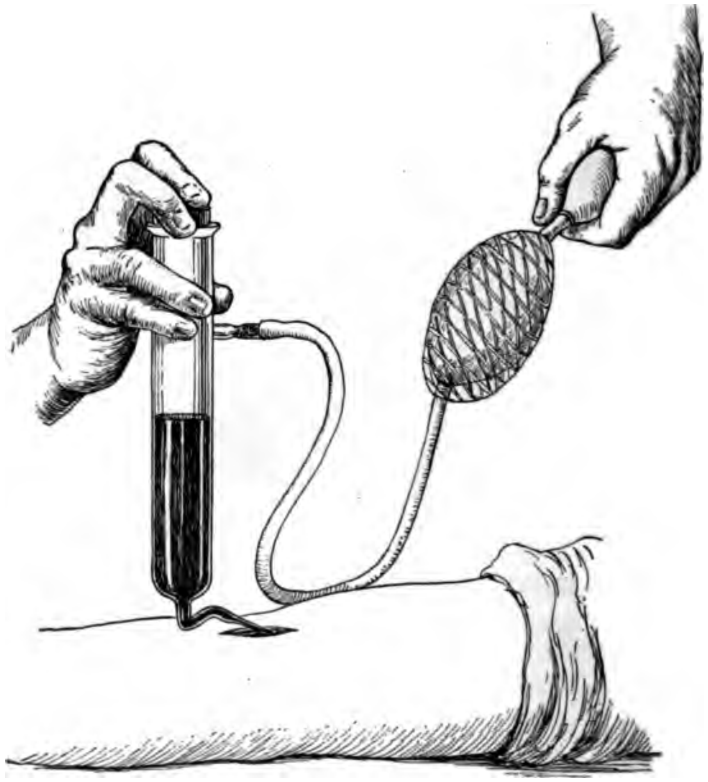


FIG. 114.—Transfusing blood with the Kimpton-Brown tube.

fusion of such blood is apparently just as effective as whole blood, if the blood is injected within an hour after it is withdrawn from the donor. Contrary to what would be supposed, the coagulation time of the recipient's blood after the introduction of citrated blood is not retarded, but is shortened immediately after such transfusion.

If used in proper strength citrated blood is without danger. According to Lewisohn 75 grains (5 grams) can be injected into an adult intravenously with safety. The injection of unlimited quantities into the circulation, however, is toxic, depriving the blood and tissues of calcium and producing dyspnoea, tonic and clonic convulsions, tetany, paralysis, etc. There is no doubt that a reaction follows the transfusion of citrated blood more frequently than when whole blood is used. This is manifested by chills and fever, but, while unpleasant for the patient, it is not harmful. Many theories have been advanced to explain these reactions, but up to the present a satisfactory reason has not been found.

Transfusion by the citrate method possesses a distinct advantage over other methods in permitting the transfer of blood from one place to another without detriment, so that the donor and recipient need not be in the same room. Furthermore, it requires none of the skill essential for the successful transfusion by other methods, and only the simplest form of apparatus is needed. In fact, the method is about as simple as an intravenous saline infusion.

Strength of Citrate Solution.—A 0.2 per cent. citrate blood was the strength originally employed, but as an added factor of safety against clotting it is of advantage to employ a slightly higher percentage of citrate—a 0.25 per cent., or 0.3 per cent. In the U. S. Army a 0.7 per cent. was used. Ampules containing 1⅔ ounces (50 c.c.) of a 2.5 or 3 per cent. sterile sodium citrate in a 0.9 per cent. saline solution may be obtained. One ampule of the 2.5 or 3 per per cent. sodium citrate in 15 ounces (450 c.c.) of blood gives a citrated blood solution of 0.25 or 0.3 per cent.

Apparatus.—Transfusion of citrated blood may be performed with a very simple apparatus. There will be required: (1) a graduated salvarsan flask, to which is attached a piece of rubber tubing ¼ inch (6 mm.) in diameter and 4 feet (120 cm.) long supplied with a glass indicator; (2) ampules of sterile citrate solution; (3) two glass graduates of 1 pint (500 c.c.) capacity, for collecting the blood, and a glass stirring rod; (4) a small measuring glass graduated in cubic centimeters up to 50; (5) a large gauge Kaliski transfusion needle for collecting the blood, and one of smaller calibre for infusing the citrated blood into the donor; (6) two pieces of rubber tubing for tourniquets; (7) two artery clamps for holding the tourniquets in place (Fig. 115). An ordinary glass irrigating jar or a large glass funnel may be used in place of the salvarsan flask.

The Medical Department of the U. S. Army supplied an excellent apparatus whereby the blood is collected in, and injected from, the same container. It consists of a quart (litre) bottle graduated in

100 c.c., 400 c.c., and 700 c.c., two rubber stoppers having two perfor-
tions, two transfusion needles, and glass and rubber tubing. Tube
for applying suction in withdrawing the blood and pressure to fill th

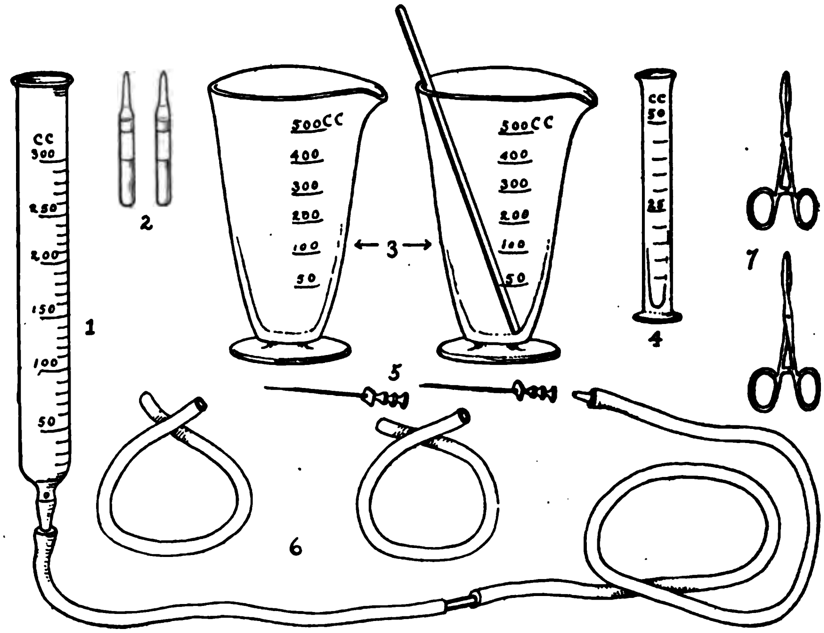


FIG. 115.—Apparatus for transfusing citrated blood. 1. Graduated reservoir with rubber tubing; 2. ampules of sterile sodium citrate; 3. two glass graduates and glass rod for stirring; 4. small glass graduate; 5. large and small calibre needles; 6. rubbe tourniquet; 7. artery clamps.

tubing of the injection apparatus are also provided (Figs. 11 and 118).

Asepsis.—The apparatus is sterilized by boiling or in an autoclave the arms of the donor and recipient are sterilized by painting with

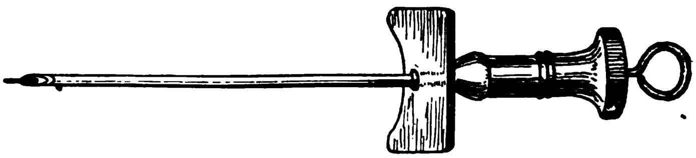


FIG. 116.—Enlarged view of the Kaliski needle.

tincture of iodin, and the operator's hands are prepared as careful as for any operation.

Technic.—A tourniquet, consisting of a piece of rubber tubing, applied to the arm of the donor with sufficient tension to produce

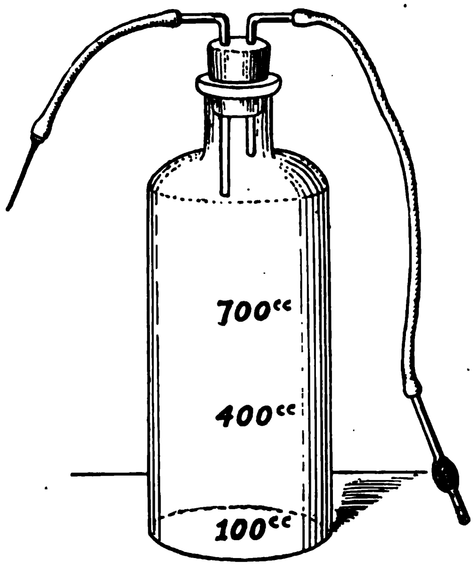


FIG. 117.—Apparatus for transfusing citrated blood used by the Medical Department he U. S. Army assembled for withdrawing blood from the donor.

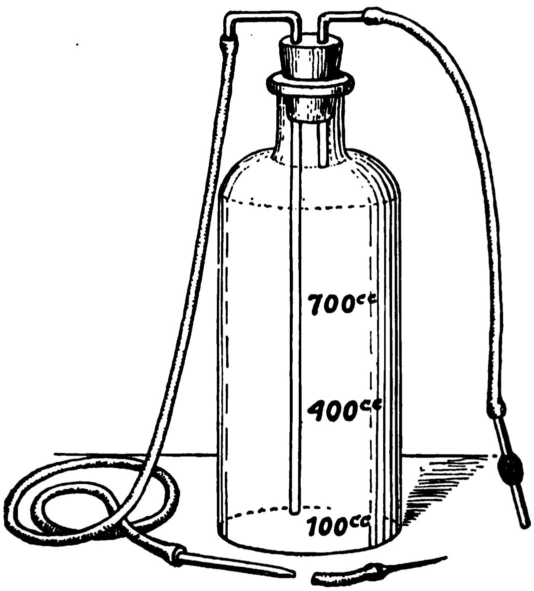


FIG. 118.—Apparatus for transfusing citrated blood used by the Medical Department of the U. S. Army assembled for infusing blood.

marked venous stasis, and is secured by clamping with an artery clamp. A tube of citrate solution is broken at the file mark, the open end is passed through a flame and 25 c.c. (6¾ drams) of the citrate solution is placed in the graduate in which the blood is to be collected, and the blood is drawn into it by inserting the large needle into one of the prominent veins at the bend of the elbow directed toward the hand. As the blood is withdrawn, the blood and citrate are stirred together with a glass rod to obtain a thorough mixing (Fig. 119). Blood is withdrawn up to the 250 c.c. mark on the graduate. Another 25 c.c. (6¾ drams) of citrate solution is poured into the graduate and more blood is withdrawn until the 500 c.c.

Fig. 119.—Withdrawing the blood from the donor into a graduate containing sodium citrate solution.

mark is reached. If more than 500 c.c. (1 pint) of blood is required the second graduate is used to collect it, employing the citrate solution as before in the proportion of 25 c.c. (6¾ drams) to each 225 c.c. (7½ ounces) of blood. When the desired amount has been collected, the tourniquet is removed and the needle withdrawn from the recipient's vein. Pressure is applied over the site of puncture a moment or two and the wound dressed with sterile gauze.

Introduction of the citrated blood is accomplished by first placing a tourniquet about the arm of the recipient to make the veins stand out prominently. The citrated blood is then transferred to the flask, into which about 2 ounces (60 c.c.) of normal salt solution has been previously placed, and care is taken to see that the rubber tubing is completely filled with salt solution and that it contains no air. The needle is then introduced into the recipient's vein directed toward the heart, and, as soon as blood flows from it, the rubber tubing of the injection apparatus *filled with the salt solution* is quickly attached and *the tourniquet is removed.* The reservoir is then elevated about 3 feet (90 cm.) and the blood allowed to flow by gravity (Fig.

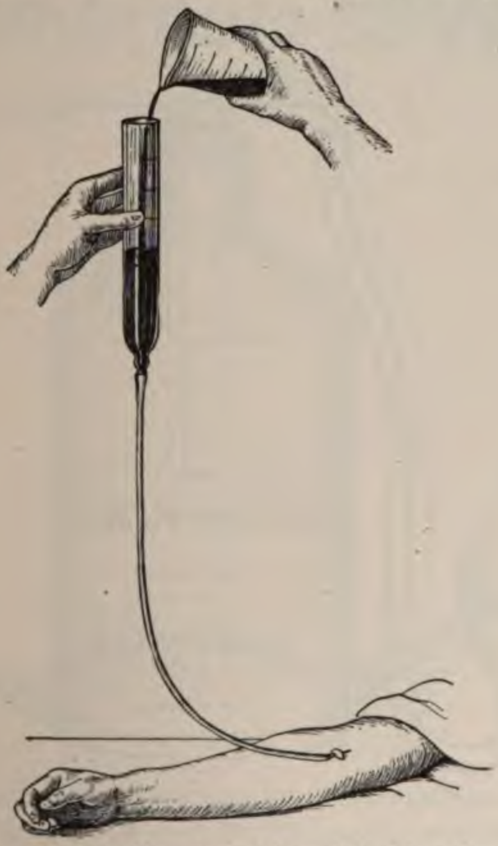


FIG. 120.—Method of introducing citrated blood into the recipient.

120). It should run in slowly, care being taken not to suddenly overcharge the right heart, and the needle should be removed before the reservoir is completely drained. Upon completion of the transfusion the puncture is dressed as described above.

TRANSFUSION OF PRESERVED RED CELLS

Experimentally it was shown by Rous and Turner in 1916 that red blood corpuscles suspended in a fluid isotonic with blood plasma may be kept for several weeks in a cool place and when injected into an animal of the same species will still functionate. They employed as an isotonic medium a 5.4 per cent. dextrose and a 3.8 per cent. sodium citrate solution in the proportion of roughly 3 parts blood, 2 parts isotonic citrate solution, and 5 parts isotonic dextrose solution.

This method has been successfully applied to humans by Robertson (*British Medical Journal*, June 22, 1918) who employed it at the front, using for the purpose the blood of Group IV donors, and it

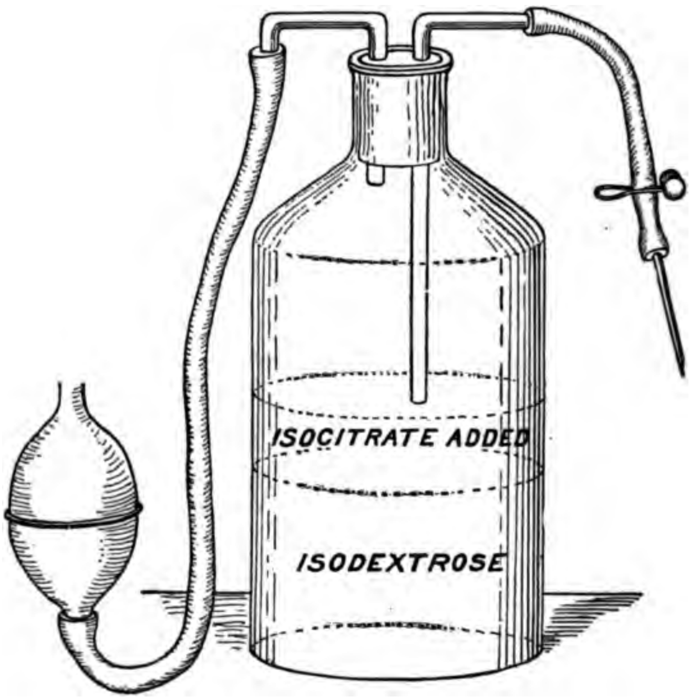


FIG. 121.—Robertson's apparatus for collecting the blood for rtansfusion of preserved red cells.

seems that blood lost through hemorrhage may be as effectively replaced by this means as by fresh whole blood. The advantages of a method of transfusion that permits the use of blood collected beforehand and kept stored in any desired quantity are obvious, and as an emergency method, where a suitable donor is not available, it is invaluable.

Preparation of the Isotonic Preserving Fluid.—The isotonic medium is a 5.4 per cent. dextrose and a 3.8 per. cent. sodium citrate solution. The solutions are made *separately* from freshly distilled water, and are sterilized separately in an autoclave. For preparing the dextrose solution powdered dextrose is employed.

For 500 c.c. (1 pint) of blood, 350 c.c. (12 ounces) of isotonic citrate solution and 850 c.c. (28 ounces) of isotonic dextrose solution are required.

Apparatus.—The apparatus employed by Robertson (*British Medical Journal*, July 22, 1918) for collecting the blood consists of a 2 quart (2 litre) glass bottle, with a stopper containing two perfora-

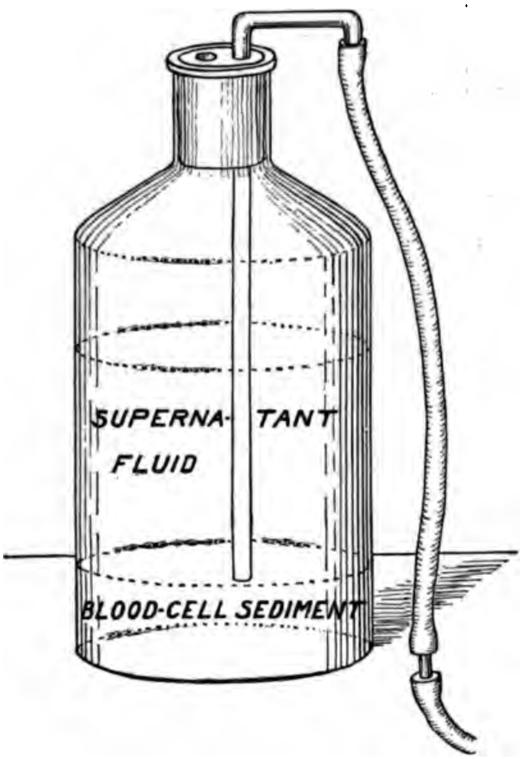


FIG. 122.—Robertson's apparatus arranged for syphoning off the supernatant fluid.

tions. One of these gives passage to a short right angled piece of glass tubing, to the free end of which a suction bulb is attached. Through the other passes a piece of right angled glass tubing with a long arm reaching nearly half way down the bottle and a short arm, to which is attached by means of a short rubber tube a vein needle (Fig. 121).

Asepsis.—The apparatus is sterilized in an autoclave, and the usual preparations of the patient's skin and operator's hands are followed.

Technic.—The blood is collected in the usual way by venous puncture (page 302) in the bottle containing the "isodextrose" and "isocitrate" solutions. The glass tube through which the blood enters should extend down to the citrate solution so that the blood does not fall into the solution through the air. Slight negative pressure may be produced in the bottle by means of the suction bulb to aid the flow of blood, and, as the blood is being withdrawn, the bottle is gently rotated so as to mix it with the solution. When 500 c.c. (1 pint) of blood has been collected, the stopper is removed and the bottle is plugged with sterile cotton and placed in an ice box.

The red cells slowly gravitate to the bottom and in 4 or 5 days they will have settled to 800 or 900 c.c. (26 to 30 ounces), and, after the supernatant fluid has been syphoned off, the blood can be used. If the supernatant fluid has a pinkish tint, the blood should be discarded as this is indicative of hemolysis. When the blood has been stored for some time, the red cells may sink to a level lower than that of the original blood, and, in such a case, Robertson employes a 2.5 per cent. solution of gelatin in normal salt solution to bring the blood up to the required amount.

Before transfusing, the blood is poured through two layers of sterile gauze into the transfusion apparatus in such a way that it flows down the side of the container and does not fall into it. The container is stoppered and placed in a water bath so as to bring its temperature up to 41° to 42°C. (106° to 107°F.). It is then ready for use.

INJECTIONS OF HUMAN BLOOD SERUM

For many years it has been known that blood serum contained some agent that hastened the coagulation of blood. In 1882 Hayem established this fact while performing experiments with different sera to determine their effect on coagulation. It is only, however, since Weil in 1905 published the results of his work along this line that the injection of fresh animal and human serum has become generally recognized as a method of value for the prevention and control of certain forms of hemorrhage, such as is seen in hemophilia, cholemia, and purpuric conditions supposed to be dependent upon deficient coagulability of the blood. More recently Welch of New York has shown that the subcutaneous injection of human blood serum is almost a specific remedy for the treatment of hemophilia neonatorum; from the rapid gain in weight after its use he also considers it a most efficient food for premature and malnourished infants.

Blood serum is, likewise, claimed to be of value in septic conditions on account of its bactericidal action.

While horse serum, rabbit serum, and human serum have all been employed in these cases of pathologic hemorrhage, the latter should always be used in preference. With animal sera there is danger of producing serum sickness and anaphylaxis, especially where repeated injections are made, but this is apparently not the case with human serum.

It should be remembered that, while the injection of human serum is an efficient method of controlling pathologic hemorrhages, it does not, of course, replace the cellular elements lost through excessive bleeding. In such cases, where the cellular elements are greatly diminished, transfusion is indicated.

Apparatus.—The apparatus for collecting the blood, described by Welch (*American Journal of Medical Sciences*, June, 1910), consists of an Erlenmeyer flask, stoppered with a rubber cork through which are two perforations. Through one is fitted a U-shaped tube, to the outer end of which is attached a short aspirating needle of No. 19 caliber by means of a rubber tubing. The needle is cotton plugged in a small test-tube in which it is sterilized. Through the other perforation is inserted a fusiform glass tube containing cotton to prevent contaminating the contents of the flask. Upon the end of this tube is placed a small suction tube for drawing the blood into the flask (Fig. 123).

FIG. 123.—Welch's apparatus for collecting blood serum.

A 30 to 60 c.c. (1 to 2 ounces) glass syringe with a glass piston should be provided for injecting the serum.

Selection of Donor.—Preferably young adults from among the relatives of the patient should be selected. The donors, of course, must be free from any constitutional or other disease, and a thorough physical examination, including a Wassermann test, should be made to determine their fitness.

Dosage.—In hemophilia neonatorum Welch advises that 1 ounce (30 c.c.) of serum be given twice a day to moderate bleeders and, if the bleeding is excessive, that it be given every four hours until the bleeding is under control.

As a preventive of postoperative hemorrhage in chronic jaundice, Willy Meyer advises that 1 to 2 ounces (30 to 60 c.c.) of serum be administered three times a day beginning two days before the operation and continuing for forty-eight to seventy-two hours afterward.

Site of Injection.—The serum is injected subcutaneously in the loose tissues of the axilla or in the subcutaneous tissues of the abdomen on either side of the umbilicus. In cases of great urgency it may be given intravenously.

Asepsis.—The apparatus for collecting the blood and the syringe for injecting the serum should be sterilized, the operator's hands should be cleansed as for any operation, and the arm of the donor and the site of injection are sterilized by painting with tincture of iodin.

Technic.—To collect the blood, a tourniquet is first placed about the arm of the donor with sufficient tension to make the veins stand out prominently. One of the veins at the bend of the elbow—preferably the median basilic—is then identified and the needle of the collecting apparatus is thrust into it, holding the needle almost parallel with the skin surface. About 10 ounces (300 c.c.) of blood is then drawn into the flask, which is promptly stoppered with a sterile plug of cotton. The flask is then placed in a slanting position until the serum has formed. It usually takes four to six hours for all the serum to separate. When this has taken place, the serum is transferred to a sterile flask and is placed on ice until used.

The technic of injecting the serum is as follows: The neck of the flask is sterilized, and the desired quantity of serum is drawn into the syringe. Care should be taken to see that all the air is expelled from the syringe. A fold of skin in the region decided upon for making the injection is then raised up between the thumb and forefinger of the left hand, and, with the right hand the needle is quickly thrust into the subcutaneous tissues at the base of this fold of skin. The serum is injected slowly, and the resulting swelling is very gently massaged until the serum is all absorbed. After withdrawal of the needle, the point of puncture is sealed with collodin and cotton. Usually within twenty-four to forty-eight hours after beginning the injections the bleeding will be controlled.

CHAPTER V

INFUSION OF PHYSIOLOGICAL SALT SOLUTION

The administration of physiological salt solution was originally introduced as a substitute for transfusion of blood in the treatment of hemorrhage on account of the numerous risks that attended the latter operation as formerly performed, and the difficulty of obtaining a suitable donor when most needed. The technic of blood transfusion has, however, been wonderfully perfected, and it can now be said to be an operation without danger if employed with proper precautions; but, notwithstanding this and the fact that no media has been found as efficient as blood in making up the loss from a severe hemorrhage, the infusion of salt solution is still extensively employed in place of transfusion. This may be readily understood when we consider that the methods of administering salt solution can be carried out on short notice, that they require but little preparation, that they are marked by simplicity in technic, and that they are within the reach of all.

Salt solution may be introduced into the circulation through a vein (intravenous infusion), through an artery (intraarterial infusion), through the subcutaneous tissues (hypodermoclysis), and by way of the bowel (rectal infusion).

Indications.—The use of physiological salt solution is indicated in the following conditions:

(1) In collapse following severe hemorrhage to replace the circulating fluid, thus giving the heart a volume of fluid to contract upon and raising blood-pressure. Salt solution, however, cannot replace the cellular constituents of the blood, and in the severest grades of hemorrhage, when the number of oxygen-carrying red cells falls below a certain point, the injection of fluids into the circulation will not avail—only the transfusion of blood can avert a fatal issue in such cases.

(2) In the prophylaxis and treatment of mild surgical shock, for the purpose of restoring heat to the body and raising arterial tension. As shown by Crile, however, in severe shock, unless due to hemorrhage, the rise of blood-pressure is so temporary that the first benefits derived from the infusion are not maintained. In

such cases, the combination with salt solution of drugs which raise blood-pressure, such as adrenalin chlorid, is followed by more marked and beneficial results. For a single infusion, 10 to 30 ℳ (0.6 to 2 c.c.) of the 1 to 1000 solution of adrenalin chlorid may be added to a pint (500 c.c.) of salt solution, or the adrenalin may be administered by thrusting a hypodermic into the rubber tubing near the cannula and injecting the drug as the solution flows into the vein.

(3) To increase the fluids in the tissues where there is deficient absorption of food, as in excessive vomiting, peritonitis, etc., or to replace the fluids lost through purging, as in dysentery and cholera. The administration of salt solution may also be used to advantage before undertaking operations upon poorly nourished individuals.

(4) For its stimulating effects and the production of a rapid elimination of impurities from the body by causing diuresis, saline infusion is indicated in suppression of urine, uremia, diabetic coma, eclampsia, septicemia, various forms of toxemia, and in poisoning from carbonic acid gas, illuminating gas, etc.

(5) For the purpose of relieving postoperative thirst.

The administration of saline solution is contraindicated in advanced dropsy, pulmonary edema, or marked cardiac insufficiency and in the presence of high blood pressure or secondary anemia with greatly reduced hemoglobin it should be employed with caution.

Preparation of the Solution.—To be exact, normal physiological salt solution that is isotonic with the blood, consists of nine parts sodium chlorid to one-thousand parts of water. A variation in the strength of the solution between 0.6 per cent. and 0.9 per cent. is permissible, however, and in practice the solution is generally made up in the strength of 0.7 per cent.—roughly, 1 dram (4 gm.) of chemically pure sodium chlorid to a pint (500 c.c.) of distilled water. It is of the utmost importance that the solution be accurately made, and it should not vary much from this strength of seven parts per thousand, as solutions not isotonic with the blood produce certain untoward changes in the corpuscles. It is the opinion of Mummery that symptoms, such as chills and sweating, which are sometimes seen after intravenous infusions, are due to the incorrect chemical composition of the fluid employed. Carelessness in this respect, as well as disregard of the proper temperature of the solution, are without doubt also responsible for many of the cases of reported sloughing of the tissues after subcutaneous infusion.

A convenient method of keeping the salt solution ready for use is to have a sterilized and very concentrated solution put up in hermetically sealed tubes, in such strength that the contents of one tube emptied into a quart (1000 c.c.) of sterile water gives a normal salt solution (Fig. 124). In hospital practice it is customary to keep the solution in stock bottles ready for use. The solution is made up in the proper strength from sterile salt dissolved in sterile water, and is then prepared as follows.[1] "Filter into flasks (sterilized by washing with bichlorid solution, then rinsing with sterile water) stoppered with nonabsorbent cotton, sterilize for one hour for three successive days at a temperature of 220° F., and cover the cotton stoppers with a small square of rubber tissue held in place by a rubber band. When needed, place the flask in a deep basin filled with hot water until raised to the proper temperature." A more

FIG. 124.—A tube of concentrated sterile salt solution.

convenient method of bringing the solution to the required temperature when needed for use is to have at hand very hot and cold salt solutions in separate flasks. The solution may be quickly heated by placing the flasks, surrounded by water to their necks, in a sterilizer or a deep basin, and bringing the water to the boiling-point. Some of the cold solution is poured into the reservoir first, and sufficient of the hot solution is then added to bring the contents of the reservoir to the proper temperature.

Artificial Sera.—Some operators prefer to employ artificial sera prepared according to certain formulæ, the object being to obtain a solution as nearly identical to the blood serum as possible. Some of those most frequently used are as follows:

		(Approximately.)
Hare's formula:		
Calcium chlorid,	0.25 gm.	gr. iv.
Potassium chlorid,	0.10 gm.	gr. 1½
Sodium chlorid,	9 gm.	dr. 2¼
Distilled water,	1000 c.c.	qt. i.
Ringer's formula:		
Potassium chlorid,	0.25 gm.	gr. iv.
Calcium chlorid,	0.3 gm.	gr. 4½
Sodium chlorid,	7 gm.	dr. 1⅔
Distilled water,	1000 c.c.	qt. i.

[1] Fowler. "The Operating-room and the Patient."

Locke's formula:			(Approximatel
Calcium chlorid,	0.2	gm.	gr. iii.
Potassium chlorid,	0.42	gm.	gr. vi.
Sodium bicarbonate,	0.3	gm.	gr. 4½
Glucose,	1	gm.	gr. xv.
Sodium chlorid,	9	gm.	dr. 2¼
Distilled water,	1000	c.c.	qt. i.
Szumann's formula:			
Sodium chlorid,	6	gm.	dr. 1½
Sodium carbonate,	1	gm.	gr. xv.
Distilled water	1000	c.c.	qt. i.

Gum Acacia Solutions.—For the purpose of providing a solut of the same viscosity as blood which would remain in the tiss and produce a more lasting elevation of blood pressure in shock a hemorrhage than is possible to obtain from salt solution, solution gum acacia have been advocated. The English shock commit first used a 6 per cent. gum acacia in 2 per cent. bicarbonate soda solution, but later a 6 per cent. gum acacia in 0.9 per ce salt solution, as recommended by Bayliss, was employed.[1] Wl the gum salt solution was used both in the American and Brit armies during the recent war in the treatment of shock, there still considerable difference of opinion as to its value; some observ being very enthusiastic, claiming that it is an effective substit for blood, while others assert that at best it is of no more ben than ordinary salt solution. That gum salt solution is not with danger, in certain cases at least, is evident from the alarming a in some cases fatal reactions that have been reported following use, for which a satisfactory explanation has not been offer

INTRAVENOUS INFUSION

The introduction of salt solution directly into a vein assures u its immediate entrance into the circulation and the certainty of absorption. The intravenous method is thus indicated in any of conditions previously mentioned where there is necessity for gr haste and a prompt response to the treatment. The advantages

[1] More recently Erlanger and Gasser (*Annals of Surgery*, April, 1919 and *Amer Journal of Physiology*, Oct., 1919) report results from the intravenous injection hypertonic solution of gum acacia and glucose. They recommend a 25 per cent. acacia and 18 per cent. glucose solution. This makes a very viscid solution and mus administered slowly. 1⅓ drams (5 c.c.) of the solution for each 2½ lbs. (Kilo body weight is given in an hour. The writers have used this solution in the treatn of shock and hemorrhage in humans as well as in experimental work on animals apparent beneficial results. The work is still in the experimental stage, however.

this method of infusion are pointed out by Matas as being almost unrestricted in possibilities in regard to quantity, comparatively much less painful than the subcutaneous method, and requiring the simplest and most readily improvised apparatus.

Apparatus.—There should be provided a thermometer, a graduated glass irrigating jar, about 6 feet (180 cm.) of rubber tubing, ¼ inch (6 mm.) in diameter, and a blunt-pointed metal infusion cannula (Fig. 125). In addition, a constrictor for the arm, a gauze compress, and a bandage will be required.

In an emergency, a fountain syringe or a large funnel will answer for the reservoir, and the glass tube of a medicine dropper will take the place of a cannula.

FIG. 125.—Apparatus for giving an intravenous infusion. (Ashton.)

Instruments.—The operator will require a scapel, a pair of blunt-pointed scissors, mouse-toothed thumb forceps, an aneurysm needle, a needle holder, two curved needles with a cutting edge, and No. 2 plain catgut (Fig. 126).

Asepsis.—Strict asepsis should be observed. The instruments and apparatus should be boiled, the thermometer should be immersed in a 1 to 500 solution of bichlorid of mercury for ten minutes, and then rinsed in sterile water, and the operator's hands should be as carefully prepared as for any operation.

Temperature of Solution.—Most operators advise that the solution be administered at a temperature of a few degrees above that of normal blood, *i.e.*, at about 105° F. (41° C.). The stimulating effect of heat upon the circulation, however, should not be lost sight of, and, when such an action is desired, the solution may be used at a temperature of 115° to 118° F. (46° to 48° C.) without harmful affects. It should be borne in mind that there will be some loss of heat while the solution is flowing from the reservoir. For this reason, the fluid in the reservoir should be kept at a temperature of from 2° to 3° higher than the temperature at which it is wished to give the infusion.

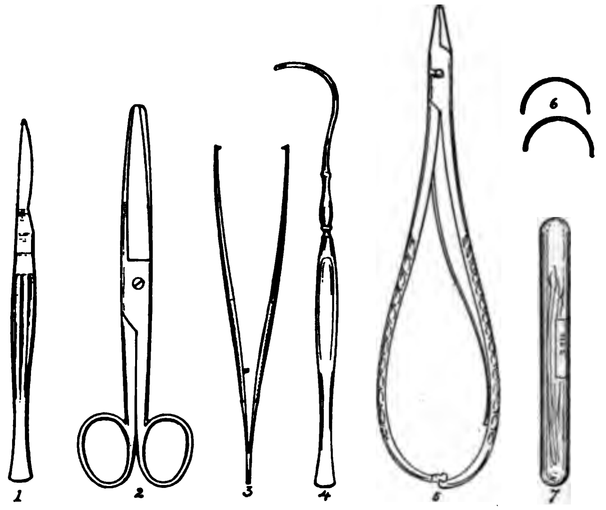


FIG. 126.—Instruments for intravenous infusion. 1, Scalpel; 2, blunt-pointed scissors; 3, thumb forceps; 4, aneurysm needle; 5, needle holder; 6, curved needles; 7, No. 2 plain catgut.

It is of the greatest importance that the solution be introduced into the body at a uniform temperature throughout the entire operation. To insure this, a thermometer is kept in the solution continuously. By watching the thermometer and adding hot solution from time to time, as that in the reservoir cools, a uniform temperature may be maintained.

Rapidity of Flow.—The speed of the flow may be regulated by raising or lowering the reservoir, or compressing the rubber tube. The rate of flow should be about one pint (500 c.c.) in five to ten minutes. It should be remembered that *the weaker the action of the heart the slower must the fluid be introduced.* Acute dilation of the heart may be produced by disregard of this caution. Furthermore, if the solution enters the circulation too rapidly, the fluid that is driven from the heart to the lungs may consist of pure salt solution, and signs of imperfect oxygenation of the blood with embarrassed respiration and restlessness will follow. If such symptoms appear, the infusion must be discontinued until the dangerous signs have passed.

Quantity Given.—It has been shown that only a certain amount of the solution will be retained in the circulation; after a time it escapes into the tissues and produces edema. Hence there is no object in infusing enormous quantities. The average amount administered at a time varies from one pint (500 c.c.) to three pints (1500 c.c.), depending on the case, but larger quantities may be required in cases of severe hemorrhage, or after venesection. The operator will be guided as to the requisite quantity chiefly by the return of the pulse, the increase in its volume, and by the improvement in the color of the patient's skin. In severe cases it may be advisable to repeat the infusion two or three times within twenty-four hours rather than to infuse an enormous quantity at one time.

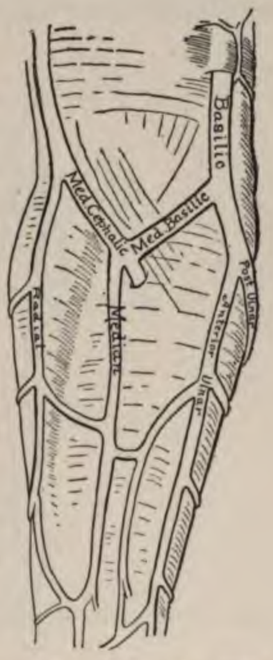


FIG. 127.—The superficial veins of the forearm. (Ashton.)

Site of Operation.—One of the most prominent veins at the bend of the elbow is usually chosen (Fig. 127), preferably the median basilic which runs across the bend of the elbow from without inward. The infusion may also be performed through the internal saphenous. At times a vein exposed in the course of an operation may be conveniently utilized.

Preparation of the Patient.—All clothing should be removed from the area selected for the infusion, and that about the axilla loosened if the arm is chosen for the infusion. The bend of the elbow is shaved, if necessary, and is then painted with tincture of iodin. A sterile bandage is tightly wrapped above the elbow to compress the veins and make them more prominent (Fig. 128). If the circulation is very feeble, even this expedient may fail to make the veins stand out conspicuously.

Anesthesia.—Anesthesia of the skin is obtained by infiltration at the site of the incision with a 0.2 per cent. solution of cocain freshly prepared or a 1 per cent. solution of procain, or by freezing with ethyl chlorid or a piece of ice dipped in salt.

Technic.—With the forearm supinated, a transverse incision is made over the median basilic vein (Fig. 129). The vein is dissected from its bed for a distance of 1 to 1½ inches (2.5 to 4 cm.), and is raised from the wound while two catgut ligatures are passed beneath it by means of an aneurysm needle, or, in its absence, by a pair of thumb forceps. The distal portion of the vein is tied off as low as possible with one ligature, and the second ligature is placed high up

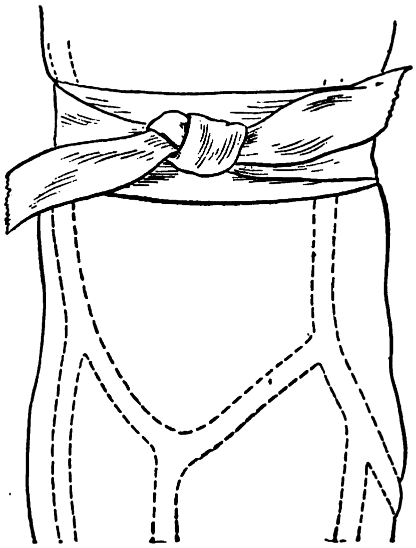
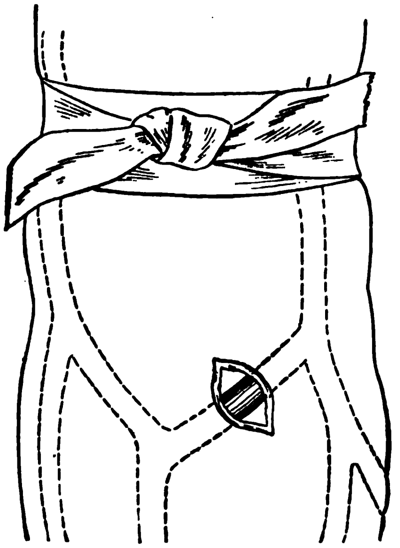
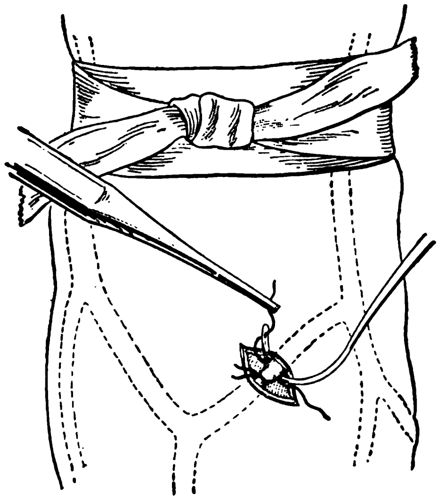


FIG. 128.—Showing the application of the bandage to the arm to constrict the veins (Ashton.)

around the portion of the vein nearest the heart, ready to be tied (Fig. 130). A portion of the exposed vein is now grasped in a mouse-toothed forceps at a short distance from the distal ligature, and, while the vein is put upon the stretch, a cut directed obliquely upward is made with scissors through half the vein, exposing its lumen (Fig. 131). *The solution is first allowed to flow through the cannula held elevated* to expel any air or fluid that may have become cold by standing, and the cannula, with the solution still flowing, is then inserted well into the cut vein (Fig. 132) and is secured in place by tying the second ligature. It is well to tie this ligature in a bow knot so that it may be easily loosened when the cannula is to be withdrawn e end of the operation (Fig. 133). *The bandage is now removed above the elbow*, and the saline solution is allowed to enter the

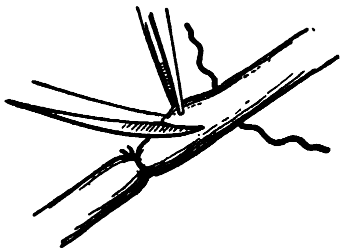


129.—Intravenous saline infusion. (Ashton.) First step, showing the vein exposed by a small incision.



G. 130.—Intravenous saline infusion. Second step, showing the distal end : vein tied and a second ligature being passed under the proximal end of the vein.

ulation, the reservoir being raised 2 to 6 feet (60 to 180 cm.) ve the patient. During the infusion the temperature of the solution must be kept uniform, the thermometer in the reservoir being constantly watched, and ***care must be taken to replenish the fluid in the reservoir before it has all escaped***, otherwise air will enter the vein when a fresh supply is added.



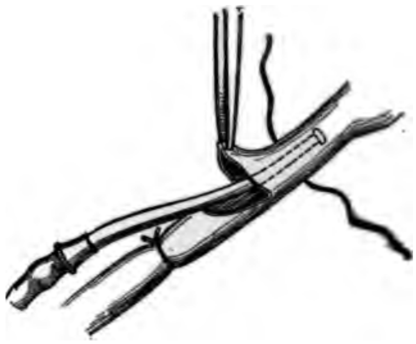
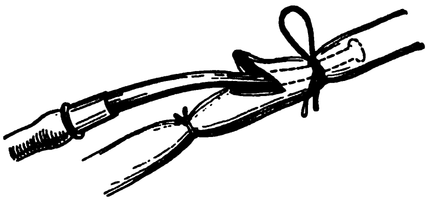


FIG. 131. FIG. 132.

FIG. 131.—Intravenous saline infusion. Third step, showing the method of incising the vein.

FIG. 132.—Intravenous saline infusion. (Ashton.) Fourth step, showing the cannula being inserted into the vein.



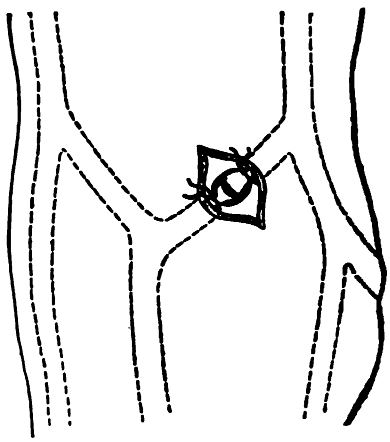


FIG. 133. FIG. 134.

FIG. 133.—Intravenous saline infusion. Fifth step, showing the cannula tied in place.

FIG. 134.—Intravenous saline infusion. (Ashton.) Sixth step, showing the infusion cannula removed and the proximal end of the vein ligated.

When sufficient solution has been introduced, the ligature about the cannula is loosened, and the latter is withdrawn. With this same ligature the proximal end of the vein may be then tied off (Fig. 134). The edges of the skin wound are united with several catgut sutures, and a sterile gauze dressing, held in place by a few turns of a bandage, is applied.

Variation in Technic.—Some operators perform intravenous infusion without making a preliminary incision to expose the vessel. The same apparatus is employed as for an ordinary intravenous infusion, except that a hypodermic or a small aspirating needle is substituted for the blunt cannula. The needle, with the solution flowing, is plunged through the skin directly into the wall of the vein.

The difficulty in placing the needle accurately in the vein, especially if the subject is very fat, or when the veins are collapsed, as is sometimes the case following a hemorrhage, places a limitation upon the field of usefulness of this method.

INTRAARTERIAL INFUSION

Saline solution may be injected into the artery instead of intravenously, if desired. The solution may be injected either into the distal end of the vessel, or into the proximal end against the blood current. The advantages claimed by its advocates for this method of infusion over the venous route is that the fluid, being first driven to the capillaries, is sent to the heart more gradually and is more evenly mixed with the circulating blood than when the entire volume of solution enters a vein, and, as a result, there is less disturbance produced in the circulation. Infusion against the blood current has, in addition it is claimed, a stimulating effect upon the heart.

Crile and Dolley (*Journal of Experimental Medicine*, Dec., 1906) have shown that the infusion of normal salt solution and adrenalin into an artery against the blood current in suspended animation from the effects of anesthesia or other causes is the most effective way of raising the blood-pressure and stimulating the heart. They point out that adrenalin administered by the venous system comes in contact with vessels having the least power of influencing blood-pressure, and that before a material rise can be effected by the action of the adrenalin upon the arteries it is necessary for the solution to pass through the right heart, the lungs, and then back to the left heart before it reaches the aorta and coronary arteries. This often causes an accumulation of solution and blood in the dilated chambers of the heart, defeating resuscitation. On the other hand, by the arterial route, the blood and solution are driven back toward the heart directly affecting the coronary arteries, thus restoring blood-pressure and stimulating the heart to beat again. They have shown that it is possible by this method to resuscitate animals that were apparently dead.

Apparatus.—The same apparatus described on page 171 for intravenous infusion, or an infusion cannula attached to a large glass funnel by a piece of rubber tubing, may be employed. In addition a hypodermic syringe will be required.

Site of Infusion.—The carotid artery or one of its large branches is chosen for the injection as being the most direct route to the coronary arteries.

Technic.—Crile (*American Journal of Medical Sciences*, April, 1909) gives the following technic for employing arterial infusion in

FIG. 135.—Showing the method of infusing salt and adrenalin solution into the carotid artery. (After Da Costa.)

humans for purposes of resuscitation. "The patient, in the prone position, is subjected at once to rapid rhythmic pressure upon the chest, with one hand on each side of the sternum. This pressure produces artificial respiration and a moderate artificial circulation. A cannula is inserted toward the heart into an artery. Normal saline, Ringer's or Locke's solution, or, in their absence, sterile water, or, in extremity, even tap water is infused by means of a funnel and rubber tubing. But as soon as the flow has begun the rubber tubing near the cannula is pierced with a hypodermic syringe loaded with 1 to 1000 adrenalin chlorid and 15 to 30♏ (1 to 2 c.c.) are at once injected. Repeat the injection in a minute, if needed. Synchronously with the injection of the adrenalin, the rhythmic pressure on the thorax is brought to a maximum. The resulting artificial circulation distributes the adrenalin that spreads its stimulating contact with the arteries, bringing a wave of powerful contraction and producing a rising arterial, hence coronary, pressure. When the coronary pressure rises to, say, 40 mm. or more, the heart is liable to spring into action. The first result of such action is to spread still further the blood-pressure-raising adrenalin, causing a further and vigorous rise in blood-pressure, possibly even doubling the normal." . . . "Just as soon as the heart-beat is established, the cannula should be withdrawn, first, because it is no longer needed, and, second the rising blood-pressure will drive a current of blood into the tube and funnel."

Dawbarn's Emergency Method of Intraarterial Infusion.—This consists in injecting saline solution into the circulation through a

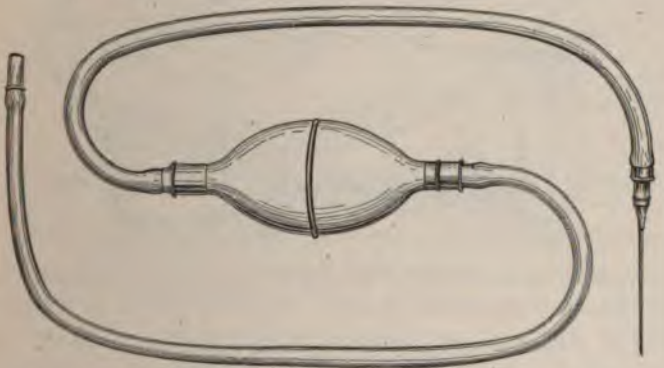


FIG. 136.—Apparatus for infusing salt solution into an artery in Dawbarn's emergency method.

hypodermic, or a long fine aspirating needle, inserted into the common femoral artery. Dawbarn recommends it as an emergency method in the absence of cannula and instruments necessary for intravenous infusion, or where the superficial veins are small and very difficult to locate.

Apparatus.—A hypodermic needle, or a long fine aspirating needle, and an ordinary Davidson syringe (Fig. 136) are all that are required.

Technic.—The femoral artery is first carefully defined just below Poupart's ligament. The aspirating needle is then forced by a slow rotary movement directly into the artery, entering it at right angles. As soon as the needle enters the vessel, bright red blood will fill its lumen. The rubber tubing of the syringe, which has been previously filled with saline fluid, is then slipped over the base of the needle and is firmly secured in place by tying. The fluid is then steadily pumped from a basin directly into the arterial circulation (Fig. 137). According to Dawbarn, it requires about half an hour to inject a pint (500 c.c.) of solution by this method. If a fountain syringe is used instead of a Davidson syringe, it must be held at least 6 feet (180 cm.) above the patient to secure the necessary pressure, otherwise the blood will be forced back up the tube.

FIG. 137.—Showing the method of infusing salt solution into the femoral artery.

HYPODERMOCLYSIS

The subcutaneous method of infusion does not permit as rapid an introduction of large quantities of solution as the intravenous, on account of the slowness with which the solution is absorbed. It is indicated in the same conditions as venous infusions, when urgency is not of prime importance. It is also frequently used as an adjunct to intravenous infusion. Hypodermoclysis is contraindicated where the tissues are edematous from dropsy, or where the circulation is so feeble that absorption of the solution is very slow or impossible.

Apparatus.—There will be required a thermometer, a graduated glass, irrigating jar, 6 feet (180 cm.) of rubber tubing, ¼ inch (6 mm.) in diameter, and an aspirating needle of fair size (Fig. 138). When it is desired to introduce the fluid under both breasts at once, two needles fastened to the rubber tubing by means of a Y-shaped glass connection, as shown in Fig. 139, may be employed.

In an emergency, a glass funnel or a fountain syringe, to which is attached an ordinary hypodermic needle by several feet of rubber tubing, may be utilized.

Temperature of the Solution.—The solution should enter the body at about 110° F. (43° C.). When using a large aspirating needle the fluid in the reservoir should be kept at a constant tempera-

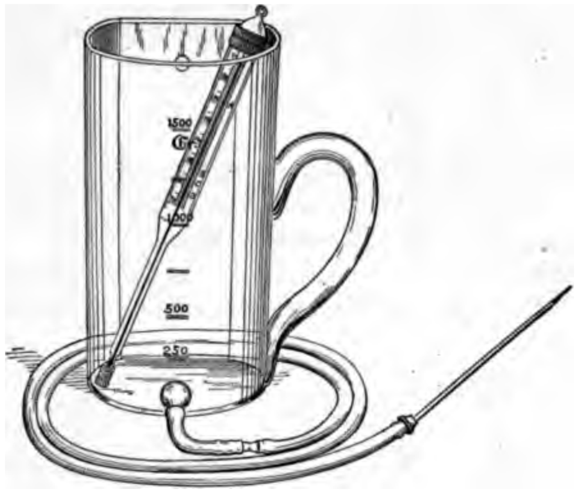


FIG. 138.—Apparatus for giving hypodermoclysis. (Ashton.)

ture of about 3 degrees higher. If a hypodermic needle be employed, about 5 degrees should be allowed for cooling.

Rapidity of Flow.—As the fluid is taken up with comparative slowness from the subcutaneous tissues, the injection is given less rapidly than by the intravenous method. With a fair-sized needle

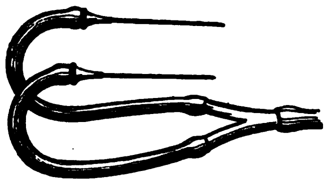


FIG. 139.—Showing two needles arranged for hypodermoclysis.

about a pint (500 c.c.) of fluid may be injected in from twenty to thirty minutes, the reservoir being held from 3 to 4 feet (90 to 120 cm.) above the patient. When a hypodermic needle is employed, the needle being so small in caliber, it will be necessary to raise the reservoir 5 or 6 feet (150 to 180 cm.) to get sufficient force.

Quantity Given.—Injections of small quantities of solution, repeated several times, give better results than a single large injection.

As a rule, 8 to 16 ounces (250 to 500 c.c.) of solution are introduced at a single injection, and repeated in a few hours, if necessary. According to Hildebrand, it is not safe to introduce a larger quantity of solution in fifteen minutes than 1 dram (4 c.c.) to each pound (453 gm.) of body weight. If this ratio is exceeded, the fluid accumulates and the tissues become water-logged, as the kidneys do not secrete rapidly enough to carry it off. Furthermore, *very large quantities of solution should not be injected into one area*, as it may produce undue distention of the tissues and consequent sloughing from the prolonged anemia.

Sites of Injection.—The area chosen for the injection should b in a region free from large blood-vessels and nerves and where ther is an abundance of loose connective tissue. The usual sites ar (1) under the mammary glands; (2) in the subcutaneous tissue b tween the crest of the ilium and the last rib; (3) in the subcutaneo

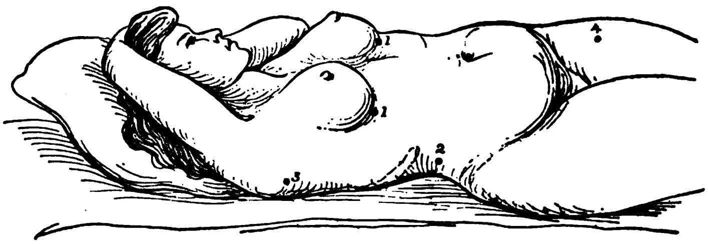


Fig. 140.—Sites for hypodermoclysis.

tissue in the axillary space; (4) in the subcutaneous tissue on the in surfaces of the thighs (Fig. 140).

Asepsis.—The necessary apparatus should be boiled, the seat injection painted with tincture of iodin, and the operator's han carefully cleansed. The thermometer is sterilized by immersion a 1 to 500 bichlorid solution for ten minutes, followed by rinsing sterile water.

Anesthesia.—The point of skin puncture may be anesthetized the injection of a drop or two of a 0.2 per cent. solution of coca or a 1 per cent. solution of procain, or by freezing with ethyl chlo or salt and ice.

Technic.—The reservoir is raised from 3 to 4 feet (90 to 120 cm above the patient, and some of the fluid is allowed to escape from t needle, to expel any air or cold solution. With the solution st flowing, the operator, using steady pressure, inserts the needle o liquely well into the subcutaneous tissue. As the solution enters, swelling appears in the subcutaneous tissues which, however, slowly subsides as the fluid is absorbed (Fig. 141). If, as soon as the tissues in one area become distended, the needle be partly withdrawn and its direction be changed slightly, a large amount of solution may be infiltrated over a wide area without producing too great tension at any one spot. The absorption of the solution may be hastened by gentle massage over the infiltrated area. During the operation, the

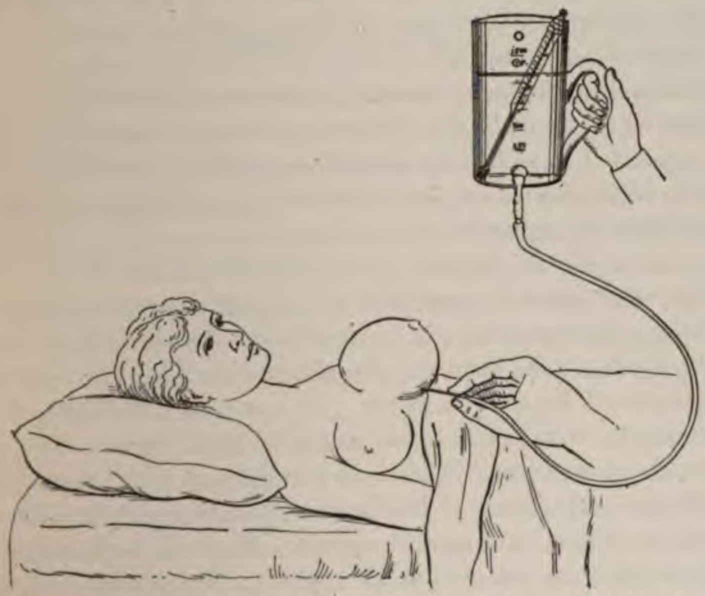


FIG. 141.—Giving hypodermoclysis under the left breast. (Ashton.)

temperature of the solution is to be kept uniform, and sufficient solution must be in the reservoir at all times to prevent air from entering the tube.

When the desired quantity of solution has been introduced, the needle is withdrawn and the finger is placed over the puncture to prevent the escape of fluid. The puncture is then sealed with sterile cotton and collodion.

RECTAL INFUSION. (See page 607.)

CHAPTER VI

ACUPUNCTURE, VENESECTION, SCARIFICATION, SUBCUTANEOUS DRAINAGE FOR EDEMA, CUPPING, AND LEECHING

ACUPUNCTURE

This is a small operation which consists in the insertion of needles or other small sharp instruments either into the superficial tissues for the purpose of relieving the tension in swollen or edematous areas, or directly into muscles or nerves for the relief of the pain of muscular rheumatism or of neuritis.

For the relief of tension, and to furnish an exit for the effusion beneath the skin, acupuncture is frequently employed in edema involving the extremities, labia, or scrotum, though, if the tissues are so greatly distended that sloughing seems imminent, incisions should be substituted for the punctures. In acute epididymitis and similar cases acupuncture is also often used with good results.

Of the second class of cases it is employed with greatest success in lumbago and sciatica. Just how acupuncture acts in such cases is not clear; relief of pain is not invariably afforded, for in some cases it seems to have no effect, but at any rate the method is worthy of trial, especially before more severe forms of treatment, as nerve stretching, etc., are instituted.

Instruments.—To relieve tension, the punctures may be made with triangular-pointed surgeon's needles or with a very narrow-

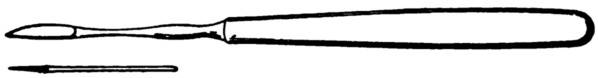


FIG. 142.—Instruments for acupuncture.

bladed bistoury (Fig. 142). Employed for the relief of the pain muscular rheumatism or neuritis, half a dozen cylindrical needles about 3 or 4 inches (7.5 to 10 cm.) long will be required. Long darning needles or sharp hat pins will answer very well.

Asepsis.—The skin should be sterilized by painting the sites puncture with tincture of iodin; the instruments are to be boiled and the operator's hands are cleansed as for any operation. It is especially important to observe all aseptic precautions both during and after puncture of dropsical effusions, as the tissues in such cases have poor resistance and are a good soil for infection.

Anesthesia.—There is but little pain connected with this operation, but if desired the skin at the sites of puncture may be frozen with ethyl chlorid.

Technic.—Puncture for the relief of tension simply consists in making a single or, when required, numerous deep stabs with the needle or bistoury into the swollen area, avoiding injury to important vessels or nerves. This allows the escape of serum which may be encouraged by the application of moist heat in the form of dressings saturated with some mild antiseptic, as boric acid.

When treating muscular rheumatism by this method, several sharp round needles are thrust through the skin into the painful parts of the affected muscle to a depth of 1 to 1½ inches (2.5 to 4 cm.), or more, depending on the amount of adipose tissue, and are allowed to remain in place five to ten minutes. In removing them, care must be taken not to break them off in the tissues. Not infrequently the relief of pain is immediate.

Applied to a nerve, the same technic is employed. An endeavor is made to transfix the affected nerve with from four to six needles along the painful part of its course. It may sometimes be difficult to strike some of the smaller nerves, but with a large nerve like the sciatic there is usually no trouble. The patient's sensations will be a guide as to whether the nerve is reached, for, as soon as this occurs, a sharp pain will be felt different from that experienced as the needle passes through the superficial tissues. The needles when properly placed should be left in site about five or ten minutes.

VENESECTION

The operation of venesection, or phlebotomy, consists in the opening of some superficial vein and the abstraction of blood from the general circulation for therapeutic purposes.

The beneficial effects of bleeding have been recognized from the time of Hippocrates. Unfortunately, though, bleeding was formerly much overdone, and in the early part of the last century it came to be the custom to bleed indiscriminately for almost any sickness. In consequence of its abuse this valuable operation has lost much of its popularity and is now but rarely practised. Popular prejudice, furthermore, often prevents its employment, so that even in cases where it is of undoubted therapeutic value the practitioner of to-day prefers to put his trust in drugs to accomplish the desired effects. In spite of this neglect, bleeding is a powerful and beneficial therapeutic measure when employed in the proper class of cases, and, as Hare points out, "the indications for venesection are as clear and well defined as are the indications for any remedy."

Indications.—These may be better appreciated by an understanding of what venesection accomplishes. In the first place, through the mechanical effect upon the circulation of removal of a quantity of blood, the tension in the blood-vessels is diminished, and the vascular tone becomes more evenly balanced, so that an engorged area, where the vessels are relaxed and dilated, is relieved. At the same time the speed of the circulating blood in the capillaries is accelerated,

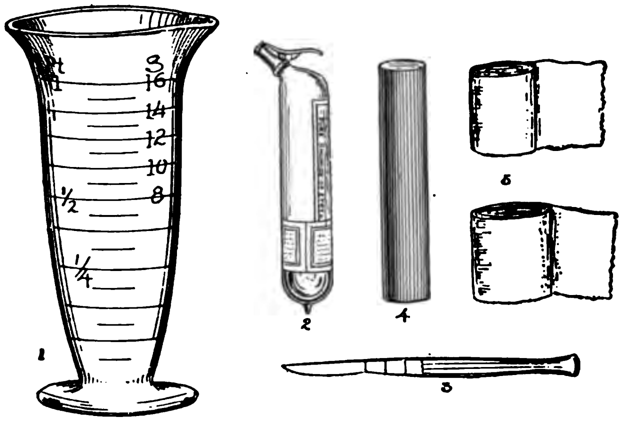


FIG. 143.—Instruments for venesection. 1, Glass graduate; 2, ethyl chlorid; 3, scalpel; 4, stick for patient to grasp; 5, bandages.

and stasis is further prevented, and the absorption of exudates hastened.

Upon the general system venesection also has beneficial effects, causing a lessened activity of the various functions; the cardiac and respiratory actions become less active, the temperature is lowered, and cell proliferation is diminished.

In general, then, it may be said that venesection is indicated for the relief of congestion in cases of excessive vascular tension evidenced by a rapid, strong, full, incompressible pulse, while low arterial tension and circulatory depression with a slow, soft, irregular, and compressible pulse are, as a rule, contraindications. Thus in sthenic types of croupous pneumonia with dilated right heart, dyspnea, and cyanosis, in pleurisy, peritonitis, pulmonary edema, pulmonary hemorrhage, emphysema with marked dyspnea and cyanosis, congestion of the brain, cardiac valvular disease with engorged right heart, bleeding both lowers vascular tension and relieves engorgement. In cases where toxins or other deleterious substances are present in the blood, as in eclampsia, uremic convulsions, illuminating-gas poisoning, poisoning by hydrogen sulphid, prussic acid, etc., bleeding serves the double purpose of reducing arterial tension and removing a definite quantity of toxic material. Largo quantities of blood may be abstracted in such cases, followed by transfusion or saline infusion (the so-called "blood washing") with unquestionably good results.

Instruments.—There will be required a scalpel or bistoury, a sterile gauze pad, several bandages, a round object as a stick or roller bandage for the patient to grasp, and a large glass graduate (Fig. 143).

Quantity Withdrawn.—On an average from 6 ounces (180 c.c.) to 15 ounces (450 c.c.) may be abstracted from an adult, and from 1 ounce (30 c.c.) to 3 ounces (90 c.c.) from a child, depending on the condition and the character of the pulse and upon the appearance of the patient. This amount may be increased, however, if the venesection is to be supplemented by transfusion or saline infusion. Under such conditions 20 ounces (600 c.c.) or more may be removed from an adult.

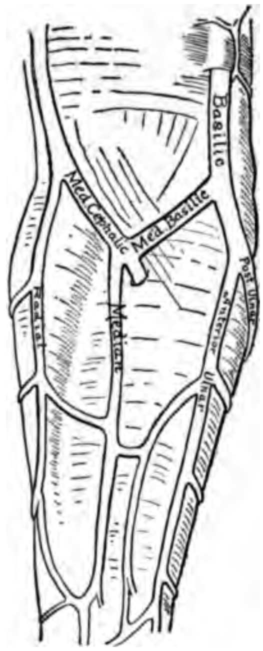


FIG. 144.—Superficial veins of the forearm. (Ashton.)

Site of Operation.—Some one of the large veins in front of the elbow-joint is usually selected (Fig. 144), but the internal jugular or internal saphenous may be utilized.

Position of the Patient.—The patient should be sitting upright or in a semireclining position on a couch, with his head turned away from the seat of operation, as the sight of blood may cause faintness. The semiupright position is a safeguard against withdrawing too much blood, as the patient becomes faint sooner than if he were lying down.

Asepsis.—While this is a small operation, at the same time all aseptic precautions should be observed. In former times many patients lost their lives from septic thrombosis. Accordingly, the instruments and dressings should be sterile, and the hands of the operator should be as carefully prepared as for any operation. The bend of the patient's elbow is first shaved, if necessary, and is then painted with tincture of iodin.

Anesthesia.—The area of incision may be anesthetized by infiltrating with a few drops of a 0.2 per cent. solution of cocain or a 1 per cent. procain solution, or by freezing with ethyl chorid or salt and ice.

Technic.—A few turns of a roller bandage are placed about the patient's arm above the elbow with just sufficient tension to obstruct

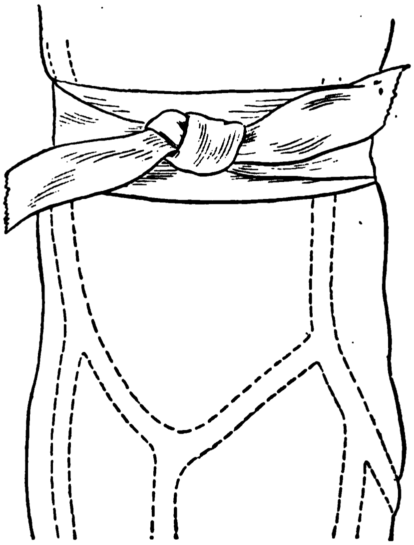


FIG. 145.—Venesection. First step, showing the application of the bandage to arm. (Ashton.)

the venous circulation and make the veins stand out prominent (Fig. 145). By directing the patient to grasp some object and wo his fingers while the arm is hanging down, the veins will become eve more distended. The patient's arm is then placed in an extended an abducted position. The operator next identifies either the media basilic or median cephalic vein, and, compressing it with his le thumb placed just below the seat of incision, makes a small cut tran versely to the long axis of the vein (Fig. 146), which is exposed by dissection and a small opening made in its anterior wall (Fig. 147). The arm is then turned over, the thumb removed, and the blood permitted to escape into a glass graduate (Fig. 148).

While cutting down on the vein care must be taken not to disturb the relative positions of the skin and vein by drawing on the skin, otherwise the cut through the skin and that into the vein will not coincide when the finger is removed and the skin released, with the result that the blood will escape under the skin into the subcutaneous tissues. If the median basilic vein is utilized, the incision into its wall must not be made too deeply for fear of wounding the brachial artery.

FIG. 146.

FIG. 147.

FIG. 146.—Venesection. Second step, vein exposed and operator's finger compressing the distal portion of the vessel.

FIG. 147.—Venesection. Third step, showing incision into vein's wall.

When a sufficient quantity of blood has been abstracted, a gauze pad is held over the wound by the thumb, and the bandage is removed from the arm. The incision is then dressed with a sterile gauze compress held in place by a bandage. If simple compression is not sufficient to stop the bleeding, both ends of the vein should be sought and ligated with fine catgut. The patient should be instructed to carry the arm in a sling for a few days following this operation.

Complications.—The most serious complication is a puncture of the brachial artery by the incision into the vein producing an arteriovenous aneurysm. This may be avoided by carefully cutting down upon the vein and not incising skin, superficial tissues, and vein at one cut.

Sometimes a very painful neuralgia is a sequel to the operation, probably due to injury to some of the cutaneous nerves of the region. If the instruments are clean and proper aseptic precautions are observed, septic thrombosis is not to be feared.

Variations in Technic.—Some operators extract the blood by means of a medium sized aspirating needle attached to a large antitoxin syringe or through a vein trocar to which is attached a piece of rubber tubing which leads to a glass graduate. The needle or trocar is plunged through the skin into the vein in the same manner as

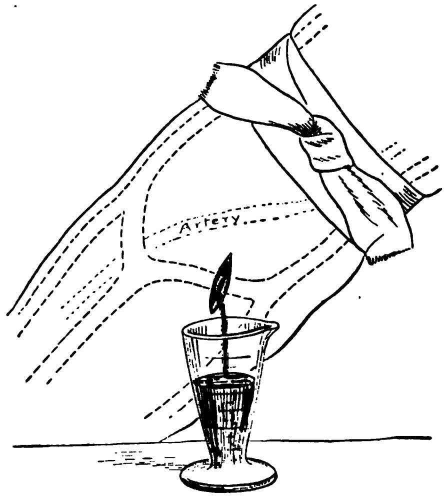


FIG. 148.—Venesection. Fourth step, showing the operator's finger removed from the vein and the blood being collected in a glass graduate.

is done in withdrawing blood for bacteriological examination (see page 302).

SCARIFICATION

Scarification consists in making multiple incisions into the tissues for the relief of local congestion or tension. By this method of local bleeding, engorged blood-vessels are emptied and effusions of serum are permitted to escape; thus undue tension from exudates is relieved, and the tendency of the tissues to slough is lessened.

For the relief of inflammatory conditions of the skin and mucous membranes scarification finds its chief application. Thus in inflamed ulcers, threatened gangrene from extreme tension, phlegmonous erysipelas, etc., prompt relief often follows its use. Scarification may also be employed in the place of multiple punctures for the relief of tension in marked edema of the extremities, labia, and scrotum. In urinary infiltration deep scarification becomes necessary to allow the escape of the extravasation and to prevent sloughing. In inflammatory affections and edemas of the pharynx, uvula, tonsils, and glottis it is often indicated; in involvement of the latter with progressive dyspnea and cyanosis the scarification should be performed without any delay.

Instruments.—An ordinary scalpel or bistoury is all that is necessary.

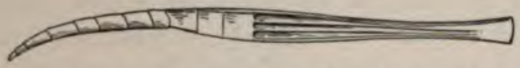


FIG. 149.—Knife wrapped with adhesive plaster.

For incising the tonsil, glottis, etc., a sharp-pointed curved bistoury wrapped with adhesive plaster to within 1/4 inch (6 mm.) of its point (Fig. 149) should be employed in the absence of a protected laryngeal knife (Fig. 150).

Asepsis.—The operation must be performed with all the usual aseptic precautions.

FIG. 150.—Protected laryngeal knife.

Anesthesia.—Where extensive incisions are required, as in urinary extravasation, for example, nitrous oxid anesthesia will be required. In other cases local anesthesia with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution, or by freezing, if the nutrition of the parts is unimpaired, will suffice. Mucous surfaces may be anesthetized with a 4 per cent. solution of cocain sprayed upon or applied directly to the parts.

Technic.—The incisions are made in parallel rows over the inflamed area, and, according to the indications, they may or may not extend through the entire thickness of the skin. They should always be made in the long axis of a limb (Fig. 151) and in other regions parallel to the lines of cleavage, care being taken not to wound the superficial nerves or large veins. Warm fomentations applied to the scarified area assist in maintaining the escape of blood and serum.

Scarification of the larynx is performed with the aid of laryngoscopy (page 440). When a clear view of the edematous parts has been obtained, incisions about ¼ inch (6 mm.) in length are made with the point of the protected bistoury in the areas of most marked swelling. When it is feasible, these incisions are made on the outer surfaces of the parts to avoid having blood flow into the larynx. A gargle of hot water or an inhalation of steam is then employed to encourage the bleeding and escape of the serum. This often gives complete relief in a few hours; if the symptoms are not improved, however, or the dyspnea recurs, tracheotomy (page 477) must be performed without hesitation.

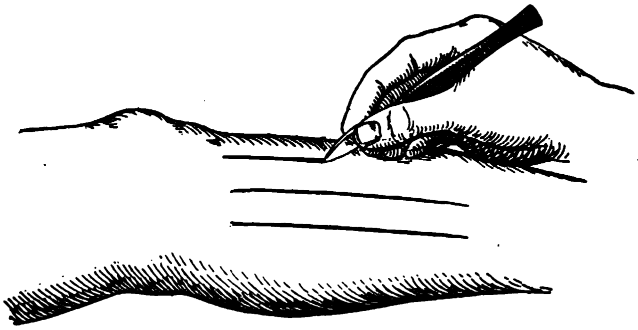


FIG. 151.—Showing the method of scarifying a limb.

DRAINAGE IN EDEMA OF THE LOWER EXTREMITIES

Three operative procedures may be employed for relieving edema of the lower extremities when the tension becomes too great, namely, multiple punctures (page 184), incision (page 190), and drainage by the trocar and cannula. Of these, the latter is less troublesome, more cleanly, and certainly far more comfortable for the patient.

From one to four cannulæ may be employed at a time, and considerable fluid may be drained off in this way. When more than one cannula is used several quarts may be abstracted in twenty-four hours, but the operator should be cautious about withdrawing too great a quantity for fear of inducing a condition of cerebral anemia. Should such a condition be produced, the drainage should, of course, be immediately stopped and stimulants administered.

Apparatus.—Southey's tubes (Fig. 152) or those of Curschmann may be employed. The former are made in a set consisting of one trocar and four cannulæ. Each cannula has lateral openings as well as a distal opening. The lumen of the cannula is about 1/25 inch (1 mm.) in diameter. In addition, pieces of rubber tubing about 3 feet (90 cm.) long to lead from the tubes to receptacles are required.

Sites for Puncture.—The back or outer sides of the legs are usually chosen.

Asepsis.—Rigid asepsis should be observed to avoid infection. The trocar and cannula are boiled, the operator's hands carefully cleansed, and the spot chosen for puncture is first shaved and then painted with tincture of iodin.

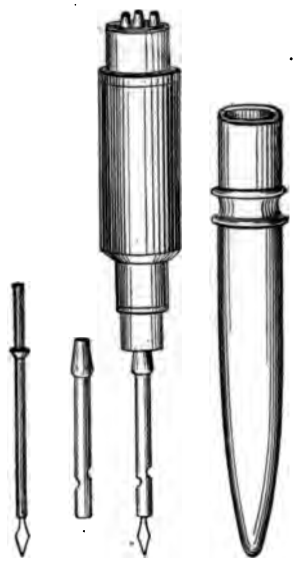


FIG. 152.—Southey's trocars and cannula.

Technic.—One cannula at a time is placed on the trocar and is inserted an inch (2.5 cm.) or more into the subcutaneous tissues at right angles to the surface. The trocar is then removed and to the free end of the cannula is attached a rubber tube filled with some antiseptic solution. The distal end of the tube is allowed to drain into a basin placed upon the floor by the side of the patient's bed (Fig. 153). Three or more cannulæ are introduced in this manner. The cannulæ should be secured in place by means of adhesive plaster, and sterilized dressings should be placed about them. Elevation of the head of the bed from 6 to 24 inches (15 to 60 cm.) allows the fluid to gravitate to the extremities and is of considerable help when the edema is generalized. Care should be taken that the cannulæ are not displaced, and for this reason, with restless patients, it is better to remove them at night. It is preferable in any case to make new punctures than to leave the cannulæ in place for several days. After the removal of the cannulæ, the sites of the punctures should be sealed with collodion and cotton.

FIG. 153.—Showing the method of draining an edematous limb with Southey's cannulæ. (After Gumprecht.)

CUPPING

Cupping may be either dry or wet according to the method of application. Dry cupping produces a local congestion of the superficial tissues and relieves congestion of the deeper subjacent organs by deviating the blood from these parts. Wet cupping, in addition, actually abstracts blood from the tissues. Cupping finds its chief application in the relief of congestion of deeply placed organs as the brain, spinal cord, lungs, liver, kidneys, etc.

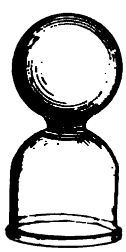
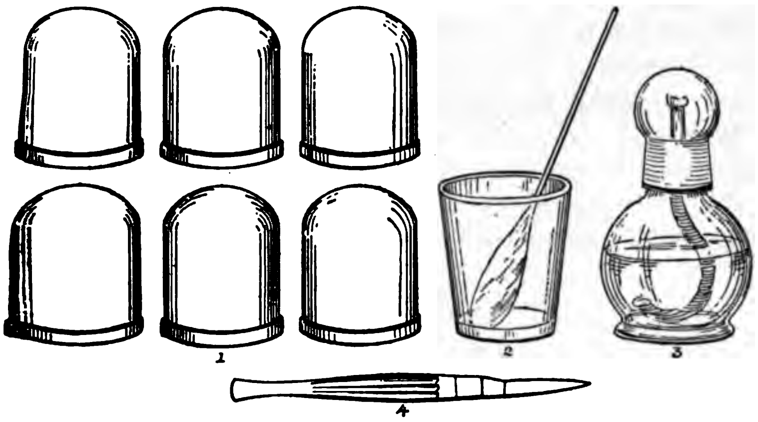


FIG. 154.—Bulb form of cupping glass.

Apparatus.—Special cupping glasses supplied with rubber bulbs for exhausting the air (Fig. 154) are obtainable and will be found very convenient, but the ordinary cupping glasses in which the vacuum is created by igniting a little alcohol smeared over the interior of the cup are just as efficient. In an emergency, 2-ounce (60 c.c.) whisky or wineglasses. or thick tumblers with smooth ounded edges will answer equally well. From 8 to 12 cups will be equired in dry cupping and from 2 to 6 in wet cupping depending pon the extent of surface to which they are to be applied.



I 55.—Instruments for wet cupping. 1, Cupping glasses; 2, swab in alcohol; 3, alcohol lamp; 4, scalpel.

In addition to the cups there should be provided some alcohol, a all stick to the end of which a cotton swab is attached, and matches an alcohol flame. If wet cupping is to be employed, there will o be required a sharp scalpel or lancet (Fig. 155).

G. 156.—Cupping. First step, swabbing the interior of the cupping glass with alcohol.

Sites of Application.—Cupping glasses are never to be applied irectly over inflamed tissues on account of the pain that would esult. Nor should they be placed over bony or irregular surfaces on ccount of the impossibility of excluding air. Where the brain is the seat of the trouble, the cups are applied to the back of the neck; in pericarditis, to the precordial region; in involvement of the lungs or pleura, to the chest between the vertebral column and scapular line; in renal congestion or acute nephritis, to the lumbar regions; in affections of the eye, to the temples; etc. Wet cups, however, are often followed by scarring, hence they should not be applied over conspicuous regions or upon the shoulders or chests of women.

Technic.—1. *Dry Cupping.*—Any hair should be first shaved off the part and the surface of the skin dampened with warm water so that the cups will adhere. To apply cups supplied with an exhausting bulb, simply compress the rubber bulb, then place the cup upon

FIG. 157.—Cupping. Second step, igniting the alcohol in the cupping glass.

the skin, and release the bulb. A partial vacuum is thus produced and the skin and underlying tissues engorged with blood are sucked up into the cup.

When ordinary cups are employed, the swab, saturated with alcohol, is lightly wiped over the interior of each cup (Fig. 156), care being taken not to leave any excess of alcohol that may run down over the edges. The alcohol is then ignited (Fig. 157), and the cup is quickly and tightly applied to the skin. The contained air is rapidly exhausted by the flame, and, as the cup cools, a strong vacuum is created, which draws up the underlying tissues (Fig. 158) and produces local congestion. A number of cups—anywhere from eight to ten—may be applied in the same manner over any given region. If the cups are air-tight, the flame is extinguished before the patient feels the heat from the burning alcohol. When the swelling of the skin and underlying tissues has taken place to such an extent as to replace the exhausted air, the cups become loosened and drop off.

If, however, it is desired to remove the cups before this has occurred, simply tip the cup to one side and press down the skin at the edge of the glass and thus allow air to enter.

2. *Wet Cupping.*—By this method a definite amount of blood may be removed, each cup being capable of abstracting from 1 to 3 drams (4 to 12 c.c.). The cups are first applied to the region as already described; then with a scalpel parallel incisions about 1/3 inch (8.5 mm.) apart are made, care being taken to incise the skin only, for, if the subcutaneous tissues are cut into, particles of fat will be drawn up into the cuts when the cups are reapplied. The cups are then immediately applied for the second time. Blood will be drawn

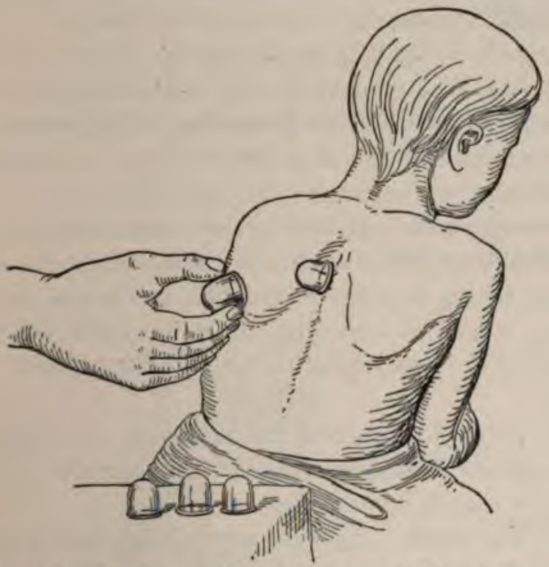


FIG. 158.—Cupping. Third step, the application of the cups.

from the scarified area into the cups until the vacuum is exhausted and the cups fall off. If it is desired to withdraw more blood, the cups are emptied and, after washing away the clots from the cut surface, they are applied again, or hot fomentations may be employed to encourage the bleeding. When sufficient blood has been withdrawn, a sterile gauze dressing is applied over the scarified region.

LEECHING

Leeching may be employed for the purpose of abstracting blood from contused or congested areas inaccessible to wet cupping. It is thus a valuable means of local blood-letting in ecchymoses, or beginning acute inflammation about the eye, ear, nose, gums, genitals, etc.

There are two varieties of leech used for this purpose; the small American leech which is capable of withdrawing about a dram (4 c.c.) of blood and the Swedish leech which will suck from 3 to 4 drams (4 to 15 c.c.). According to the amount of blood it is desired to remove, from one to six leeches may be applied at one time. Only those coming from clean, uncontaminated water should be used.

Sites of Application.—It should be remembered that the leech produces a triangular cut in the skin which results in a permanen scar, hence they should not be placed upon conspicuous portions o the body. They should never be applied to regions where there i much loose cellular tissue, such as the eyelids, labia, scrotum, or penis for extensive ecchymoses may be the result. As their bite is irritat ing, they should not be applied directly to an inflamed area; instead they are to be applied to the periphery. They should never b allowed to take hold of the skin directly over a superficial artery vein, or nerve.

Leeches are generally applied to the temples or the back of th neck in congestion or inflammation of the brain, to the mastoid an in front of the tragus in acute mastoiditis and acute otitis media, t the perineum when the scrotum, penis, or labia are the region affected, and to the coccyx for the relief of congested or inflame hemorrhoids.

Asepsis.—To avoid infection the skin over the region to whic the leech is applied should be washed with soap and water. If th part is hairy, it should be first shaved.

Technic.—The leech is applied to the part and confined und a pill-box or wineglass until it takes hold. A special leech-tube a test-tube may be employed for this purpose, in which case t leech is placed in the tube tail or large end first and the tube is th inverted so that the leech's head comes in contact with the sk This may be removed as soon as the leech takes hold, but, in emplo ing leeches about the orifices of mucous cavities, they should alw be confined so as to prevent their escape into the interior. If t leeches are removed from the water an hour or so before using, th will take hold more readily. Making a puncture in the skin a applying the leech to the bleeding spot or rubbing the skin wi sweetened water or milk will cause the leech to take hold, if it do not seem inclined to do so. When once the leech has begun draw blood, it should not be pulled off—it will drop off when fille

If it is desirable, however, to remove it sooner, sprinkling salt over it will induce it to let go.

By applying hot fomentations to the part after the removal of the leech bleeding can be encouraged and often an ounce (30 c.c.) or more of blood may be withdrawn in this way. After removal of the

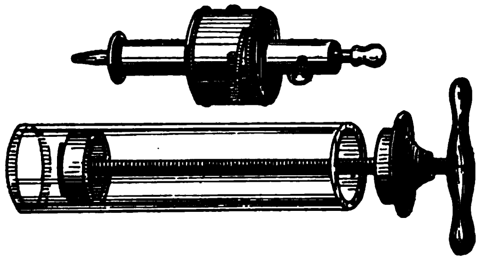


FIG. 159.—Artificial leech.

leech, the bite should be bathed with sterile water and a small gauze dressing applied.

Sometimes a considerable and troublesome bleeding continues from the leech bite, due to the fact that the tissues become infiltrated with material excreted from the throat of the leech which prevents

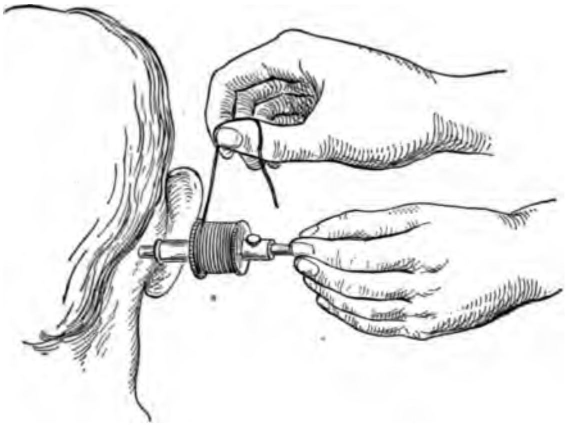


FIG. 160.—Application of the artificial leech to the mastoid. (After Ballenger.) First step, showing the method of scarifying.

coagulation of the blood. The bleeding can usually be controlled, however, by compression or by applying a piece of cotton saturated with some styptic, as a solution of 1 to 1000 adrenalin chlorid, alum, or tannic acid. The use of the actual cautery or passing a harelip pin or needle beneath the bite and winding a thread about the two ends so as to constrict the part are also advised. Failing in these measures, the bite should be excised and the tissues sutured.

The Artificial Leech.—This apparatus may be employed instead of live leeches. It consists of a small cupping apparatus combined with a scarifier (Fig. 159). The latter is in the form of a small steel cylinder containing a circular lancet propelled by a cord or a spring. The skin is first scarified, by drawing upon the cord which causes the

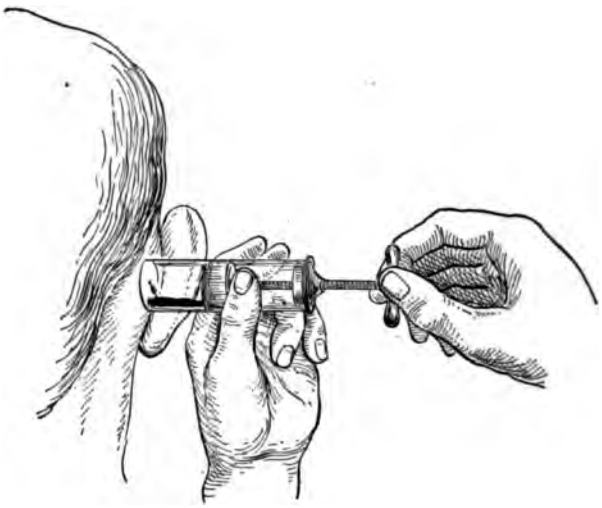


FIG. 161.—Application of the artificial leech to the mastoid. (After Ballenger.) Second step, withdrawing blood.

lancet to rapidly rotate, as shown in the accompanying illustration (Fig. 160), the blades of the instrument being adjusted so as to cut to the desired depth. Then the cupping tube is applied and blood abstracted by withdrawing the piston and creating a vacuum (Fig. 161). With this instrument as much as 1 ounce (30 c.c.) of blood may be withdrawn.

CHAPTER VII

HYPODERMIC AND INTRAMUSCULAR INJECTIONS, THE ADMINISTRATION OF ARSPHENAMIN AND NEO-ARSPHENAMIN, THE ADMINISTRATION OF DIPHTHERIA ANTITOXIN, VACCINATION

THE HYPODERMIC AND INTRAMUSCULAR INJECTION OF DRUGS

Drugs may be administered by injection into the subcutaneous or muscular tissues when a rapid effect is desired, or when, for any reason, medication by the mouth is undesirable or is contraindicated. The injection of soluble, nonirritating substances is made into the subcutaneous tissues, from which the absorption is very rapid; but when the solution is insoluble or irritating, so that its presence in sensitive tissues would produce pain, it had best be given intramuscularly.

The advantages of hypodermic medication, besides the promptness of the effects obtained, consist in affording a method whereby it is possible to administer remedies in the presence of nausea and vomiting, or inability or unwillingness on the part of the patient to swallow; furthermore, the absorption of the drug is not dependent upon the functional activity of the gastrointestinal tract.

The Hypodermic Syringe.—The ordinary hypodermic syringe consists of a glass barrel protected by a metal case and furnished

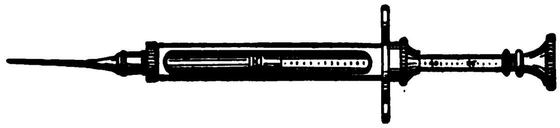


FIG. 162.—Ordinary glass and metal hypodermic syringe.

with a leather-covered piston (Fig. 162). Such syringes, however, are difficult to keep clean and, if they are frequently boiled, the leather packing soon dries out and becomes inefficient unless carefully attended to. Syringes of solid metal (Fig. 163) or those consisting of a glass barrel and solid glass piston, as the Luer (Fig. 164), or with an asbestos-covered piston, as the "Sub-Q," will be found preferable, and may be easily cleaned and repeatedly boiled without harm. A syringe with a capacity of 30♏ (2 c.c.) is amply large for ordinary use.

The needles should be as fine as possible (28 to 27 gauge) and very sharp, and for injection beneath the skin they should be about 1 inch (2.5 cm.) in length. For the administration of liquids of a heavy consistency a needle of somewhat larger caliber will be required. For intramuscular injections, the needle should be 1 ½ to 2 inches (4 to 5 cm.) long, and, if one of the insoluble preparations of mercury is employed, the caliber of the needle should be correspondingly large. To prevent the needles rusting and the lumen becoming plugged, they should be first well cleaned out with water after using, followed by alcohol and ether to remove any remaining

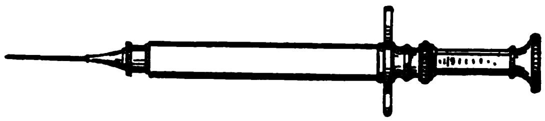


FIG. 163.—All metal hypodermic syringe.

fluid from the interior that might cause rusting, and, finally, they should be put away with a fine wire inserted in the lumen.

Preparation of the Solution.—The drugs most frequently used for hypodermic medication are morphin, atropin, strychnin, hyoscin, pilocarpin, caffein, cocain, apomorphin, quinin, mercury, digitalis, ergotin, nitroglycerin, adrenalin, alcohol, ether, etc. As the majority of these are either very powerful or poisonous, the dose should be accurately measured in every case.

The solution employed for the injection should always be sterile and preferably freshly prepared. The strength of the solution is also

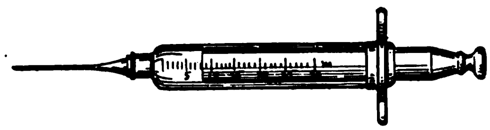


FIG. 164.—Luer's hypodermic syringe.

important, for, if too concentrated, it may prove irritating, while if greatly diluted, the bulk of solution necessary for the injection becomes objectionable. Most of the drugs for hypodermic use may be obtained in the form of soluble tablets which are dissolved in 5 to 10♏ (0.3 to 0.6 c.c.) of boiled water when required for use. Sterile solutions of the drugs, however, may be obtained in hermetically sealed glass ampules, each containing sufficient for one dose. The solution must be as nearly neutral as possible; irritating solutions or strongly alcoholic preparations should be avoided on account of the danger of subsequent sloughing at the seat of injection. When whisky or brandy is employed, it is, therefore, well to dilute them with an equal amount of water before using. Insoluble preparations, as the salicylate of mercury, for example, are best administered in some sterile oil as albolene or benzoinol.

Sites for Injection.—For ordinary injections the least sensitive portions of the body provided with plenty of cellular tissue are selected, the spot chosen, of course, being distant from the immediate neighborhood of large blood-vessels or nerves, bony prominences, or

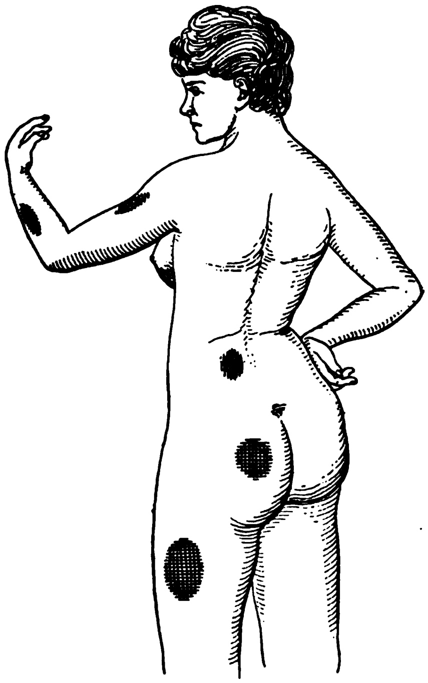


FIG. 165.—Sites for hypodermic injections.

inflamed areas. The common sites are the outer surfaces of the arm, forearm, thighs, or the buttocks.

For deep intramuscular injections of drugs not rapidly absorbed an area in the gluteal region, lying between the gluteal fold below and a horizontal line through the upper margin of the great trochanter, is usually chosen (Fig. 165). Where numerous injections are given care should be taken to alternate between the two sides and to avoid repeating the injections in the same spot each time. Meltzer (*Medical Record*, March 25, 1911) recommends that intramuscular injections be made in the lumbar muscles, claiming that absorption is more rapid than from the glutei. The spot chosen is at the junction of the inner and middle thirds of a line uniting the highest points of the iliac crest with the third or fourth lumbar spinous process.

Position of Patient.—For a deep intramuscular injection the patient lies upon the opposite side or upon the abdomen.

FIG. 166.—Showing the method of giving a hypodermic injection.

Asepsis.—The strictest regard as to cleanliness should always be observed. The needle and syringe should be boiled or at least immersed in some antiseptic solution before use, and the skin at the site of the injection should be painted with tincture of iodin or rubbed clean with a piece of cotton or gauze saturated with alcohol.

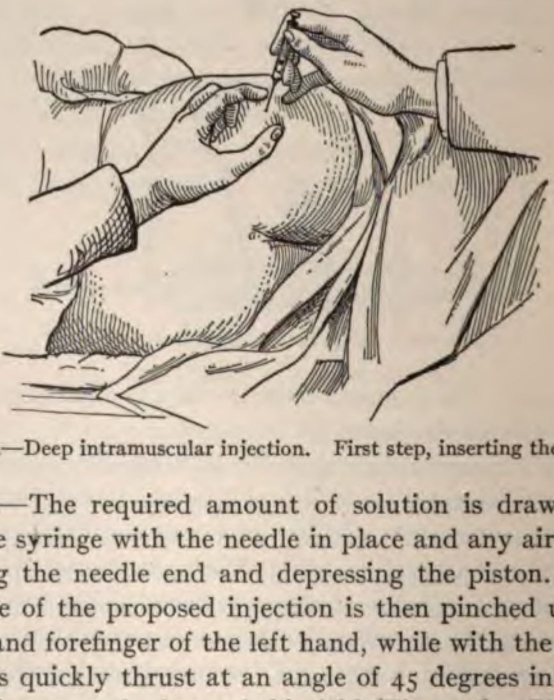


FIG. 167.—Deep intramuscular injection. First step, inserting the needle.

Technic.—The required amount of solution is drawn into the barrel of the syringe with the needle in place and any air is expelled by elevating the needle end and depressing the piston. The skin over the site of the proposed injection is then pinched up between the thumb and forefinger of the left hand, while with the right hand the needle is quickly thrust at an angle of 45 degrees into the subcutaneous tissues at the base of this fold (Fig. 166). If the needle is sharp and it be quickly plunged through the skin, but little, if any, pain will be experienced. The solution should be injected slowly to avoid too sudden distention of the tissues. When the required

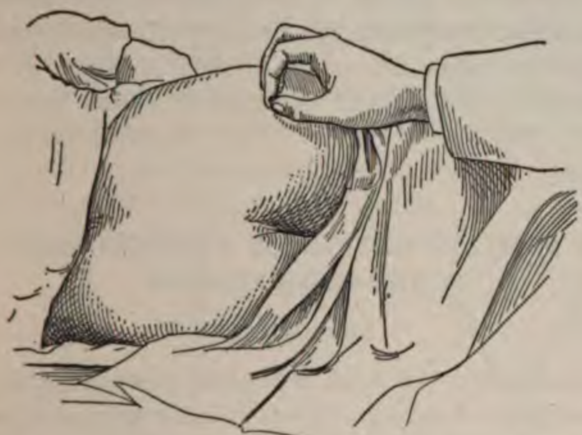


FIG. 168.—Deep intramuscular injection. Second step, showing the syringe removed and inspection of the needle for the flow of blood.

amount has been introduced, the needle is quickly withdrawn, and the finger is placed over the site of puncture, and gentle massage is practised for a moment or two to diffuse the solution.

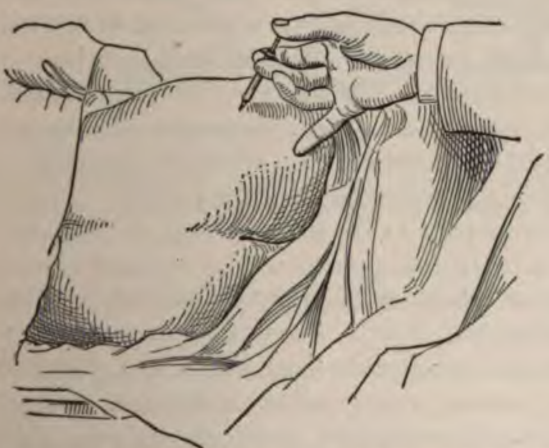


FIG. 169.—Deep intramuscular injection. Third step, injecting the solution.

In giving a deep intramuscular injection, the skin over the chosen site is held tense by the fingers of the left hand, and the needle is steadily forced through the skin and subcutaneous tissues directly into the glutei muscles up to its hilt (Fig. 167). As soon as the needl is in place, it is advisable to remove the syringe and observe whethe there is any flow of blood from the needle (Fig. 168); if so, a ne puncture should be made. Observance of this precaution wi obviate injecting the solution into the blood current should the needl point penetrate some vein. The solution is then injected slowl (Fig. 169), and at the completion of the operation the site of punc ture is sealed with collodion or by means of a small piece of adhesiv plaster.

THE ADMINISTRATION OF ARSPHENAMIN AND NEOARSPHENAMIN

ARSPHENAMIN

Arsphenamin is a yellowish crystalline powder containing abou ⅓ of its weight of arsenic. It was introduced under the name c salvarsan or "606" by Ehrlich in 1910 for the cure of syphilis afte years of experimental work upon animals with spirillicidal drug Although arsphenamin has proved a most important addition t therapeutics, we have been compelled to revise materially our earl conceptions of its value. It was originally claimed that one larg dose would entirely destroy the spirochetes of syphilis, but unfortu nately this early promise has not been realized in the majority c cases. There is no doubt that it is a powerful spirochetal poison an it unquestionably causes certain of the manifestations of syphilis t disappear very rapidly, but whether the results obtained from it use, even in repeated doses, are permanent or only temporary wi require many years to establish. Owing to numerous relapses tha have followed single injections, it is now generally agreed that a singl dose is not curative. At the present time, the majority of author ties advise that the injection should be repeated one or more tim and that its use should be followed by the administration of mercu for the usual period.

Arsphenamin is indicated in all stages of syphilis. It gives tl best results, however, the earlier in the disease it is used, being mo rapidly effective than mercury, especially upon mucous lesions, a causing the Wassermann reaction to become more quickly negativ So that in the primary and early secondary stages the most brillia results are obtained, while in the late secondary and tertiary stag it becomes more difficult to eradicate the infection. It has little no effect in well marked locomotor ataxia and paresis, unless shown by Swift and Ellis it is administered intraspinously in the form of salvarsanized (arsphenaminized) serum (see page 338). It is contraindicated in advanced degenerative processes of the central nervous system and in long-standing cardiac and vascular degenerations, and in nonsyphilitic retinal and optic nerve affections. Syphilitic eye and ear diseases, however, are not contraindications to its use. Any known idiosyncrasy against arsenic should lead to great caution in its use.

Arsphenamin has also been employed in the treatment of other diseases due to spirilla with excellent results. In relapsing fever,

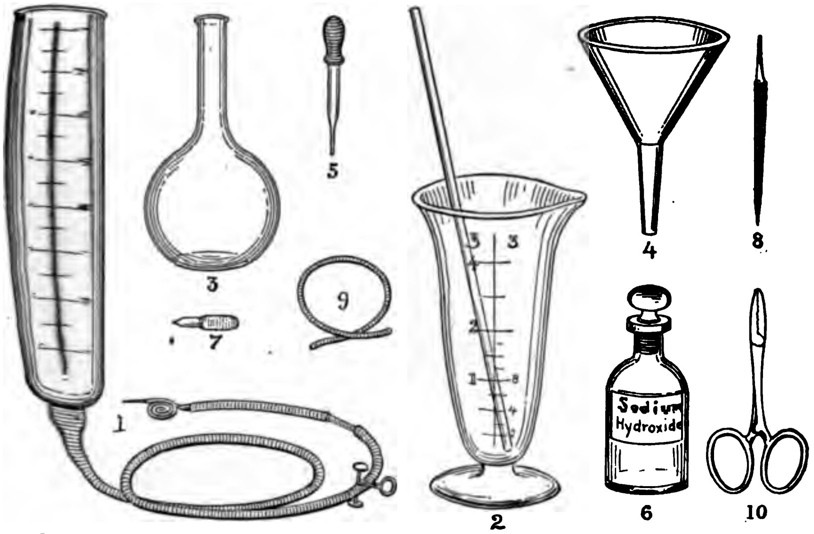


FIG. 170.—Apparatus for intravenous injection of arsphenamin. 1, Graduated reservoir, rubber tubing, and vein needle; 2, graduate and glass rod for mixing the solution; 3, decanter for distilled water; 4, glass funnel; 5, medicine dropper; 6, bottle of sodium hydroxid solution; 7, tube of arsphenamin; 8, file; 9, catheter for constricting arm; 10, artery clamp.

filariasis, yaws, and in some forms of malaria, it has proved very efficacious, frequently one injection sufficing to produce a cure. It has also been tried in leukemia, splenic anemia, leprosy, tuberculosis, and pellagra with questionable results.

Arsphenamin was at first given subcutaneously. Then intramuscular injections were substituted, but these proved very painful. The drug was not always absorbed, and at times caused great irritation at the site of injection and, in some cases, sloughs that were very slow in separating. At the present time the intravenous method of administration is generally adopted.

Its administration is likely to be followed in from one to six hou by a systemic reaction, consisting of a chill, a rise of 1 to 2 degrees i the temperature, gastric irritation, and diarrhœa. These symptom however, are not always present, and the temperature and chill a less likely to occur if *freshly distilled* water is used in the preparatio of the solution. In exceptional cases, following an injection, or a late as one or two days after, the patient becomes quite sick; he ha headache, vertigo, severe gastric irritation, high temperatur loose stools, and disturbance of circulation. A transient album nuria may be present during elimination of the drug. In some cas death has resulted with all the symptoms of arsenical poisoning.

Apparatus.—There will be required (1) a graduated glass cylind with a capacity of about 10 ounces (300 c.c.), (2) 4 feet (120 cm.) rubber tubing with a short piece of glass tube inserted in it to allo detection of any air bubbles, (3) a Schreiber infusion needle, 2 inches (6 cm.) long and of No. 18 caliber, (4) a glass decanter for di tilled water, (5) a glass graduate for mixing the solution, (6) a funn

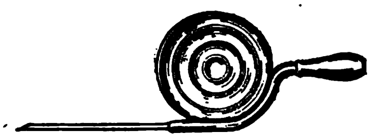


FIG. 171.—Enlarged view of vein needle.

in which is placed filter paper or sterile cotton to filter the solutic through, (7) a glass stoppered bottle containing a solution of 15 p cent. sodium hydroxid, (8) a medicine dropper, (9) a glass stirri rod, (10) a catheter and artery clamp for constricting the arm of t patient, (11) a tube of arsphenamin and a file to open it with (Fi 170).

In addition, it is well to have at hand a scalpel and a coca syringe in case it is necessary to expose the vein before inserting t needle.

Asepsis.—The apparatus is sterilized by boiling. The tube co taining the arsphenamin and the file are placed in alcohol, and t operator's hands are prepared as carefully as for any operation.

Preparation of the Solution.—It has been found that much the immediate systemic reaction is due to impurities in the wat for this reason only *freshly distilled sterile water* should be employ in the preparation of the solution. The ampule of arsphenam is dried off, the glass is nicked with the file, the tube is broken ope and its contents are poured into 30 to 40 c.c. (1 to 1½ ounces) of h sterile distilled water previously placed in the mixing glass. The solution is then shaken or stirred until all the drug is thoroughly dissolved. To the resulting clear acid solution is added drop by drop the 15 per cent. sodium hydroxid solution by means of the dropper, the solution being shaken after each drop is added. This causes a precipitate to form, which dissolves as the solution becomes alkaline. It requires about 20 drops of the sodium hydroxid solution to render a mixture containing 0.5 gm. (7½ gr.) of arsphenamin perfectly clear. Having obtained an absolutely clear solution, it is diluted with sterile 0.5 per cent. saline solution, made from chemically pure sodium chlorid and sterile, freshly distilled water, up to 250 c.c. (8 ounces) if, for example, 0.5 gm. (7½ gr.) is the dose, that is, 50 c.c. (1 ⅗ ounces) of fluid is used for every 0.1 gm. (1½ gr.) of arsphenamin. The solution is now ready for use and is finally filtered through sterile cotton placed in a funnel into the intravenous apparatus.

Temperature of the Solution.—The solution is given at about a temperature of 105° F. (41° C.).

Dosage.—An average dose for men is 0.4 to 0.5 gm. (6 to 7½ gr.), for women 0.3 to 0.4 gm. (4½ to 6 gr.), for children 0.2 to 0.3 gm. (3 to 4½ gr.), and for infants 0.02 to 0.05 gm. (⅓ to ¾ gr.). In this country it is becoming customary to employ smaller initial doses, that is, 0.2 and 0.3 gm. (3 and 4½ gr.) doses and, if no unpleasant symptoms follow, the second dose may be increased 0.1 gm. (1½ gr.).

Repetition of the Dose.—The injection may be repeated in from one to four weeks, depending upon the reaction produced and the effect on the lesions. In the early cases from three to four injections are usually given, and in the late cases from five to six, or more, until the Wassermann reaction remains negative.

Site of Injection.—Some one of the prominent veins on the anterior aspect of the arm in front of the elbow-joint—preferably the median basilic—is chosen for the injection.

Position of the Patient.—The injection should be given with the patient in the recumbent posture.

Preparations of Patient.—All tight clothing should be removed from the arm selected for the infusion. The site of puncture is painted with tincture of iodin, and the rubber catheter is secured about the arm with sufficient tension to make the veins stand out prominently.

Technic.—With the tourniquet properly applied about the forearm, the operator identifies the vein into which he wishes to insert the needle and instructs the patient to work his fingers until th vein becomes quite prominent. The needle, held almost flat wit the skin surface, is then thrust through the skin into the vein towa the axilla (Fig. 172). The successful entrance into the vein is ind cated by a flow of blood from the end of the needle. Care must b taken to insert the needle *into* the vein and not through the opposi wall of the vein. If the needle is held almost parallel with the su face of the arm, this accident is not likely to occur. If there is an difficulty in finding the vein, it should be exposed by a small tran verse nick through the skin under infiltration anesthesia and th needle inserted by sight. The tourniquet is then removed from th patient's arm, and, after seeing that all the air is expelled fro

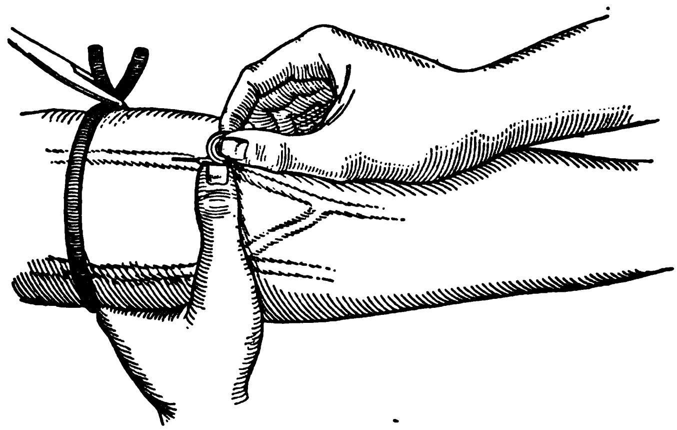


FIG. 172.—Method of inserting needle into the vein.

the tubing of the intravenous apparatus, the latter is connect with the needle, and the solution is permitted to flow into the ve The solution is injected very cautiously at first until it is certa that it is entering the vein and not the surrounding tissues, or test injection of a small amount of normal salt solution is mac Any leakage of the arsphenamin solution into the tissues caus a severe burning pain and necessitates the immediate stoppage the injection. During the injection the reservoir is raised 24 30 inches (60 to 75 cm.) above the level of the patient. It tak about ten minutes for the entire quanity of solution to flow in the vein: at the completion of the operation the needle is quickl removed and a sterile pad is placed over the site of puncture an is secured by a few turns of a bandage.

NEOARSPHENAMIN

The general properties of neoarsphenamin (neosalvarsan) are similar to those of arsphenamin and it is claimed to be just as efficacious. It, however, possesses certain decided advantages over arsphenamin in that it is better tolerated and is less often followed by a systemic reaction, so that larger doses can be employed and the dose may be repeated more frequently. Furthermore, the preparation of the solution is very

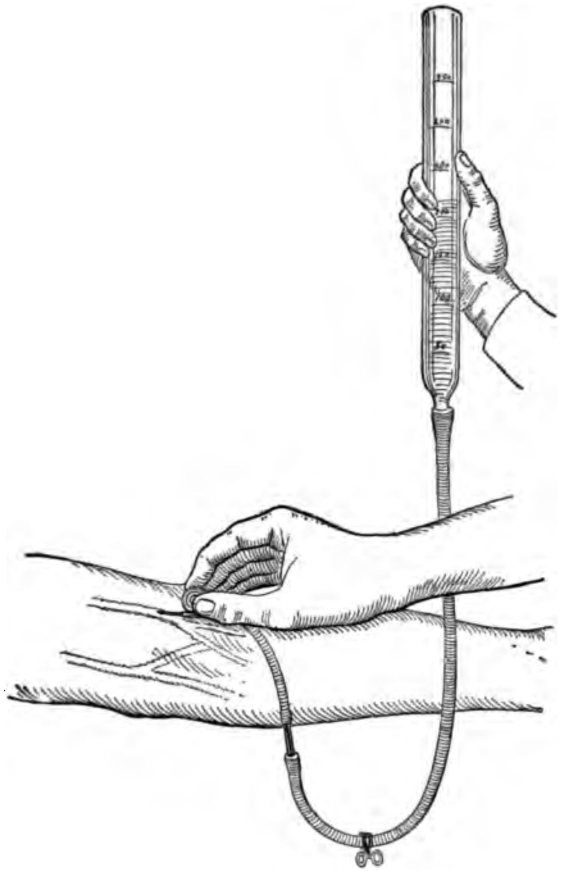


Fig. 173.—Method of giving arsphenamin intravenously.

simple, the drug being quite soluble in water and not requiring to be neutralized with caustic soda.

Neoarsphenamin is given intravenously or by intramuscular injection—preferably by the former method.

Apparatus.—For the intravenous administration of dilute solutions of neoarsphenamin the same apparatus described for the administration of arsphenamin (page 208) will be required.

For the intravenous administration of concentrated solutions and for intramuscular injections there will be required: (1) a Luer or Record syringe with a capacity of 10 to 20 c.c. (2½ to 5 dr.), (2) a needle about 2½ inches (6 cm.) long and of No. 18 caliber, (3) a glass decanter for distilled water, (4) a medicine glass for mixing the solution, (5) a tube of neoarsphenamin and a file to open it with, and (6) a glass rod for stirring (Fig. 174). In addition, for an intravenous injection a tourniquet will be required.

Asepsis.—The apparatus and instruments are sterilized by boiling, the operator's hands are cleansed as for any operation, and the tube of neoarsphenamin and the file are immersed in alcohol.

Preparation of the Solution.—For intravenous injections a dilute or a concentrated solution may be used. The former is prepared by

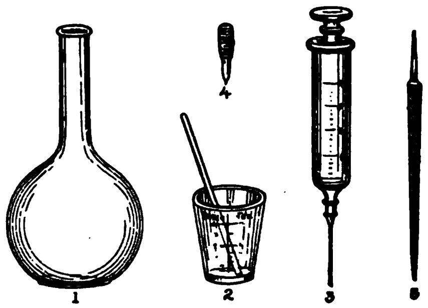


FIG. 174.—Apparatus for intramuscular and intravenous injections of concentrated solutions of neoarsphenamin. 1, Decanter of distilled water; 2, medicine glass; 3, all glass syringe and needle; 4, tube of neoarsphenamin; 5, small file.

dissolving each 0.15 gm. (2 ⅓ gr.) of neoarsphenamin in 25 c.c. (6¾ dr.) of *freshly distilled sterile water*. The water should not be heated, but should be at the temperature of the room, that is, 68° to 71.6° F. (20° to 22° C.).

The concentrated intravenous solution is prepared by dissolving 0.45 to 0.6 gm. (6¾ to 9 gr.) of neoarsphenamin in 10 c.c. (2¾ dr.) of *freshly distilled sterile water*, or 0.75 to 0.9 gm. (11½ to 14 gr.) of neoarsphenamin in 15 c.c. (4 dr.) of *freshly distilled sterile water*.

The solution for an intramuscular injection is prepared by dissolving each 0.15 gm. (2⅓ gr.) of neoarsphenamin in about 3 c.c. (48 minims) of *freshly distilled sterile water*.

Temperature of the Solution.—The solution should not be injected at a higher temperature than 68° to 71.6° F. (20° to 22° C.).

Dosage.—The average dose of neoarsphenamin for men is 0.6 to 0.75 gm. (9 to 11½ gr.), for women 0.45 to 0.6 gm. (6¾ to 9 gr.), for children 0.15 to 0.3 gm. (2⅓ to 4⅔ gr.), and for infants 0.05 gm. (¾ gr.).

Repetition of the Dose.—Injections of neoarsphenamin may be repeated at intervals of from 3 to 7 days.

Site of Injection.—Intravenous injections are given in the median basilic or some other prominent vein at the bend of the elbow.

Intramuscular injections are given in the gluteal region (see page 203).

Position of Patient.—For an intravenous injection the patient should be recumbent; for an intramuscular injection the patient lies upon the abdomen.

Preparation of the Patient.—If the intravenous method is employed, all constricting clothing should be removed from the patient's arm. The site of puncture is well painted with tincture of iodin.

Technic.—(1) *Intravenous Administration.*—The technic differs in no material way from that already described for the administration of arsphenamin (see page 209). When the concentrated solution is employed, however, the injection is more conveniently made with a syringe instead of a gravity apparatus.

(2) *Intramuscular Injection.*—A spot in the gluteal region distant from the course of the sciatic nerve is chosen, and the needle is thrust deeply into the muscle. If there is no bleeding, about 60 drops of 0.5 per cent. procain solution is injected into the region in order to diminish the sensibility. Then, after waiting a few moments, the desired quantity of neoarsphenamin is injected through the same needle. The site of puncture is finally sealed with a piece of adhesive plaster. (The technic of intramuscular injections is more fully described on page 205.) Following the injection, the patient is kept in the recumbent position on his side or abdomen for 15 to 20 minutes.

The Rectal Administration of Arsphenamin and Neoarsphenamin.—Arsphenamin and neoarsphenamin have been administered in an enema by rectum, and reports would seem to show that the results are about as prompt as when the intravenous method is employed. The method is especially useful in children. Reactions, such as chills, fever, gastric irritation, diarrhoea, etc., which may follow the intravenous administration are claimed to be absent.

Apparatus.—Any of the forms of apparatus described on page 595 may be used, or a salvarsan flask, attached by a piece of rubber tubing to a rectal tube, may be employed.

Preparation of Solution.—The solution is prepared in the usual way (see pages 208, 212), the appropriate dose being diluted in 150 to 250 c.c. (5 to 8 ounces) of saline solution.

Preparation of the Patient.—The rectum should be empty. Inability to retain the enema may be overcome by giving a dose of paregoric or tinct- of opium by mouth.

Technic.—The enema is administrated with the patient in the knee chest or the Sims position. (For a full description of the technic see page 598.) Following the injection the patient should remain in bed 4 or 5 hours, with the foot of the bed elevated.

Enemata are given once or twice a week.

THE ADMINSTRATION OF DIPHTHERIA ANTITOXIN

Antitoxin is now almost universally used in the treatment of diphtheria. It has enormously reduced the mortality from this disease, and, if the serum is of reliable quality, its use is without danger. The diphtheria bacilli are not killed by the antitoxin, but the toxins are neutralized and a condition is produced in the blood which inhibits the growth of the bacilli so that they gradually disappear.

The Serum.—The serum should always be obtained from an unquestionable source. Antitoxin of the greatest concentration, that is, containing as little serum and as many units[1] of antitoxin as is possible, should be used in preference, as smaller amounts at a dose will be required and joint pains, skin eruptions, etc.—symptoms which are now considered to be due to the horse serum and not the antitoxin—will be avoided.

Dosage.—There is no definite rule for fixing the dose. It is known how much antitoxin is required to neutralize a given amount of toxin, but in practice there is no method of estimating the latter in any given case. Conclusions drawn from experience and clinical studies give the only practical guides. The dose will depend upon the age of the patient and the severity and the stage of the disease. It should always be large for the serum is harmless and it is better to administer too much than not enough. According to Holt "for a child over two years, an initial dose for a severe attack, including all laryngeal cases, should not be less than 4000 to 5000 units; and the dose should be repeated in six or eight hours provided no improvement is seen. Children under two years should receive from 20[illegible]

[1] The strength of the serum is measured in units, a unit being the amount of anti-toxin necessary to neutralize in a guinea-pig 100 fatal doses of diphtheria.

to 3000 units. Cases of exceptional severity where the injection is given late should receive from 8000 to 10,000 units, to be repeated in from six to eight hours if the progress of the disease is unfavorable. Mild cases should receive from 2000 to 3000 units as an initial dose, a second being rarely required."

Schick, who has done considerable experimental work on the dosage of diphtheria antitoxin, recommends giving 100 units of antitoxin in mild cases and in severe cases 500 units for each kilogram (2½ lbs) of weight.

An immunizing dose should be given to those exposed to the contagion in all cases, 1000 units for a child under two years old, and for older children and adults a larger dose (2000 units) may be administered. The immunity thus furnished is not permanent, however, lasting only three or four weeks.

Time of Administration.—Antitoxin should be given as soon as a clinical diagnosis is made, not waiting for a bacteriological examination. There are no contraindications to its use in the presence of urgent symptoms. No matter how late a case is seen, an injection should be given, though it may not be possible to undo the harm already produced by the diphtheria toxin. Cases treated very early give the best results.

The Syringe.—The simpler the syringe, the better. The syringe should have a capacity of about 1¼ to 2½ drams (5 to 10 c.c.). Glass syringes with asbestos packing or those with the solid

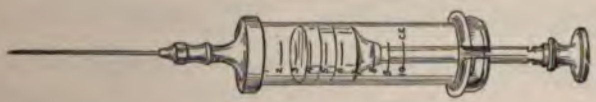


FIG. 175.—The record antitoxin syringe.

glass piston, as the Luer, are most easily sterilized. The record syringe (Fig. 175) is also an excellent instrument. A moderately fine needle or the smallest through which the serum will flow is preferable to one of very large caliber. In charging the syringe it is better to remove the piston and pour the antitoxin into the syringe, as it is difficult to draw it up through the needle. The piston is then inserted and, with the syringe elevated, any air is expelled. Many of the manufacturers at the present time supply a syringe already sterilized and filled with antitoxin (Fig. 176). The advantages of this in the saving of time are obvious.

Site of Injection.—The subcutaneous tissues of the outer aspect of the thigh, of the back part of the axilla, or of the upper portion of the abdomen are usually chosen for the injection (Fig. 177).

Asepsis.—The syringe and needles should be sterilized by a thorough boiling before use. The operator's hands are cleansed as for any operation, and the skin at the site of injection is sterilized by painting with tincture of iodin.

Technic.—In order to prevent any undue excitement, the injection should be made with the patient in such a position that he cannot

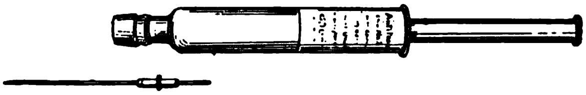


FIG. 176.—The New York Board of Health Antitoxin Syringe. The syringe comes sterilized and already loaded with antitoxin and, upon inserting the needle into the distal end, is ready for use.

see what is going on; in children this is especially necessary. Care must be taken to expel any air from the syringe by elevating its point and depressing the piston a little. A fold of the skin from the area previously sterilized is then raised up between the thumb and forefinger of the left hand, and with the right hand, the needle is quickly plunged into the subcutaneous tissue (Fig. 178). If done quickly with a sharp-pointed needle, preliminary local anesthesia of the skin

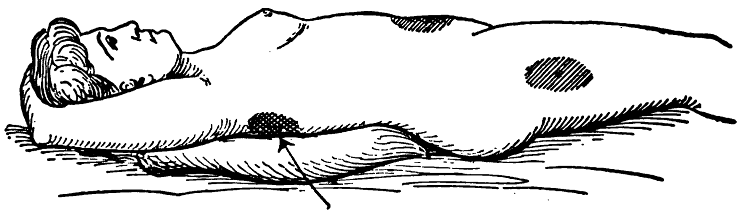


FIG. 177.—Sites for antitoxin injection.

is unnecessary. The serum is then injected very slowly and the swelling produced is not massaged, being allowed to subside as the serum is absorbed. After withdrawal of the needle the puncture is sealed with collodion and cotton. Following the injection there may be a slight reaction consisting of some redness, edema, and pain at the site of puncture, but these usually subside in a short time.

Effects of Antitoxin.—In favorable cases a prompt and marked improvement in the local and general symptoms follows the use of antitoxin. In a few hours the pseudomembrane begins to lose its dirty color and becomes blanched and somewhat swollen. Within twelve to twenty-four hours the membrane loosens at the edges and rolls up, becoming detached in a mass, or in small pieces. This seems to take place more rapidly about the tonsils than elsewhere. The usual time for restoration to the normal condition in the throat is twenty-four hours to three or four days. Sometimes the membrane, after disappearing, forms again; such cases should promptly receive more antitoxin.

In nasal diphtheria similar effects are observed, each irrigation bringing away small or large pieces of detached membrane. The

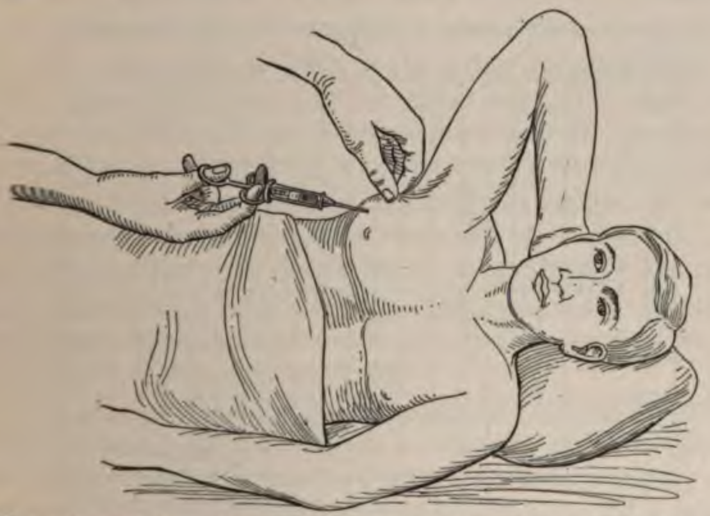


FIG. 178.—Showing the method of injecting diphtheria antitoxin in the subcutaneous tissue of the axilla.

nasal discharge and swelling soon diminish, and at the same time the mouth breathing ceases.

In laryngeal diphtheria antitoxin prevents the extension of the membrane into the trachea and bronchi in the majority of cases, and since its introduction it has been necessary to operate upon a much smaller proportion of cases than formerly.

The effects upon the constitutional symptoms are likewise impressive. In favorable cases the general condition of the patient improves noticeably within twelve to twenty-four hours. The constitutional symptoms of toxemia disappear, the color and general appearance are altered, and the appetite begins to improve. The temperature may rise 1 or 2 degrees in the first four or five hours after the injection, and the pulse may be accelerated at the same time, but this is followed in favorable cases by a fall of the fever either by crisis or by lysis, the temperature becoming practically normal in two or three days. The persistence of fever is an indication for a second dose of antitoxin.

The reduction in the mortality rate since the introduction of antitoxin is well shown in the following table (Fig. 179) prepared by the New York Department of Health, the small reduction shown in the first three years of its use being explained by the fact that sufficiently large doses of antitoxin were not used at first and that the serum used later was more efficient.

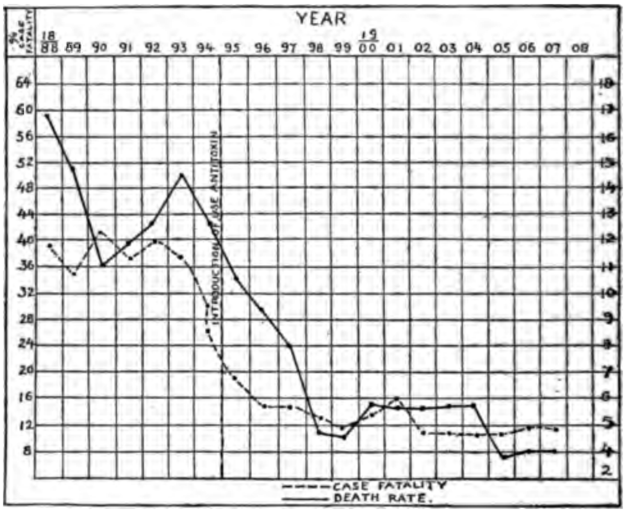


FIG. 179.—Chart prepared by the New York Board of Health, showing the reduction in the mortality from diphtheria since the introduction of antitoxin.

Complications.—In a certain percentage of cases skin eruptions develop after several days. These may be erythematous, scarlatiniform, morbiliform, or urticarial in character. Urticaria is said to follow in about 30 per cent. of the cases and usually comes on from the eighth to the fourteenth day. It frequently develops upon the buttocks, abdomen, and chest and may be the cause of great discomfort and annoyance to the patient. Infection and cellulitis may result from the injection if due regard to asepsis is not observed.

Painful conditions in the large joints, as the hips, knees, wrists, and shoulders, occur in a small proportion of the cases. These symptoms, however, are not due to the antitoxin, but are caused by the horse serum, and depend upon the susceptibility of the patient to the serum.

VACCINATION

Vaccination is the inoculation with the vaccine or virus of cowpox for the purpose of inducing that disease in man and thereby affording partial or permanent protection against smallpox.

The immunity rendered by vaccination is not claimed to be invariably complete. In a great majority of cases, though, a successful inoculation grants a person immunity to smallpox for a number of years, though the effects may in time wear off and the individual again become susceptible. The mortality in such cases, however, is very low compared with the mortality in those who have never been vaccinated. According to Osler, in the former it is 6 to 8 per cent. and in the unvaccinated not less than 35 per cent. The nature of the protection thus afforded is not absolutely understood, but the results of vaccination are unquestionable and admirably attest its efficiency. Localities in which vaccination is systematically carried out develop fewer cases and present the lowest death rate from smallpox.

The Virus.—The virus should always be obtained from a reliable source. That from the calf is to be used by preference. Humanized lymph should never be employed except upon imperative occasions when bovine lymph is not procurable.

The virus is obtained under rigid aseptic precautions by curetting the pustule from a calf and making an emulsion of it with glycerin. This is then collected in capillary tubes and is hermetically sealed until used. The lymph should not be distributed until it has been tested for tetanus and other pathogenic germs, and an autopsy has been performed upon the calf to make certain it was free from disease. The lymph may also be obtained spread upon ivory or celluloid points, but they are not preferable to the capillary tubes as there is danger of the virus being contaminated by handling.

Time for Vaccination.—In choosing the time for vaccination the age and the general health of the individual should be taken into consideration. As a general rule, unless contraindicated, the child should be three to six months old before vaccination. The operation should be avoided if possible in dentition; and children who are delicate or suffering from malnutrition, syphilis, or skin eruptions should not be vaccinated until in good condition. The best season is in the early fall or spring when there is less danger of epidemics of contagious diseases, such as scarlet fever, measles, diphtheria, whooping-cough, etc. Upon exposure to small-pox, whether the individual is in infancy or in old age, he should always be immediately vaccinated.

Instruments.—A sharp-pointed scalpel or a lancet is as useful an instrument as can be found for performing the scarification. Sharp needles may also be employed and, as they are cheap, the same needle need not be used for more than one case. Special scarificators are made, but they have no advantages over a lancet or a needle. If the vaccine points are used, no scarificator is necessary.

The New York Department of Health supplies with each capillary tube of vaccine virus, a needle, a flat tooth pick for spreading the virus, and a piece of small rubber tubing which fits over one end of the capillary tube and is used to force the vaccine out of the tube (Fig. 180).

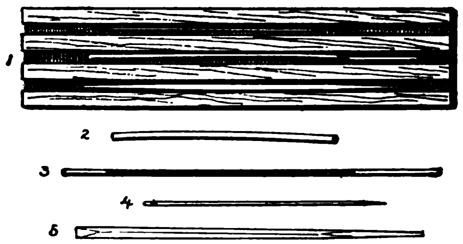


FIG. 180.—New York Department of Health vaccination outfit. 1, Instruments in case; 2, rubber tube for forcing the virus out of the tube; 3, tube containing virus; 4, needle for scarification; 5, stick for spreading the virus.

Site of Vaccination.—The vaccination is performed either upon the arm or leg. As a rule, the arm is preferred as a site, especially in children who are running about, as being more easily kept at rest and less likely to be injured. Mothers often prefer to have their girls vaccinated upon the leg to avoid the disfiguring effect of the scar. If the arm is chosen, the point selected is at about the insertion of the deltoid muscle; in the leg a spot on the outer aspect at the junction of the middle and upper third is selected.

Asepsis.—The operation of vaccination should be regarded as an important one and, as most of its dangers are due to infection, the operator should see that all aseptic precautions are observed. The instrument employed for scarifying the skin should be carefully sterilized and the same instrument should not be used more than once without resterilization. The hands of the operator are prepared as carefully as for any operation. The patient's skin is washed with soap and warm water followed by alcohol and ether and is allowed to dry. The use of strong disinfectants is not advised as the chances of a successful inoculation may be lessened.

FIG. 181.—Vaccination. First step, scarifying the arm.

Technic.—(1) *By Scarification.* Vaccination by the scarification method is generally practised in this country. A proper spot is

FIG. 182.—Vaccination. Second step. Rubbing the virus into the scarified area.

chosen upon the arm or leg, and an area 1/8 to 1/4 inch (3 to 6 mm.) in diameter is scarified by making a number of scratches at right angles to each other in the skin with the point of the instrument just deep enough to draw serum, but no blood (Fig. 181). If more than one inoculation is to be made, as is frequently done, the area scarified should be at a distance of at least 1 inch (2.5 cm.) apart. The virus is then deposited upon the scarified area, being rubbed in with some sterile instrument for a full minute and allowed to dry (Fig. 182). The site of vaccination is finally covered with a piece of sterile gauze held in place with two small strips of adhesive plaster, or, if desired, a wire shield (Fig. 183) may be used, provided it is applied in such a way as not to constrict the arm (Fig. 184). After the vesicle has formed, the part should be gently washed with sterile

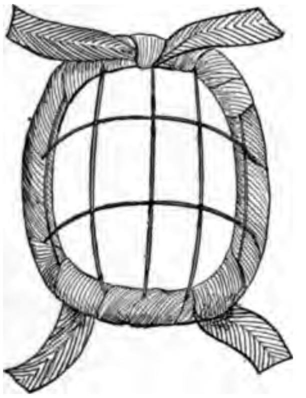


FIG. 183.—Vaccination shield.

FIG. 184.—Showing the shield in place.

water once a day and dressed with fresh gauze or covered with a shield to prevent contact with the clothing.

(2) *By Acupuncture or Epidermic Puncture.*—By some this method of vaccination is preferred to scarification. Hill (*Canadian Medical Association Journal*, March, 1916) describes the method as follows: The arm is washed with soap and water, then with alcohol and finally with ether. Drops of the virus are deposited upon the skin at three points so that each drop forms one of the angles of a triangle with sides 2 inches (5 cm.) long. The skin is then drawn tight by the operator's left hand which grasps the part from behind, while with the tip of a sterile needle, held almost parallel with the surface, punctures are made through the virus into the superficial layer of the skin to the depth of 1/1000 of an inch (.025 mm.). Six punctures

are made close together at the site of each drop. The excess of the virus is then wiped off, no dressing or shield being required.

Course of Vaccination.—Outside of a little irritation and redness at the site of inoculation there are no immediate developments and the wound heals. On the third day a papule appears surrounded by an area of slight redness. This is followed in twenty-four hours by the formation of a small vesicle which by the seventh or eighth day reaches its full development. It is usually round, 1/4 to 1/2 inch (6 to 12 mm.) in diameter, and full of limpid fluid. The center of the vesicle is depressed, while the margins are elevated and slightly indurated. By the tenth day a bright red areola has developed covering a space of from 1 to 2 inches (2.5 to 5 cm.) around the vesicle and the contents of the vesicle become purulent. In a day or two more the areola commences to fade and the vesicle dries up forming a dark brown crust. Usually about the twenty-first day this crust falls off, leaving a bluish pitted scar which later slowly fades to white.

Constitutional symptoms more or less marked accompany the eruption. Remittent fever of from 101° to 104° begins on the fourth day and may persist until the eighth or ninth day, when it drops gradually to normal. In children irritability, loss of appetite, and restlessness at night may accompany the fever. The axillary or inguinal glands become swollen and sore, depending upon whether the arm or leg is the seat of inoculation.

Certain irregular types of vaccination are sometimes met with. In rare cases a generalized vaccine eruption with marked fever and other severe symptoms may occur. Single vesicles may also be produced on other parts of the body distant from the site of inoculation by autoinoculation from scratching. Sometimes the period of incubation is prolonged and the vesicle formation is delayed.

Complications.—Urticaria, impetigo contagiosa, and rashes resembling those of scarlet fever or measles have been observed. Erysipelas may occur at any time before the sore heals.

Suppuration and abscess of the axillary or inguinal glands sometimes follow vaccination. In anemic and unhealthy subjects, if infection occurs, cellulitis and deep ulcers may form, followed by extensive loss of tissue and large scars.

Syphilis is no longer feared under modern methods of vaccination; the same is true of tuberculosis, and it has been shown in addition that the tubercle bacillus is destroyed in glycerinated lymph. Tetanus can only follow carelessness as to asepsis and neglect of precautions in preparing the lymph.

Revaccination.—Immunity furnished by vaccination is not pe manent, and in all persons revaccination should be performed seve years after the first vaccination. The New York Health Departme advises that revaccination be repeated at intervals of not more th three years if permanent immunity is to be acquired. The vaccir tion should be as thoroughly carried out as in the first instance. cases of exposure to contagion during the interval, revaccinati should be performed at once.

CHAPTER VIII

TREATMENT OF NEURALGIA BY INJECTIONS

TIC DOULOUREUX

For the purpose of relieving the pain of trifacial neuralgia various drugs and gases, such as stovain, cocain, chloroform, antipyrin, osmic acid, and air, have been injected into the branches of the fifth nerve or subcutaneously into the painful areas. Schlösser in 1900 was the first to practise direct injection with 80 per cent. alcohol of the different branches of the fifth nerve at their exit from the skull through the basal foramina. Schlösser's method of injection was, however, rather difficult, and it was not until Lèvy and Baudouin in 1906 devised a comparatively simple technic that alcoholic injections were employed to any great extent. While injection of the superficial branches of the fifth nerve with osmic acid and the deep branches with alcohol have both given brilliant results, the use of osmic acid necessitates exposure of the affected nerve or nerves and, for this reason, it has been largely discarded in favor of alcohol alone or in combination with other drugs.

Alcohol when injected into a nerve causes a degeneration of its fibers. Relief from pain is thus obtained usually for a period of six months to two years, but it varies considerably depending upon the thoroughness with which the nerve is injected. In some cases one injection has given an apparent cure, but, as a rule, the injection has to be repeated several times.

All three branches of the nerve have been injected,[1] but, on account of the difficulty of reaching the ophthalmic branch and the proximity of the optic nerve, and the third, fourth, and sixth nerves, deep injection of this branch has been abandoned by the majority of operators.

Anatomy.—The fifth nerve closely resembles a typical spinal nerve, being a mixed nerve with its sensory and motor roots arising separately from the brain, and the sensory root possessing a ganglion, the Gasserian ganglion. The latter is a crescent-shaped body, composed of nerve fibers and nerve cells, lying in a depression, Meckel's cave, on the apex of the petrous portion of the temporal bone. From the anterior convex border of the ganglion the sensory portion emerges

[1] More recently injections have been made directly into the Gasserian ganglion.

in three trunks: the ophthalmic, the superior maxillary, and the inferior maxillary. The superior maxillary division is joined on the distal side of the ganglion by the motor root.

The first division passes from the skull through the sphenoidal fissure in three branches: the lachrymal, the frontal, and the nasal. It is purely a sensory nerve supplying the upper eyelid, conjunctiva, eyeball, lachrymal gland, forehead, anterior portion of the scalp, frontal sinus, and the root and anterior portion of the nose.

The second division leaves the skull through the foramen rotundum, crosses the spheno-maxillary fossa, and, after entering the orbital cavity through the spheno-maxillary fissure, passes to the face by way of the infraorbital groove. It is also a sensory nerve, supplying the cheek, anterior portion of the temporal region, the lower eyelid, ridge of the nose, upper lip, upper teeth, mucous membrane of the nose, nasopharynx, antrum, posterior ethmoidal cells, soft palate, tonsil, and roof of the mouth.

FIG. 185.—Anatomy of the trifacial nerve. (After Campbell.)

The third division is a mixed nerve formed from a sensory and motor root. The two pass from the cranium through the foramen ovale and immediately unite to form a single branch. The sensory portion of the nerve supplies the skin of the side of the head, auricle of the ear, external auditory meatus, lower portion of the face, lower lip, lower teeth and gums, mucous membrane of the mouth, tongue, and mastoid cells, and salivary glands. The motor portion supplies the muscles of mastication.

Instruments.—There will be required a special needle 4¾ inches (12 cm.) long and 1/14 in. (1.75 mm.) in diameter, a glass syringe with a capacity of at least 30 minims (2 c.c.), a scalpel, a fine needle, 2½ inches (5 cm.) long which can be fitted to the syringe for the purpose of infiltrating the skin at the site of puncture or performing peripheral injections of nerve branches, and two medicine glasses, one for a cocain solution and the other for the alcohol solution (Fig. 186).

FIG. 186.—Apparatus for injecting the branches of the fifth nerve. 1, Two medicine glasses; 2, Luer syringe; 3, Lèvy and Baudouin needle; 4, small hypodermic needle; 5, ampule containing anesthetic; 6, scalpel.

The needle should have rather a blunt point and should be provided with a stylet which extends flush with the point of the needle when pushed home. The outside of the distal portion of the needle is graduated in centimeters up to five. The proximal end of the needle should be made to accurately fit the end of the syringe (Fig. 187).

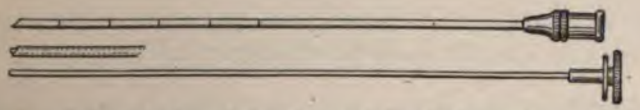


Fig. 187.—Enlarged view of the Lèvy and Baudouin needle and stylet.

Solution Used.—The solution originally used was a mixture of cacain, morphin, chloroform, and 80 per cent. alcohol, but the morphin and chloroform are generally discarded at the present time. The addition of chloroform causes considerable reaction at the site of injection and the formation of scar tissue. Patrick (*Journal of the American Medical Association*, Jan. 20, 1912) uses the following:

Cocain muriat.,	gr. ii (0.13 gm.)
Alcohol,	dr. iiiss (13 c.c.)
Aq. dest., q.s. ad.,	oz. ss (15 c.c.)

The solution should be freshly prepared for each injection.

Quantity Used.—For a deep injection 30♏ (2 c.c.) of solution are generally injected into each branch. Eight minims (0.5 c.c.) is sufficient for a peripheral injection.

Position of Patient.—The injection is made with the patient sitting upright in a chair or the recumbent position may be employed with the patient's head resting on the side.

Asepsis.—The instruments are sterilized by boiling, the operator's hands cleansed as for any operation, and the site of injection painted with tincture of iodin.

Anesthesia.—General anesthesia is to be avoided if possible, as the best guide to a successful injection is the spasm of pain and the

Fig. 188.—Showing the method of injecting the supraorbital branch of the first division of the fifth nerve.

Inesthesia that results over the area of distribution of the nerve anfiltration of the skin with a few drops of 0.2 per cent. cocain solution or a 1 per cent. procain solution at the point through which the needle enters is usually sufficient.

Technic.—The site of injection and the direction in which the needle is inserted will vary according to the branch injected.

First Division.—Deep injection of this nerve at the sphenoidal fissure is rarely practised on account of its dangers; instead, the supraorbital nerve is injected at the supraorbital notch or foramen. The supraorbital notch is located by palpation or by the sensations of the patient when the nerve is compressed between the finger and the skull. The skin over the site of the notch is anesthetized, and an attempt is made to insert the fine needle into the foramen, the eyeball being protected by the index finger of the operator's left hand (Fig. 188). When the needle strikes the nerve a sharp shooting pain extending up the forehead will be felt by the patient. If possible, the needle should be inserted for a distance of 1/5 to 2/5 of an inch (5 to 10 mm.) into the canal. About 10 minims (0.6 c.c.) of the alcohol solution is then injected. A successful injection will result in immediate anesthesia within the distribution of the nerve.

The Second Division is injected at the foramen rotundum. The posterior border of the orbital process of the malar bone is identified and from it is dropped a vertical line to the lower border of the zygoma; 1/5 inch (0.5 cm.) behind the point where this perpendicular line crosses the zygoma is the point for entrance of the needle. The

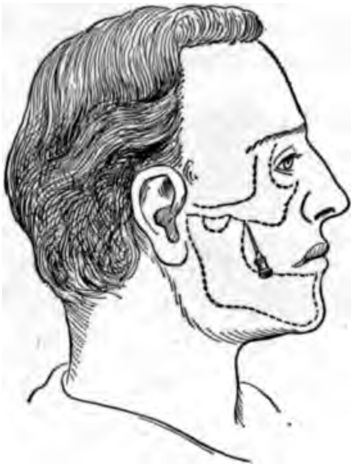


FIG. 189.—Needle in place for injecting the second division of the fifth nerve.

skin at this point is infiltrated with cocain and is nicked with a scalpel. The needle is inserted with the stylet withdrawn until it is well into the subcutaneous tissues; then the stylet is pushed home in order to furnish a blunt point and avoid any injury to the blood-vessels. The direction of the needle should be at first horizontally inward and then slightly upward, and at a depth of 2 inches (5 cm.) the needle should reach the nerve at the foramen rotundum. If, after passing through the subcutaneous tissue, the needle strikes the coronoid process of the lower jaw, it will have to be re-inserted at a point slightly more forward. This will necessitate changing the angle of the needle to correspond with the new site of entrance. Care must be observed against inserting the needle so far forward that the orbit will be entered or so deep that the sixth nerve is reached. With the needle introduced the correct distance, the stylet is withdrawn and the alcohol solution is slowly injected and, if the needle is properly placed, a sharp pain will be felt by the patient in the area of distribution of the nerve. If the nerve is not reached, the needle should be withdrawn a little and its direction slightly changed. At the completion of the injection, the needle is removed and the point of puncture is sealed with collodion and cotton. The patient shoulc be kept in a recumbent position for 10 to 15 minutes following th injection.

If it is found impossible to reach the nerve at its exit from t skull, its infraorbital branch may be injected at the infraorbit foramen, using a long fine needle for this purpose. About 10 to minims (0.6 to 1 c.c.) of the solution are injected.

The Third Division is injected at the foramen ovale. The d cending root of the zygoma is identified, and at a point 1 inch (

FIG. 190.—Needle in place for injecting the third division of the fifth nerve.

cm.) in front of it just below the zygoma, the needle enters the sk The skin at this point is anesthetized and is nicked with a scalp and the needle with the stylet withdrawn is pushed through the sul cutaneous tissues in a direction slightly upward and backwar The stylet is then pushed home, and needle is carried in through th deeper tissues, still slightly upward and backward, until it reache a depth of 1½ inches (4 cm.); it should then be at the forame ovale. When the needle strikes the nerve, the patient, as a rule, wi be conscious of a sharp pain in the tongue or lower jaw. Th stylet is then removed, the syringe, loaded with the alcohol solutio is fitted to the needle, and the injection is made. At the completio of the operation, the needle is withdrawn and the skin puncture is sealed with collodion and cotton.

Following a deep injection, there is considerable swelling of the face, which the patient should be warned beforehand to expect. Sometimes a hematoma may result from puncture of some vessel during the insertion of the needle. To avoid this, Patrick advises that the needle always be inspected for oozing and, if present, that the needle and stylet be left in place until it stops.

SCIATICA

The injection of alcohol and other drugs which have a destructive action upon nerves and which have been effectively employed in neuralgia of the fifth nerve should be avoided in sciatica, as the

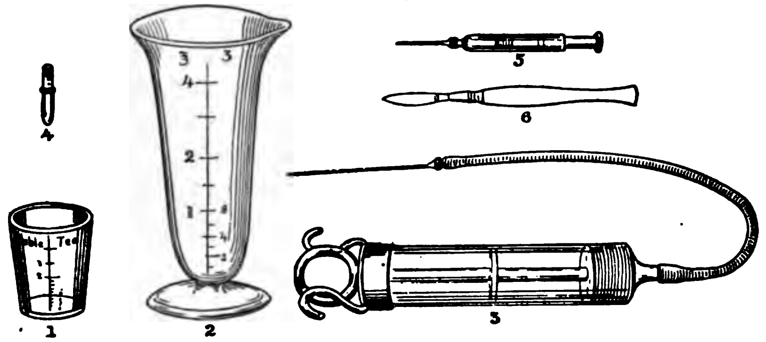


FIG. 191.—Apparatus for injecting the sciatic nerve. 1, Medicine glass; 2, glass graduate; 3, large glass syringe and blunt needle for injecting the nerve; 4, ampule of cocain; 5, small syringe and needle for the preliminary infiltration of the site of puncture; 6, scalpel.

sciatic is a mixed nerve and the use of such drugs has produced grave motor changes in the nerve. The injection of physiological salt solution, however, has given good results in relieving the pain of sciatica without causing any harmful results. The injection is made into the nerve-sheath with the idea of separating the adhesions that have formed around the inflamed nerve, and, if it is used in the proper cases, in the great majority of instances it gives relief. Frequently more than one, and in the severe cases, a number of injections are required to produce a cure.

Apparatus.—There will be required a needle 4¾ inches (12 cm.) long and 1/16 inch (1.5 mm.) in diameter, a glass syringe with a capacity of 3 to 4 ounces (90 to 120 c.c.), a piece of rubber tubing to connect the syringe and needle, a scalpel, a cocain syringe, a small medicine glass for the cocain solution, and a glass graduate for the salt solution (Fig. 191).

The needle is of a type similar to that used for trifacial injections (see Fig. 187). It should be graduated in centimeters from 1 to 10, and the point should be rather blunt.

Solution Used.—Normal salt solution (salt 1 dram (4 gm.) to a pint (500 c.c.) of boiled water) with or without the addition of a local anesthetic is used.

Temperature of the Solution.—The solution is injected either at about the temperature of the body or at 32°F. (0° C.).

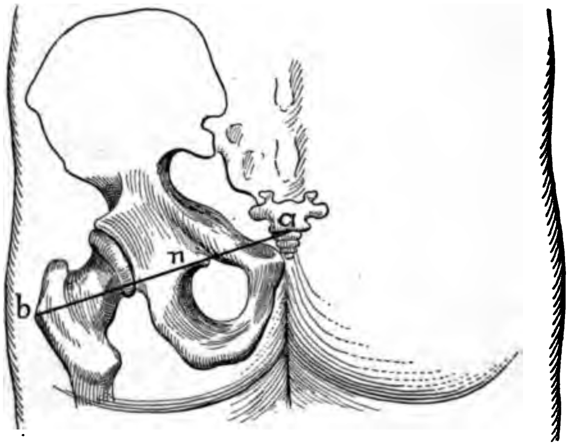


FIG. 192.—Showing the method of locating the point for injecting the sciatic nerve. (After Hoecht.)

Quantity.—Two to 4 ounces (60 to 120 c.c.) of the warm solution and 2½ to 5 drams (10 to 20 c.c.) of the cold solution may be injected.

Intervals between Injections.—When it is necessary to repeat the injections, they may be given at intervals of 24 to 72 hours.

Site of Injection.—Several points for reaching the nerve are advised. That used by D'Orsay Hoecht and one that gives access to the nerve high up is as follows: A line is drawn from the sacrococcygeal joint to the postero-external border of the great trochanter, and one finger's breadth external to the junction of the inner one-third and outer two-third of this line is the point for inserting the needle (Fig. 192).

The nerve may also be reached by inserting the needle at a point where a horizonal line through the tip of the great trochanter cuts a ine through the outer margin of the tuberosity of the

›n of the Patient.—The patient lies upon the abdomen with xtended and with a pillow beneath the groins.

s.—The instruments are boiled, the hands of the operator :ed as carefully as for any operation, and the field of opera- nted with tincture of iodin.

ıesia.—The point on the skin through which the needle is s anesthetized by infiltration with a few drops of a 0.2 solution of cocain or a 1 per cent. solution of procain.

ic.—The syringe is filled with the salt solution of the proper ıre and is placed ready for use near at hand. A small ıde in the skin at the point chosen for the puncture, and :, armed with the stylet, is inserted perpendicularly to the ugh the tissues until it hits the nerve. If the needle strikes then withdrawn 1/25 inch (1 mm.) and should be in close to the nerve. The moment the nerve is reached the pa- riences a sharp lancinating pain low down the back of the he heel, frequently accompanied by a jerking motion of the stylet is then removed, the syringe is attached to the d the desired amount of solution is slowly and steadily in- ıt the end of the injection, the needle is removed, and the n puncture is sealed with collodion and cotton.

ing the injection, the patient should be instructed to keep several days. For the first few days there may be some and not infrequently there is a slight rise of temperature st 24 to 48 hours.

CHAPTER IX

DISINFECTION OF WOUNDS BY THE CARREL-DAKIN TECHNIC

The Carrel method of treating infected wounds is based on the belief that a non-toxic and non-irritating antiseptic, applied to, and kept in contact with all parts of a wound during a certain period of time and in a constant concentration, is capable of destroying microorganisms and eventually sterilizing the wound. The opportunity to employ the Carrel technic during the recent war has fully demonstrated the soundness of Carrel's teachings, and the value of the method not only in preventing, but in suppressing, suppuration. Under this treatment wound complications are greatly diminished, convalescence is more rapid than under the old methods of treatment, and the period of incapacity is reduced to a minimum. Favorable results, however, depend upon the strict adherence to all the details of the technic so carefully developed by Carrel, for, as he emphasizes "the success of the method which enables us to render aseptic an infected wound is not due to the marvellous properties of a new drug. It should rather be attributed to a combination of means, which enables us to make use of a definite antiseptic substance, under such conditions of concentration and duration that its action becomes efficacious. This method is a combination of which each single part is essential to the rest. The antiseptic cannot be altered without changing the manner of using it. In the same way, a modification of the technic demands an antiseptic endowed with different chemical properties."

Dakin's hypochlorite solution, having powerful bactericidal powers and at the same time being but slightly irritating to the tissues, was chosen as the antiseptic best meeting the requirements of the Carrel method after an exhaustive examination of many substances with regard to their bactericidal action and effect upon normal tissues. The solution is instilled into the wound at frequent intervals, the object being not to irrigate the wound, but to keep it constantly bathed in the solution. Frequent instillations are necessary, because, in contact with wound fluids, the solution rapidly loses its chlorin. If the solution is used early in a wound, before the microorganisms have time to multiply and spread, infection may be aborted and the wound closed by suture without suppuration, while, if suppuration is already present, it can be controlled, provided the focus is reached by the solution, the wound being gradually freed from infection and put in such condition that it can be early closed by suture. Favorable response to the treatment is not gauged only by the clinical appearance of the wound, but is determined first by a diminution, and finally the disappearance of microorganisms demonstrated by microscopical examination of the secretions.

Properties of Dakin's Solution.—Dakin's solution is a 0.5 per cent. neutral hypochlorite of soda solution. It differs from Javel water, Labarraque's solution, and other hypochlorites in that it contains no free alkali and so is non-irritating to the tissues. The effects are entirely local and, regardless of the amount used, there is no danger of toxemia from absorption. It has the property of disintegrating necrosed tissue, blood clots, etc., but does not harm the tissues undergoing repair or normal tissues with blood supply.

The solution of sodium hypochlorite for the treatment of wounds should meet the following requirements. It must contain no caustic alkali and the hypochlorite content must be between 0.45 per cent. and 0.5 per cent. Solutions of hypochlorite with a strength below 0.45 per cent. are not active enough, while above 0.5 per cent. the solution is irritating. The solution must be carefully prepared, preferably by a trained chemist, and should be tested regularly. It should be kept in a cool place, free from exposure and light. It should never be heated, as by so doing its composition is altered and it loses its antiseptic properties.

Preparation of Dakin's Solution by Daufresne's Method[1].—For the preparation of the solution three chemicals are necessary: calcium chlorid, sodium carbonate (dry, obtained in the market under the name of Solvay's soda), and sodium bicarbonate. The last two ingredients are fairly uniform in compositions, but the commercial chlorid of lime is subject to wide variations as to the amount of active chlorin it contains, and, for this reason, it is essential to determine by titration the percentage of active chlorin in the calcium chlorid employed.

Titration of the Calcium Chlorid—For this purpose there will be required a 25 c.c. buret, graduated in tenths of a cubic centimeter, a 10 c.c. pipet, and a decinormal solution of sodium hyposulphite.

[1] Infected Wounds, Carrel and Dehelly.

An average sample of the calcium chlorid is obtained by selecting small amounts from different parts of the stock and mixing them carefully. Twenty grams of this average sample are then weighed out and are dissolved in one liter of tap water. This solution is allowed to stand for several hours. Ten c.c. of the clear fluid is then measured off and to it is added 20 c.c. of a 10 per cent. solution of potassium iodid and 2 c.c. of acetic or hydrochloric acid. To the resultant mixture a decinormal solution of sodium hyposulphite is added drop by drop until the mixture is decolorized. The number of cubic centimeters of the hyposulphite solution employed to decolorize the mixture, multiplied by 1.775, gives the weight of active chlorin contained in 100 grams of calcium chlorid. The estimation of the chlorin must be carried out for each new sample of calcium chlorid employed.

Daufresne gives the following table of the quantities of the chemicals required to obtain a correct solution, according to the amount of active chlorin contained in the calcium chlorid:

Titration of chlorid of lime (Cl per cent.)	Quantities to be used to obtain 10 liters of solution of hypochlorite of 0.475 per cent.		
	Chlorid of lime, grams	Carbonate of soda anhydrous, grams	Bicarbonate of soda, grams
20	230	115	96
21	220	110	92
22	210	105	88
23	200	100	84
24	192	96	80
25	184	92	76
26	177	89	72
27	170	85	70
28	164	82	68
29	159	80	66
30	154	77	64
31	148	74	62
32	144	72	60
33	140	70	59
34	135	68	57
35	132	66	55
36	128	64	53
37	124	62	52

Preparation of Dakin's Solution.—(1) To make ten liters of the solution, weigh the exact quantities of the calcium chlorid, sodium carbonate, and sodium bicarbonate determined by titration of the calcium chlorid. For example, if the calcium chlorid contains 25 per cent. active chlorine there will be required:

Calcium chlorid	184 grams
Sodium carbonate, dry, Solvay	92 grams
Sodium bicarbonate	76 grams

(2) Place the calcium chlorid in a 12 liter flask with 5 liters of tap water and, after shaking thoroughly for several minutes, allow it to stand over night.

(3) Dissolve the carbonate and bicarbonate of soda in another 5 liters of cold water.

(4) Pour the solution of soda salts into the flask containing the super-saturated solution of calcium chlorid and, after shaking vigorously for a few moments, allow it to stand so that the carbonate of calcium, which is formed, can settle.

(5) At the end of half an hour syphon off the clear fluid and filter it through two thicknesses of filter paper. A perfectly clear fluid should be the result.

The fluid is now ready for use. To avoid mistaking it for other solutions permanganate of potash, (5 mgm. to the liter of filtered solution), may be added for the purpose of coloring it.

Titration of Dakin's Solution.—The strength of the solution should be determined from time to time by titration. It is performed as follows. To 10 c.c. of Dakin's solution add 20 c.c. of a 10 per cent. solution of potassium iodid and 2 c.c. of acetic or hydrochloric acid. To this mixture is added drop by drop, a decinormal solution of sodium hyposulphite until it is decolorized. The number of cubic centimeters of the sodium hyposulphite solution used, multiplied by 0,03725, will give the weight of hypochlorite of soda contained in 100 c.c. of solution.

Test of Alkalinity of Dakin's Solution.—Place 20 c.c. of the solution in a glass and drop a few centigrams of powdered phenolphthalein on the surface of the liquid. If the solution is properly prepared, it will remain colorless, while a red tint indicates the presence of free caustic soda.

Apparatus.—For instilling the solution into a wound there will be required: (1) A glass reservoir with a capacity of 1 quart (liter), (2) a red rubber irrigating tube ¼ inch (6 mm.) in diameter and 6 feet (2 m.) long, (3) a glass drop counter, (4) a clamp for controlling the flow of the solution, (5) glass connections and distributing tubes, and (6) rubber instillation tubes about 16 French in diameter and

12 to 16 inches (30 to 40 cm.) long. For intermittent insti
with numerous tubes, which is the usual method employ
apparatus is assembled without the "drop-counter" (Fig. 193)
latter is essential only when continuous instillations with a sing

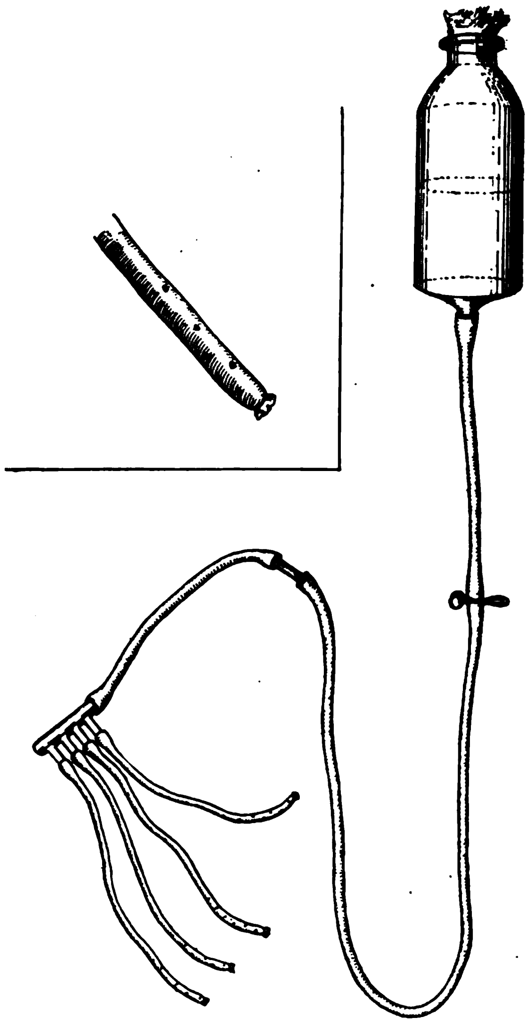
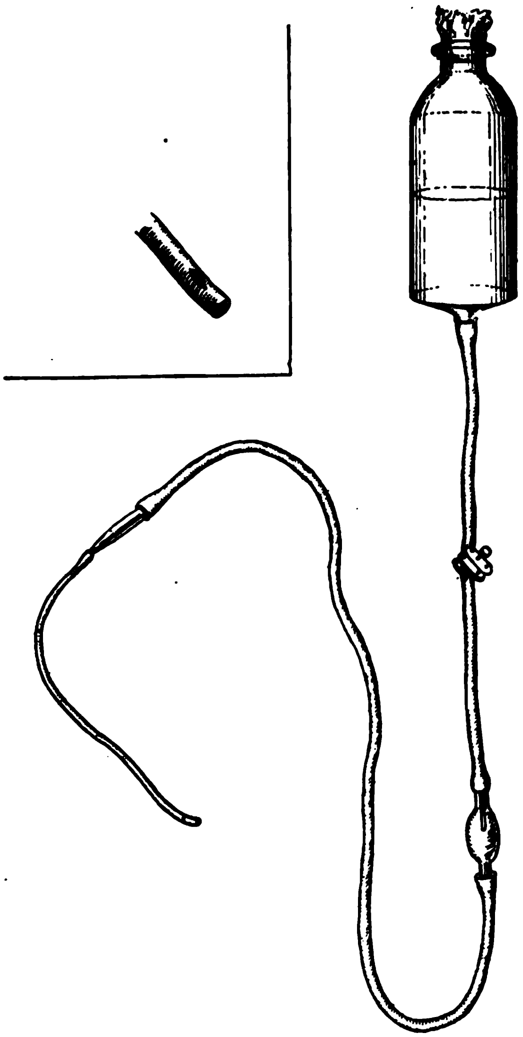


FIG. 193.—Carrel apparatus assembled for intermittent instillation wit
ous tubes. Small figure shows the arrrangement of the perforations and the
tube tied off.

s used, a screw pinch cock regulating the flow of the solutic
194).

The instillation tubes are of two varieties—(1) non-perf
with ends open and a large flat lateral opening 1/5 of an inch

om the distal end (see Fig. 194), and (2) perforated tubes, with e distal end closed with a ligature (see Fig. 193). A punch producing a hole with a diameter of about 1/25 of an inch (1 mm.) (Fig. 5) is used to make the perforations. The tubes are perforated over



ig. 194.—Carrel apparatus assembled for continuous instillations. Note the tube, drop-counter, and screw pinch-cock for regulating the flow. The small shows an enlarged view of the distal end of the tube with lateral opening.

ace of from 2 to 8 inches (5 to 20 cm.) from the closed end, it eight perforations being made in each 2 inches (5 cm.) of e. For use on a large circular area such as an amputation stump, tubes may be employed in which the perforations are made in the middle third of the tube, leaving both ends open. For super-

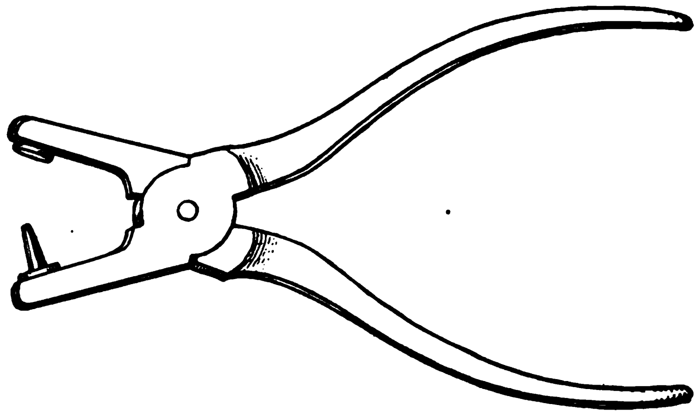


FIG. 195.—Punch for making the perforations in the tubes.

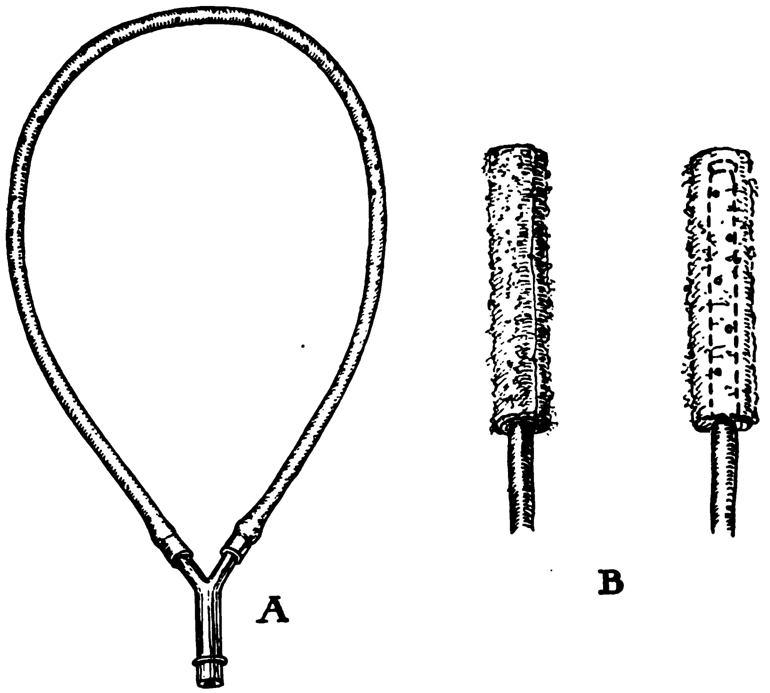


FIG 106.—Carrel tubes. A. Two way tube with perforations in the center. Perforated tubes covered with Turkish towelling.

ficial wounds where it is desired to distribute the fluid over a large surface and for wounds with dependent openings, perforated tubes are covered with Turkish towelling, and threads are fastened to the towelling and left long, to act as guy ropes and maintain the tubes in position. The threads may be sutured to the skin edges, or they can be held sufficiently fixed if covered by the vaseline gauze used to protect the skin edges.

The glass distributing tubes are employed for connecting the instillation tubes with the main conducting tube. They are provided with 1, 2, 3, or 4 branches, so that the instillation may be carried out through one tube or through groups of 2, 3, or 4 tubes. When more than four tubes are required, a Y shaped glass tube is inserted into the conducting tube, thus allowing two sets of instillation tubes to be connected with one reservoir.

Dressings, etc.—For protection of the skin in the neighborhood of the wound, strips of gauze bandage, 2½ by 5 inches (6 by 12 cm.) in size, impregnated with sterile vaseline, are employed. These may be conveniently prepared by laying the strips of gauze

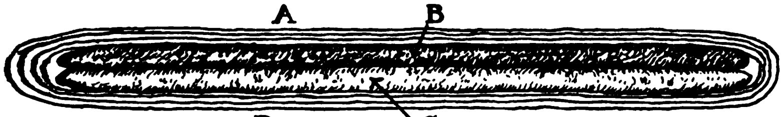


FIG. 197.—Cross section of large pad, showing A and D. gauze, B. non-absorbent cotton, and C. absorbent cotton. (After Carrel and Dehelly.)

in a shallow tin wafer box and pouring yellow vaseline melted to a liquid over them, so that the vaseline soakes into all portions of the gauze. The box is then covered and the whole is sterilized in an autoclave. Sterile gauze tampons for holding the tubes in place in the wound, are also required.

The dressings are in the form of pads, of three sizes: one large enough to encircle the thigh, one for the arm or leg, and a smaller size. These pads consist of a layer of absorbent cotton and then a layer of non-absorbent cotton wrapped in a layer of gauze, which is carefully folded over the back of the pad. Secretions are thus absorbed, yet do not escape to the exterior. For holding these outside dressings in place web straps, safety pins, or clamps may be utilized.

In addition to the above, scissors, dressing forceps, and rubber gloves are required.

Asepsis.—The instillation tubes are sterilized by boiling or in an autoclave and the dressings are sterilized in an autoclave. In dressing the wounds everything that comes in contact with the wound is handled with sterile forceps, and not even the gloved hands are allowed to touch the dressings or tubes. *The instruments must thus be freshly sterilized for every case,* and it is sometimes necessary to use newly sterilized instruments in dressing different wounds on the same patient.

Frequency of Instillations.—Intermittent instillation, the method applicable to the great majority of wounds is practiced every two hours day and night.

Quantity of Solution Instilled.—The length of time the solution flows should be sufficient to thoroughly bathe the wound and yet not flood it and wet the patient. The quantity of solution necessary to fill the wound may be determined at the first dressing by allowing the solution to flow after the tubes are in place before the wound is covered. Usually the pinch cock is opened from a half to three seconds, depending on the size of the wound. The amount of solution that escapes will thus vary from ⅔ to 3 ounces (20 to 100 c.c.), and from 8 ounces to 2½ pints (250 to 1200 c.c.) in the twenty-four hours.

For continuous instillations the pinch cock should be so regulated that the solution flows at the rate of 5 to 6 drops per minute.

Height of Reservoir.—The pressure under which the solution enters the wound is regulated by the height of the reservoir, and will vary according to the sensitiveness of the patient and the type of wound. The pressure should not exceed three feet (1 meter) and often 16 inches (40 cm.) is sufficient. The entrance of the fluid should not cause the patient pain; if it does, the cause is either excessive pressure or an inability of the solution to escape from the wound from a small opening.

Duration of Instillations.—The instillations are maintained day and night until all microorganisms disappear from the wound. This usually requires from 5 to 8 days in moderate sized wounds of the soft parts, and longer if there is bone involvement.

Technic. (1) *Mechanical Cleansing of the Wound.*—The first essential of the treatment is the preparation of the wound for the penetration of the liquid by a thorough mechanical cleansing. This should be carried out at the earliest possible moment before the inflammatory stage sets in. It consists of a careful and thorough débridement of the wound and the removal of any shell fragments, pieces of clothing, dirt, etc. It must be thoroughly and methodically done with all aseptic precautions under a general anesthetic.

The field of operation is sterilized with tincture of iodin. The wound must be opened up sufficiently to enable the operator to explore *by sight* the entire tract of the missel. The incisions should therefore, be free and one should not hesitate in this respect, as closure is readily effected when the wound is sterilized. The incisions are made, as far as possible, in the long axis of limbs or parallel with underlying muscle fibers, large vessels, and nerves. The débridement is commenced by cutting away with the aid of a scalpel and thumb forceps the bruised edges of the skin. The instruments used for this are then discarded for clean ones, and the same procedure is applied to the subcutaneous and muscular tissues. The incision exposing the tract through the muscles is of the same extent as the skin incision so that the depths of the wound may be laid open. The entire tract is then carefully explored, removing infiltrated blood, all tissues contaminated with particles of clothing, dirt, grass, or other foreign bodies, and tissues of doubtful vitality. All pockets are carefully explored for foreign substances. The same mechanical cleansing is applied to injured bone, removing splinters lying free but preserving those adherent to periosteum.

If drainage of the wound is required, counter openings at dependent portions should be avoided as far as possible, for the success of the instillation treatment depends upon keeping the solution in contact with the wound and not allowing it to escape through the bottom.

In the handling of the tissues gentleness is essential to avoid bruising and additional traumatism. Rough wiping of the wound and the careless use of retractors frequently aggravate the preexisting damage and increase the chances for injection.

Before completing the operation it should be seen that there is complete hemostasis and no oozing. Tissues infiltrated with blood are prone to infectión and, furthermore, carelessness in this respect may invite secondary hemorrhage, as Dakin's solution has the power to dissolve fresh blood clots.

(2) *Arrangement of the Tubes.*—The tubes are so placed in the wound that the solution will come in contact with every portion of it. They are placed directly in contact with the wound surface with a gauze compress over them (Fig. 198). Gauze *should not* be placed between the wound and the tubes, as the gauze quickly becomes impregnated with wound secretions and prevents the solution from reaching the wound.

In superficial wounds one or more perforated tubes according to the size of the wound are placed on the wound surface, the tubes

being prevented from slipping by gauze compresses laid over th
or a two-way flow tube in the form of a ring with perforations in
center may be employed (Fig. 199). By means of rubber c

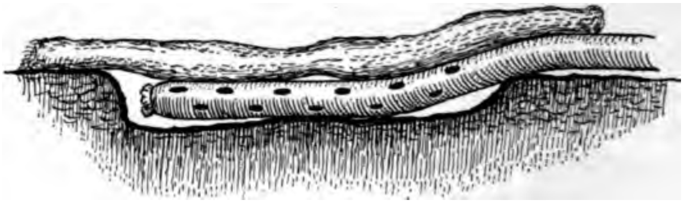


FIG. 198.—Method of placing the tube in a wound and covered with a gauze comp
(After Carrel and Dehelly.)

and threads the tube may be arranged in any desired shape. If
wound is on the lateral aspect of the body so that the wound surf

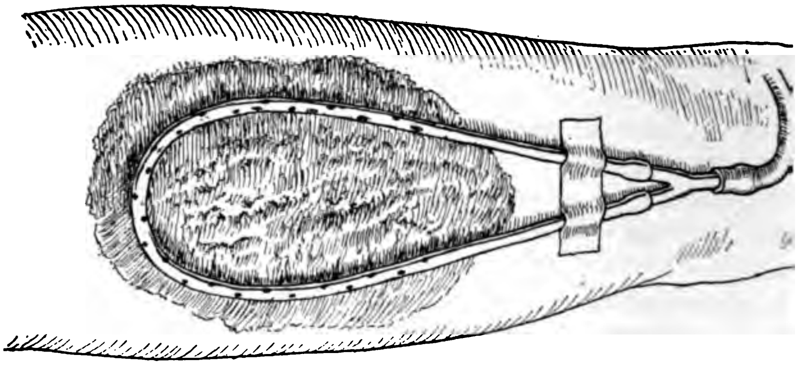


FIG. 199.—Arrangement of a perforated two-way tube on a large superficial wo
(Carrel and Dehelly modified.)

is inclined, the tubes are placed along the superior border so
solution will spread by gravity over the surface (Fig. 200).

Fig. 200.—Method of placing tubes in a wound with an inclined surface (After Ca
and Dehelly.)

Penetrating wounds with the opening situated above requ
but a single tube. A tube without perforations, the opening be

at the extremity, is introduced to the bottom of the wound, and the wound filled with solution (Fig. 201). It is to this type of wound that continuous instillation drop by drop is applicable. When the

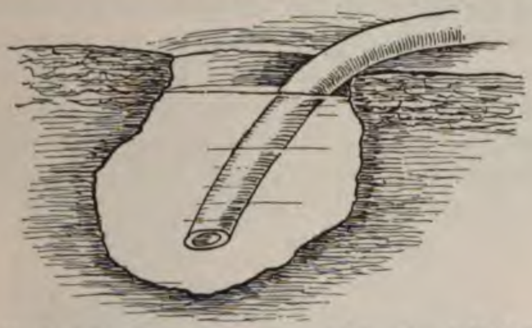


Fig. 201.—Single tube in cup-shaped wound (Carrel and Dehelly modified.)

opening is on the lateral aspect of a part, perforated tubes are employed and retention of the fluid is attained by placing a light compress about the orifice of the wound. A wound with the opening

Fig. 202.—Method of using a tube covered with Turkish towelling in a wound of the soft parts in a dependent portion of a limb.

located dependently is more difficult to sterilize. In such a case a tube covered with Turkish towelling, which tends to spead the solution over the wound and keeps it in contact for a longer period is employed (Fig. 202), or in large wounds several perforated tubes may be used, the solution being introduced under slightly greater pressure.

Perforating wounds with the openings on the anterior surfaces of the body present no great difficulty in the arrangement of the tubes. When one of the openings is dependent, the fluid tends to escape by gravity from the lowest opening, and the tubes must be arranged in such a way that the solution will escape at the highest point and flow back over the wound surface. Retention of the solution is favored by lightly tamponing the wound orifices (Fig. 203).

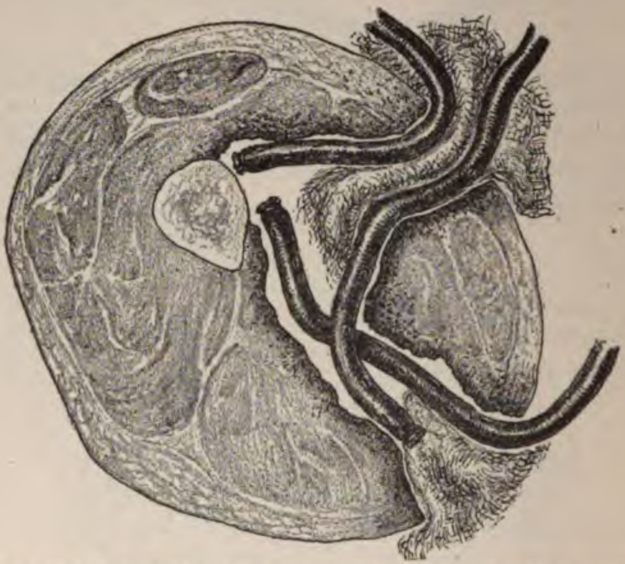


FIG. 203.—Method of placing the tubes in a large irregular perforating wound. (Carrel and Dehelly modified.)

(3) *Dressing the Wound.*—When the tubes are properly arranged, they are fixed in position by small gauze compresses soaked in Dakin's solution. Care must be taken to see that all of the perforated portion of the tubes lies in the wound, otherwise the solution will escape outside the wound. Squares of vaseline gauze are placed on the skin adjoining the wound for its protection, and readily adhere in place. (Fig. 204). The dressing is completed by applying a cotton pad with the absorbent layer next to the wound. The dressing is secured in place by web straps or by safety pins. The ends of the instillation tubes which emerge from the dressing at different points are grouped in twos or fours and are attached to the branched

unions. The tube from the reservoir is then attached and the branched cannula is fixed in place by safety pins to the highest point of the dressing (Fig. 205). Motion of the injured part must, of course, be guarded against by proper splinting.

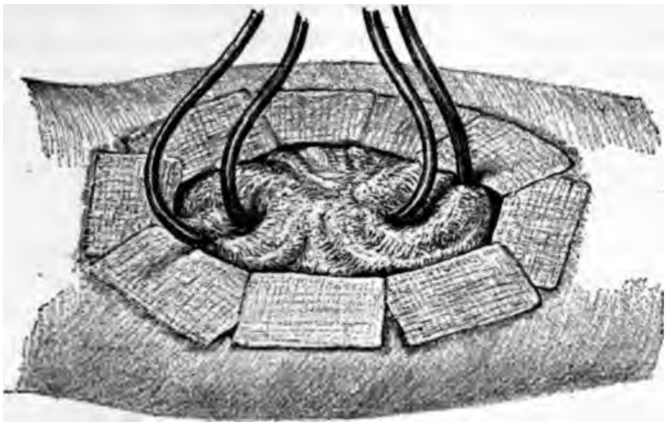


Fig. 204.—Wound partly dressed. Instillation tubes held in place by gauze and skin protected by squares of vaseline gauze. (Carrel and Dehelly modified.)

Dressings are renewed every twenty-four hours, at which time the wound is carefully inspected and the tubes renewed.

Bacteriologic Examination of the Wound. This consists of an examination of smears from the wound at regular periods and the

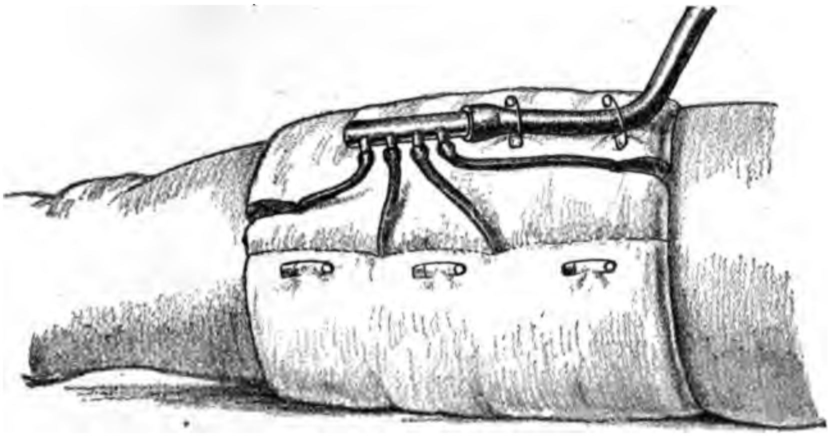


Fig. 205.—Dressing completed. Large gauze pad in place and distributing tube pinned to the dressing by safety pins. (After Carrel and Dehelly.)

estimation of the number of bacteria in the wound. Such examination, carried out from the beginning during the course of the treatment, not only enables the surgeon to determine the proper time for closure of the wound without danger of the infection recurring, but it also shows the progress of the sterilization. The method of examination is simple and consists in transferring one or more specimens of the secretions from the wound by means of a standard platinum wire loop, previously sterilized by passing through an alcohol flame, to a slide and counting the number of microorganisms to the microscopic field. This is done every other day and

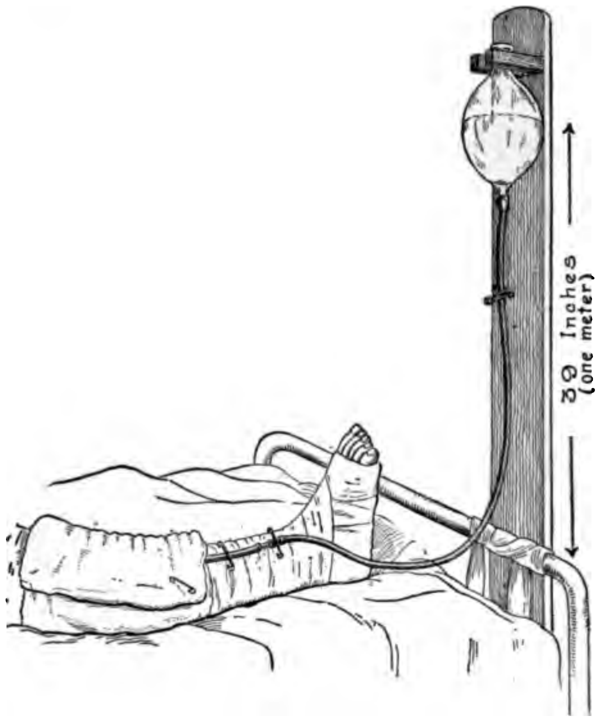


FIG. 206.—Showing the arrangement of the irrigating apparatus in an injury of the lower extremity. (Da Costa, modified from Carrel and Dehelly.)

the results entered on a chart kept for the purpose to show at a glance the progress of the disinfection. The specimens should not be taken within less than two hours after fluid has been instilled into the wound, and care should be taken to obtain specimens of secretion from those parts of the wound which seem to be most infected, such as the deeper portions, necrosed points, pockets under exposed bone, cul de sacs, or small tracts less likely to be reached by the solution.

Under the treatment the number of microorganisms should diminish. If the count remains stationery for several days or increases the wound should be carefully examined with a view to modifying the treatment. The failure to obtain favorable results may be due to errors in the preparation of the solution, to insufficient distribution of the solution from too few tubes, to the fluid not reaching all parts of the wound, to the presence of necrotic tissue, sequestra of bone, and foci of infection around foreign bodies that have been overlooked, etc. When the bacteria are absent from the wound or the number is reduced to one in every four or five fields, and this is verified by three successive examinations at intervals of two days, the wound is considered surgically sterile and may be closed. In streptococcic infections, however, the wound should not be closed until there is a complete absence of bacteria.

As a rule, moderate sized wounds of soft parts may be closed in from five to eight days. Large, badly traumatized wounds may require twelve days or more to sterilize. Compound fractures require a longer period—from two to four weeks. In these cases it will be found that sequestra of bone are a frequent obstacle to sterilization and require removal before success is attained

CHAPTER X

BIER'S HYPEREMIC TREATMENT, THE PRODUCTION OF AN ARTIFICIAL PNEUMOTHORAX, AND THE DIAGNOSIS AND TREATMENT OF FISTULOUS TRACTS BY MEANS OF BISMUTH PASTE

HYPEREMIC TREATMENT

While the value of artifically producing hyperemia with the definite purpose of increasing the inflammatory reaction has only been recognized comparatively recently, it is interesting to note that as early as the sixteenth century Ambroise Paré employed artificial congestion in delayed union of fracture due to insufficient callus formation. Others later and independently have called attention to the value of hyperemia in similar conditions. To Bier, however, belongs the credit of placing treatment by hyperemia upon a logical and scientific basis, and of demonstrating its great practical value.

There are two distinct forms of hyperemia, namely, active and passive. The former, obtained by means of dry hot air, produces an active flow of arterial blood through the parts, and is especially useful for the absorption of the products of chronic, nontuberculous inflammations. The passive, venous, or obstructive form of hyperemia, as it is designated, has for its object the increase of the amount of venous blood in the part, and may be produced by means of elastic compression of the venous circulation, or by suction cups. This form gives the best results in pyogenic infections, whether acute or chronic.

PASSIVE HYPEREMIA

Bier was first led to employ passive hyperemia through study of the observations of Farre and Travers who, as far back as 1815, called attention to the frequency of phthisis in persons whose lungs were rendered anemic because of stenosis of the pulmonary orifice, and by the reverse of this, namely, the rarity of pulmonary tuberculosis in individuals suffering from cardiac conditions tending to produce congestion or hyperemia of the lungs, as later pointed out by

Rokitansky. Impressed by these observations, Bier conceived the idea of artifically producing a hyperemia for the cure of tuberculous affections in other parts of the body. Encouraged by the results obtained in the treatment of tuberculous affections, he soon extended the use of hyperemia to the treatment of acute inflammatory surgical conditions, with most remarkable results. In this he was materially aided by his associate, Klapp, who broadened the scope of the method by devising variously shaped glass cups and vacuum apparatus for producing a hyperemia of regions of the body not amenable to the constricting band, though it is true Bier had himself employed this method previously and had abandoned it.

Treatment by hyperemia is based on the theory that inflammation represents nature's efforts for protection of the body against bacterial invasion and in the restoration of a part to a healthy condition. Bier's teachings in regard to inflammation take exactly the opposite view from what has hitherto been held and taught. Formerly it was the aim of treatment to combat in every way possible the phenomena accompanying an inflammation. In the presence of pain, heat, redness, and swelling, cold applications, elevation of the part, rest, and immobilization were advocated for the relief of these symptoms. According to Bier, however, the redness, heat, and swelling of an inflammation are but the outward signs of the effort on the part of nature to overcome noxious influences and produce a cure; and these are to be encouraged as beneficial instead of combated. An attempt was accordingly made to artifically reproduce the most evident of these phenomena, namely, congestion or hyperemia, and thereby increase the natural resistance of the tissues.

Difficult as it may be to give up our old ideas and accept a method of treatment so radically at variance with former teachings, the results obtained under hyperemia, properly carried out, are in certain cases so remarkable and so far in advance of any other methods as to furnish ample evidence of its superior value and to prove conclusively the correctness of the theories upon which Bier's treatment rests.

Effects of Hyperemia.—The beneficial effects of hyperemia are most striking—the more marked, the earlier the treatment is begun.

Diminution of Pain.—The prompt relief of pain is one of the most remarkable features of the treatment. Accepting the theory that pain from an inflammation is due to irritation of the cells and end organs by toxins, as well as to the high specific gravity of the inflammatory exudate, its relief under the influence of hyperemia, which both destroys and dilutes toxins and also dilutes the exudates, may be readily understood. If pain be not relieved, or at least mitigated or if discomfort results from the treatment, the operator's technic is probably at fault. The patient should always be impressed with the necessity of reporting any discomfort in the part subjected to the hyperemia, and his sensations should be an important guide for the operator.

Through the prompt decrease of pain and sensitiveness, reflex contracture of muscles is avoided and earlier motion in a part is possible. This is especially important in infections involving tendon sheaths and joints, as with early motion much better functional results are possible. Even in an extremely sensitive joint, it is remarkable how quickly slight motion may be painlessly practised under hyperemia.

Bactericidal Action.—It has been shown by experiments upon animals as well as by clinical evidence that through hyperemia certain forces are brought to bear which either directly or indirectly antagonize bacterial growth and either destroy or dilute the toxins Beginning infection, such as a furuncle or a carbuncle, in which redness, tenderness, swelling, and slight infiltration are the only signs present, can thus often be made to subside without suppuration while, if suppuration has already developed, the infectious process may be prevented from extending to the deeper tissues and the clinical course be greatly shortened. Accidental soiled wounds, which from experience we have every reason to believe will become infected under the influence of hyperemia can often be made to heal withou infection, and not infrequently by primary union, and there is no better means than the increased secretion induced by the hyperemia for thoroughly flushing out and rapidly cleansing these dirty wounds

Limitation of the Pathological Process.—Under hyperemia, necrosi of even badly damaged parts is often prevented by the superabundan nourishment of the tissues, or, when the infection has advanced to th destruction of tissues, the disease process is more promptly localized and a line of demarcation between the healthy and diseased tissues earlier in evidence. Sloughs and sequestra are thus early separate and cast off, while in tuberculous affections connective tissue replac the tuberculous, and the disease gradually dies out.

Solvent and Absorbent Action.—Both the active and the passi forms of hyperemia act as solvents, while the active, in addition, h a very marked absorbent action. The products of inflammation, infiltrations, exudates, and plastic changes, are dissolved, so to spea and their absorption is thus favored. Careful application of hyperemia thus makes unnecessary many of the operations of resection, etc. This is well illustrated in the excellent functional results, with freedom from ankylosis and deformity, obtained in tuberculous and other joint affections.

Indications.—Passive hyperemia has been recommended for all kinds of acute inflammatory processes and many of the chronic ones, and the literature contains numerous favorable reports of its use, not only in purely surgical affections, but in the specialties and in medicine as well.

The surgical conditions in which it has been found to be especially beneficial may be summarized as follows: Acute infections and inflammations, such as furuncles, carbuncles, felons, infected wounds, infection of tendon sheaths, lymphangitis, lymphadenitis, mastitis, gonorrheal arthritis, and other forms of acute infections of joints, acute bone infections, burns; as a prophylactic measure in soiled or dirty wounds, compound fractures; in chronic affections, such as tuberculosis of bones, joints, glands, tendon sheaths, testicles; delayed union of fractures; fistulæ; old discharging sinuses; and infected leg ulcers uncomplicated by varicose veins. Its use is, however, contra-indicated in lesions complicated by thrombosis of veins. In erysipelas its value is doubtful; in fact, erysipelas has been known to develop under prolonged hyperemia in tuberculous lesions which were complicated by open sinuses. In diabetes, likewise, the results have not always been good.

Passive hyperemia has also been employed with success in medicine for such conditions as acute rheumatism, gout, and pulmonary tuberculosis. For the latter condition Kuhn has devised a mask of thin celluloid which, by means of an adjustable valve, cuts off some of the air entering the alveoli and thus idduces a suction hyperemia. In a host of other affections falling within the domain of rhinology, otology, gynecology, obstetrics, and dermatology, passive hyperemia has been recommended and applied with varying degrees of success.

General Principles Underlying Hyperemic Treatment.—As emphasized by the author of this method of treatment, and others, it is not a panacea or cure for all troubles. One should recognize that it has its limitations. In some of the milder forms of infection, complete cure may often be effected by hyperemia alone; in other cases, of the more severe infections, it forms only a part of the treatment, and operative interference should never be delayed when indicated. *Pus must always be promptly evacuated*, and cold abscesses likewise are to be opened. This is accomplished by small incisions or punctures, the old-time extensive incisions, which often result in unsightly scars and even deformities, being unnecessary under this form of treatment. The hemorrhage incident to such incisions should be controlled by packing the wound for two to three hours before the hyperemia is induced. In an infection of the tendon sheaths, the anatomy of the parts should be carefully kept in mind and the incisions made accordingly. Small multiple incisions are employed and should be so placed as to avoid cutting the transverse palmar ligaments opposite the finger joints. In the case of infection of a large joint, the pus is aspirated and the joint cavity is irrigated through a large trocar; in other localities, ordinary surgical principles should be the guide as to the incision. The curettage of abscess cavities is avoided, while drains and tampons are discarded, as the secretions that are poured out under the artificial hyperemia serve to keep the wound open. *Certain cases of very rapidly extending infection, with acute onset, however, require early incision in conjunction with the hyperemia*, even before softening has occureed. If incisions are not made, the hyperemia may do harm and the local inflammation become worse, for the transudate which is induced by the hyperemia added to the exudate already present, has no outlet and may drive the bacteria and their toxins into healthy tissue and favor the extension of the infection.

In inflammations involving joints or tendon sheaths, mild active and passive motion are carried out from the first in order to obtain the best functional results, provided this can be done without producing pain. Slight motion is harmless so long as it is painless. For this reason, no immobilizing dressing need be applied during the treatment, open wounds being merely covered with moist antiseptic gauze.

In acute infections, the results are often prompt and most striking. In favorable cases, the temperature declines, pain is relieved, extension to deeper tissues is prevented, and the process rapidly subsides or at least the clinical course is much shortened. Swelling and redness are temporarily increased, and are to be expected as part of the treatment. The discharge from open wounds is at first more abundant, but this likewise rapidly subsides, and with it the edema and redness.

In chronic lesions of a tuberculous nature, the treatment must be carried out for months. In the case of joints, the pain and swelling slowly diminish, the contour of the joint again becomes distinguis able, and mobility gradually increases; secretions from sinuses become serous instead of purulent, the sinus takes on a healthy appearance and finally closes. In tuberculous affections, likewise, slight motion of the affected limb is allowed, provided it produces no pain. Fixation of the joint, in cases of tuberculosis of the wrist, elbow, or shoulder can thus usually be dispensed with—a sling at most is used—but in knee or foot tuberculosis a suitable apparatus should be worn, or the part so immobilized by a movable splint when the patient is moving about that pressure is removed from the diseased articular surfaces. In the presence of contractures of the joints, suitable extension is applied and used in conjunction with the hyperemic treatment.

Bier gives as contraindications to the use of hyperemia in tuberculosis of joints the following:

1. Commencing amyloid disease and advanced pulmonary involvement.

2. Large abscesses, filling up the whole joint cavity and demanding operation.

3. Faulty position of the joint, such that cure would give a joint less useful than could be obtained by resection. In such conditions he advises operative interference.

Successful hyperemic treatment necessitates correct technic, and many of the poor results at first obtained by those unfamiliar with this method may be ascribed to errors in this direction. It certainly requires time and close attention, as well as considerable experience on the part of the attendant, to obtain good results; but, if the treatment be properly carried out with perseverance, one will be amply repaid. At first the patient must be carefully watched as, with the use of the elastic band, for instance, it may be necessary to remove or reapply the constriction several times in the course of a single treatment in order to maintain the proper degree of hyperemia. Intelligent patients may later be instructed in carrying out the treatment with either the bandage or the cup, and in time they themselves can apply the treatment at home, but they should always remain under the supervision of the surgeon.

Methods of Producing Passive Hyperemia.—As already indicated the passive form of hyperemia may be produced by means of soft rubber bandages or by special suction apparatus. The principle in each is the same, but the technic requires special description.

Passive Hyperemia by Means of Constricting Bands. This is the oldest method of producing an obstructive hyperemia. It is especially applicable to affections involving the extremities, and neck. The hip-joint is the only one in either of the extre to which the method cannot be satisfactorily applied. Theri doubt that the proper application of the band requires moi than does cupping. Exact technic is necessary, and great c must be observed not to exceed the proper grade of hyperemi in tuberculous cases not to lower the vitality of the tissues by t longed obstruction. Only a mild hyperemia is necessary to p

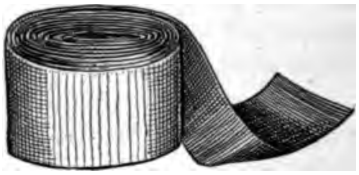


FIG. 207.—Esmarch elastic bandage for obstructive hyperemia.

results; otherwise, distinct harm is done. For this reason, the age should be applied by the surgeon himself until an int and competent person of the household can be instructed proper application.

Apparatus.—For most cases, a soft, thin elastic bandage, s Esmarch's or Martin's, about 2½ inches (6 cm.) in brea employed (Fig. 207).

For the shoulder-joint and testicles, rubber tubing is used i of a bandage. That used about the shoulder should be of

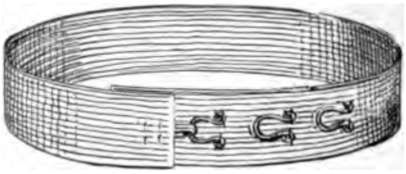


FIG. 208.—Elastic garter for producing obstructive hyperemia of the neck. Meyer-Schmieden.)

stout rubber, and about a foot long (30 cm.); while for the sc a catheter or a piece of drainage-tube of small size answers.

To produce hyperemia of the head and neck, a rubber b measuring about 1¼ inches (3 cm.) in width may be use special neck-band made for the purpose may be obtained. A elastic, about 1 inch (2.5 cm.) in width and provided with hoc eyes so that it may be adjusted to any size, as shown by companying illustration (Fig. 208,) answers the purpose adm

Site of Application.—The constriction should always be applied over healthy tissue and well above the area of inflammation. In involvement of the hand, for instance, the bandage is applied above the elbow, and above the knee if the foot be the seat of trouble. To avoid undue compression continually at the same spot, it is well to change the location of the bandage at each application, moving it a little either up or down the limb.

Duration of Application.—In the treatment of acute processes, the best results are obtained from prolonged stasis, namely, from twenty to twenty-two hours a day. The bandage is accordingly applied for ten or eleven hours, then discarded for two or one hours, and reapplied for another ten to eleven hours. The bandage is applied daily and, as the condition improves, the duration of the daily constriction may be diminished until it is only of from one to two hours.

For tuberculous affections the applications are of shorter duration, the bandage being applied once or twice a day from one to four hours at a time. In his early work on tuberculous affections, Bier first employed short periods of hyperemia, and then prolonged and almost continuous hyperemia, but he experienced many failures and bad results with the latter. He found that prolonged stasis in this class of cases was apt to devitalize the parts and lead to the rapid formation of cold abscess, as well as to the development of septic abscess, lymphangitis, adenitis, erysipelas, etc., so that he returned to the short applications of from one to four hours a day. In cases of acute hot abscess formation, however, due to a mixed infection of open sinuses, the application may be extended to the longer periods—twice, ten or eleven hours—until the acute process has subsided.

Technic.—To apply the bandage, its initial extremity is first wet sufficiently to make it adhere to the skin and prevent it from slipping. The bandage is wound around the limb with moderate tension six or eight times well above the seat of disease, each layer overlapping the preceding by about ½ inch (1 cm.). The bandage is then made secure by adhesive plaster or tapes previously sewed to the terminal end (Fig. 209).

The degree of hyperemia is of the utmost importance. The object is to moderately constrict the veins of a part, without in any way interfering with the arterial supply, thereby partly checking the reflux of blood and increasing the quantity of venous blood normally present. It requires practice and careful attention to detail

17

to apply the bandage in such a way that the arteries are not compressed, while at the same time the right amount of venous obstruction is obtained. If the constriction is applied properly, the veins in the part distal to the bandage become slightly distended, and the part takes on a bluish red hue and becomes warm to the touch. This degree of hyperemia is essential, as the hot hyperemia only has therapeutic value. As already emphasized *the pulse should never be obliterated.* It must at all times be distinguished, not even weakened. Furthermore, the application of the bandage should never cause pain or annoyance, or hyperesthesia of the part. If too great a degree of compression is employed, nutritional disturbances from the increased

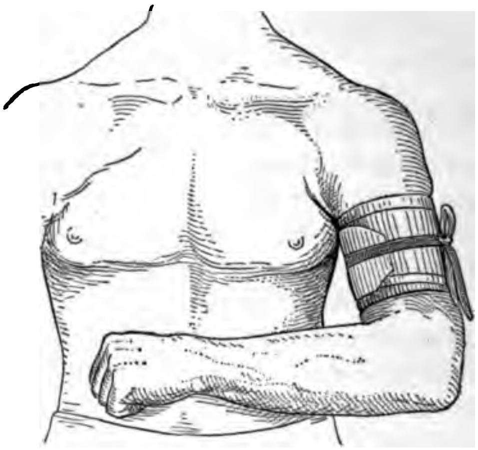


FIG. 209.—Showing the method of applying the elastic bandage to the arm.

stasis injures the tissues and reduces their natural resistance. In such a case, a white edema is produced, or the skin becomes grayish-blue in color, or has a mottled red and white appearance, and the part remains cold to the touch. Such a condition demands removal of the bandage and its proper reapplication.

For obtaining the proper degree of hyperemia, it has been suggested that a sphygmomanometer, such as the Riva-Rocci instrument, for example, be employed. The cuff is secured about the part in the same manner as would be done in taking the blood-pressure and the systolic pressure is estimated (see page 132). The mercury is then allowed to drop about 10 mm., which gives the proper tension, after which the tube leading to the inflation band is tightly clamped.

In chronic cases it is sometimes very difficult to obtain the proper amount of hyperemia, and several procedures have been advised to increase the congestion. Placing the part in a bath of very hot water for ten minutes before the constriction is applied often suffices. In other cases, the part may be first exsanguinated by means of an Esmarch bandage, as would be done preliminary to an amputation, and upon removal of the bandage a profuse reactionary flow results, after which the constrictor is applied.

If the constriction is to remain in place for long periods at a time, it is advantageous to apply a soft flannel bandage beneath the rubber to prevent undue pressure upon the soft parts, which might produce an irritation of the skin, or even atrophy of the muscles. This is especially necessary when treating aged or thin, flabby individuals. While the bandage is in place, all dressings, splints etc., are removed so as not to interfere with the hyperemia. If open wounds or sinuses be present, they are simply covered loosely with sterile or antiseptic gauze.

A marked edema results from the hyperemia, extending up to the seat of constriction, and this has to be kept within proper limits. When the application is only for short periods of a few hours each day, the edema is absorbed spontaneously in the intervals, but under prolonged hyperemia of twenty to twenty-two hours the time for this absorption is very short, and it is often not possible to entirely reduce it between applications. Elevation of the part upon pillows must consequently be performed during the intermissions. Massage of the region subjected to the pressure of the constriction should also be practised in order to guard against pressure atrophy.

In producing hyperemia of the shoulder-joint, head and neck, or testicles, a slight variation in technic, requiring separate description, is necessary.

Head and Neck.—About the neck a special band, already described (page 256), is used. It should be applied about the root of the neck, well below the larynx, with only moderate tension. To obtain the greatest degree of hyperemia with least constriction, small pieces of felt or wadding may be placed under the constricting band on either side of the larynx over the great veins (Fig. 210). If properly applied, such a bandage can be worn with entire comfort. It causes a pronounced edema of the face, particularly about the eyelids. This is no contraindication to its use, however. Care should be taken not to apply the band too tightly—of course it should never strangulate or interfere with eating or swallowing. If throbbing or a feeling of marked fullness in the head is complained of, the bandage should be removed and reapplied.

Shoulder.—A soft bandage or cravat is placed loosely about the patient's neck and tied. Through the loop a stout piece of rubber

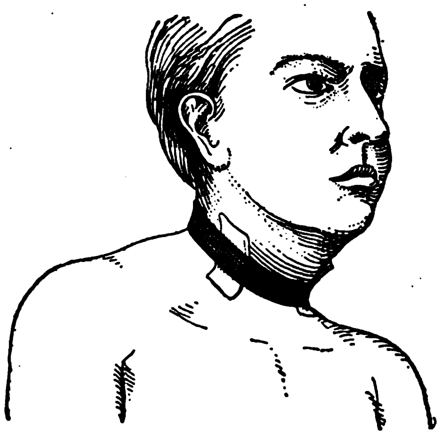


FIG. 210.—Showing the application of the neck band.

tubing about a foot in length is passed as a ligature encircling shoulder-joint, the middle portion being placed in the axilla and

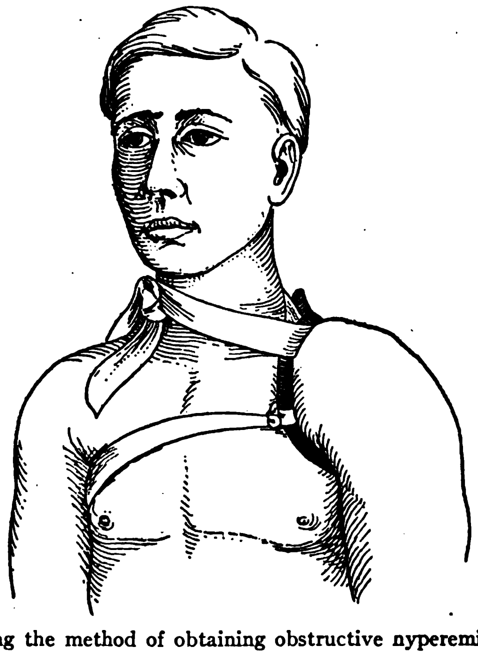
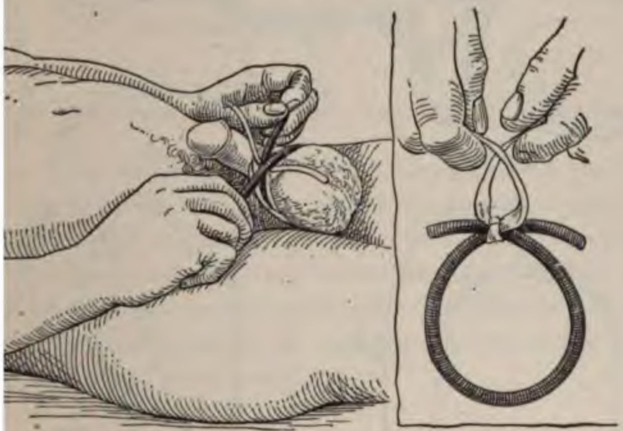


FIG. 211.—Showing the method of obtaining obstructive nyperemia of the should

two ends passing up—one in front and the other behind the joint— a point above the shoulder, where they are secured by tying or

amp. A second piece of bandage is secured to the tub-
f the joint, and passes across the chest, under the oppo-
d around the back, where it is secured to the portion of
ng behind the joint (Fig. 211). By adjusting the band-
ulating the tightness of the rubber tubing, the proper
striction may be obtained.
mical reasons it is not possible to change the location of
or at each application, as is done upon the extremities,
re and attention is necessary to avoid pressure necrosis.
on, it is better to apply the constriction for short periods
or four hours—at a time, repeated several times in the



ving the method of producing obstructive hyperemia of the testicles. (After Meyer-Schmieden.)

hours, with correspondingly longer intermissions, in
the ten or eleven hour applications.
—Tuberculous and other affections of the testicle may be
neans of constriction about the root of the scrotum. A
f rubber tubing or catheter is wound several times about
he scrotum over a layer of cotton and is secured in place
h a piece of tape or cord (Fig. 212).
nia by Means of Suction Cups.—Innumerable forms
f suction cups for producing hyperemia in regions not
constriction, as well as large chambers for use upon the
and large joints, have been devised. The hyperemia
these devices is also a venous one, and is applicable to
ss of cases as is obstructive hyperemia by the bandage.
use of the constricting band, exact technic is necessary,

and the importance of obtaining the proper degree of hyperemia cannot be too strongly emphasized.

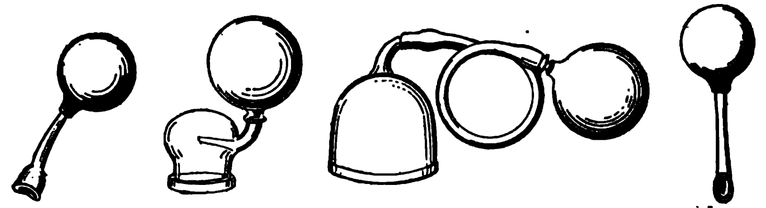


Fig. 213 Fig. 214 Fig. 215 Fig. 216

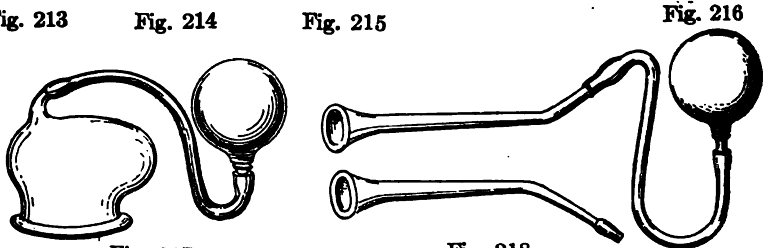


Fig. 217 Fig. 218

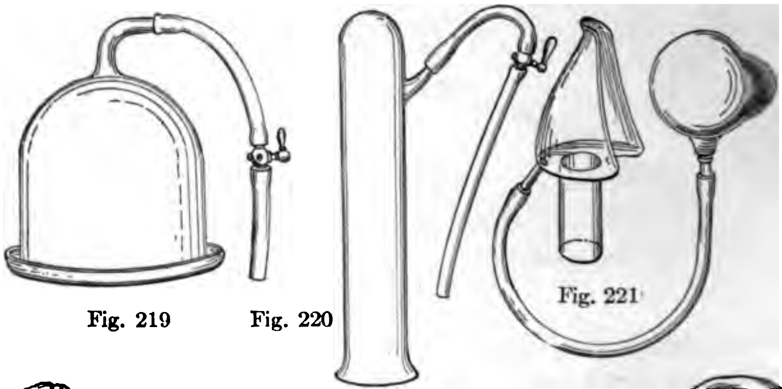


Fig. 219 Fig. 220 Fig. 221

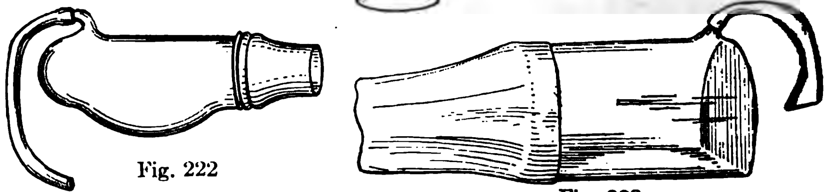


Fig. 222 Fig. 223

FIG. 213.—Cup for sty. 214. Cup for small abscess. 215. Cup for large abscess. 216. Cup for gums. 217. Cup for carbuncle. 218. Cups for tonsils. 219. Breast cup. 220. Cup for cervix. 221. Cup for nose. 222. Finger suction glass. 223. Hand suction glass.

When one of the cups is applied to a surface and a vacuum produced, the skin and underlying tissues are sucked into the chamber and venous stasis with a consequent increase in the supply of blood in the skin and deeper layers results. Besides producing hyperemia, the mechanical effect of the cupping glass is also of distinct advantage. From an open discharging wound pus and broken-down tissues are rapidly and effectually aspirated. Small sequestra of bone are often quickly separated and discharged through a sinus under the influence of the hyperemia combined with suction. In the presence of tuberculous sinuses, daily applications of the suction cups may be employed in conjunction with the rubber bandage.

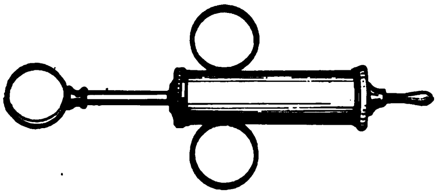


FIG. 224.—Pump for producing a vacuum in the larger cups and suction glasses.

Apparatus.—Cups suitable for furuncles, styes, carbuncles, breast abscess, etc., chambers in which are placed the fingers, hands, feet, and large joints, as well as apparatus to be used by the gynecologist, orthopedist, otologist, and other specialists are now manufactured. Types of some of these are shown in the following illustrations (Figs. 213 to 223). If there is considerable discharge, a type of cup shown in Fig. 213 will be found most useful.

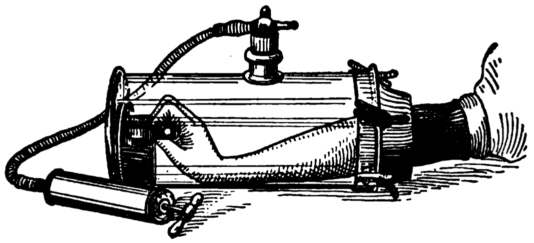


FIG. 225.—Showing the method of obtaining motion in a stiff wrist by the aid of passive hyperemia.

In selecting the cup, one should be chosen of sufficiently large diameter to extend well outside the limits of an acute inflammation, and with edges that are thick and smooth, in order to avoid undue pressure upon the skin. In the smaller glasses the suction is obtained by means of small rubber bulbs. With the larger apparatus, stronger suction is required and a special exhausting pump is necessary (Fig. 224). A further convenience for use with the larger apparatus is a three-way stopcock inserted between the glass chamber and the pump to allow admission of air when the negative pressure is great or is to be discontinued.

In addition to these cups and chambers, larger and stronger ap ratus for orthopedic use is made for the purpose of bending joints by atmospheric pressure, as shown by Fig. 225. Here the is drawn firmly in the glass case as the air is exhausted until the h meets the obstacle at the lower end of the chamber, when the w turns in the direction of least resistance. Other joints of the b may be similarly treated by the use of suitable apparatus. Kl has also devised metal chambers which are provided with an pump and a heavy rubber bag for obtaining motion in a parti ankylosed joint. Upon exhausting the air in the apparatus,

FIG. 226.—Showing the method of obtaining motion in a stiff knee-joint by the a passive hyperemia.

rubber bag descends and exerts an evenly regulated pressure u the part to be treated, as shown in Fig. 226.

Asepsis.—In using suction apparatus in the neighborhood of o wounds or sinuses, strict asepsis should be observed. To avoi danger of adding to the infection, the cups should be boiled be used. They should be again boiled and well cleaned before b put away.

Duration of Application.—In the use of cups, brief applicat often repeated are essential. Accordingly the cup is applied for minutes, and is then removed for an interval of two or three min to allow the congestion, edema, and swelling to subside. The c then again applied for five minutes, and an entirely fresh suppl blood with bactericidal properties is brought to the part, the e treatment consuming about three-quarters of an hour.

Technic.—*Pus, if present, is always to be evacuated by means of a small incision or puncture,* as previously described, before application of the suction apparatus.

To apply the cup, the edges of the glass are first moistened with vaselin, to avoid leakage of air. Gentle pressure is then made on the bulb, and the cup is placed over the affected region, *care being taken to use a cup that is large enough.* Upon releasing the bulb, the air in the cup is partly exhausted, causing the area covered by the cup to be drawn up into it, and, if a proper amount of suction is exerted, the cup adheres to the surface and a pronounced hyperemia results (Fig. 227). If the application is made over an open infected wound, pus will be drawn out, accompanied by some blood.

FIG. 227.—Showing a cup applied to a carbuncle.

The importance of obtaining just the proper degree of hyperemia has already been strongly emphasized and is reiterated here. It must be remembered that the suction should be just sufficient to slightly decrease the outflowing blood without interfering with the inflow. The object is to produce a reddish-blue color of the part. *A distinct blueness or mottling of the skin, or complaint of pain on the part of the patient, indicates too great an amount of suction and requires withdrawal and reapplication of the cup.* Pain should never be produced even in acutely inflamed regions. Sometimes more than one application of the cup is necessary before the proper degree of hyperemia is obtained. With the suction pump, the degree of hyperemia may be more nicely regulated. In this case, the cup with the edges well lubricated is simply applied to the affected region, and the air is slowly exhausted until the proper degree of hyperemia is induced. If the vacuum is produced too rapidly, it is apt to cause some pain. Should it be found that too great a degree of suction is produced, the stopcock may be opened slightly and air allowed to enter the chamber until the desired degree of congestion is attained.

In the use of the large chambers, such as are employed for the treatment of a hand or foot, the member to be subjected to hyperemia is first coated with soap or vaselin so that the rubber sleeve will more easily slip over the skin and at the same time leakage of air may be avoided. The patient then thrusts the arm or foot into the apparatus, and the rubber sleeve is bandaged securely about the limb with a rubber bandage (Fig. 228). A partial vacuum is then produced. This causes the part to be drawn more deeply into the chamber, and

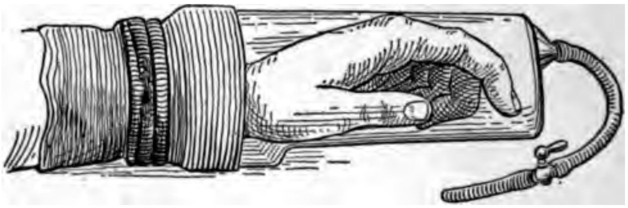


FIG. 228.—Showing a suction glass applied to the hand.

some care will be necessary to avoid injuring the limb by suddenly drawing it against the closed end of the apparatus. A distinct hyperemia of the whole part within the chamber is thus produced, which may be increased or lessened at will by increasing or decreasing the amount of air in the apparatus.

During the intermissions between applications, the congestion may be relieved by elevation if the part be an extremity. Discharge or secretions from open wounds or sinuses should be removed between applications by gentle bathing of the part with warm sterile water or some antiseptic solution. At the end of the treatment the whole part should be gently bathed with warm solution, and all loose exudate or necrotic tissue removed with forceps or sterile gauze. A simple wet dressing is then applied. At the next sitting, if a crust has formed over the opening or sinus, it is gently removed with forceps and the treatment is continued as outlined above.

The suction treatment should be applied daily at first. The amount of pus usually rapidly decreases each day, first becoming less purulent and more serous, until finally only a little serum is withdrawn with each application. The swelling diminishes and the part begins to regain its normal appearance and dimensions. As the suppuration decreases, the treatment may be given every second day, and finally every third day, until recovery is complete.

ACTIVE HYPEREMIA

The active or arterial form of hyperemia is produced by means of dry hot air. Any portion of the body when subjected to heat becomes red and hyperemic through local increase in the supply of arterial blood. The effects of hot-water bags, hot compresses, hot poultices, hot sand, etc., are all familiar examples of active hyperemia Hot air in a dry form, however, is the most effective means for inducing such a hyperemia on account of the high degrees of heat that can be borne without discomfort. A part may be subjected to the influence of dry hot air of a temperature of 212° F. (100° C.) or more without danger of producing a burn or other injurious effects. On the other hand, moist heat of a temperature of 125° F. (52° C.) is capable of doing distinct harm, and is unbearable even for short periods.

The use of hot air as a therapeutic agent is by no means new, and has been employed with varying degrees of success for ages, but the methods of application were crude and often unsatisfactory. Improvements in the modern baking apparatus have placed this method upon a firm basis, and properly applied in certain cases active hyperemia becomes a therapeutic agent of distinct value.

Indications.—Active hyperemia has a solvent and absorbent action upon exudates, infiltrations, adhesions, etc., and a marked analgesic effect, causing a sensitive part to become less so or to be entirely relieved soon after the application is begun. It thus acts favorably in chronic rheumatism, chronic arthritis, chronic synovitis, and arthritis deformans. It aids greatly in promoting the absorption of edemas and of effusions of blood into the soft parts, and in synovial sacs—as in traumatic synovitis. Other affections in which active hyperemia has given good results are neuralgia, sciatica, neuritis lumbago, gout, varicose veins, varicose ulcers, etc.

In fractures near a joint with painful involvement of the joint itself, it is of great value in reducing the edema and at the same time hastening the repair, thus increasing the chances of obtaining a more useful limb through the ability to perform early passive motion. In a Colles' fracture, for example, the bones should be properly reduced and within a few days the part should be daily subjected to the influence of heat. After ten days the splint may be discarded entirely, unless there seems a likelihood that the deformity will recur, and the hot-air treatment is daily continued, with the addition of both active and passive motion.

While active hyperemia is of distinct therapeutic value, it should not be employed to the exclusion of other means of treatment. Internal medication should always be carried out when the condition is such that it seems indicated, and the hot-air treatment used as an adjunct. In affections of the joints, neuralgias, etc., massage should

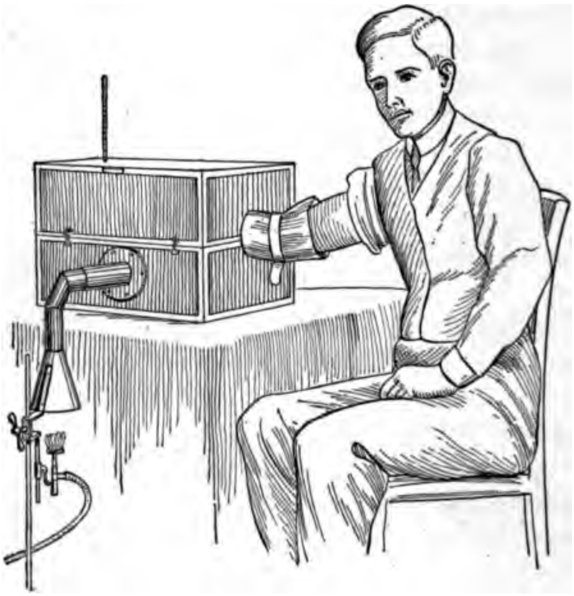


FIG. 229.—Apparatus for applying active hyperemia to the hand and wrist and the method of its application.

form an important part of the treatment. Too much stress cannot be laid on the value of massage when judiciously used in appropriate cases.

Apparatus.—Active hyperemia may be induced either by the use of hot-air boxes or hot-air douches. There are many makes of hot-air boxes on the market. The simplest are made of cotton-wood carefully fitted together and covered with cloth to prevent any leakage of air. They are provided with a lid and have openings at one or both ends for receiving a limb. These openings are lined with cuffs of felt to avoid any danger of burning the skin, and are provided with straps so that the cuffs may be securely fastened to a limb. Openings for hot air are provided on both sides of the box, the one not in use being shut by a slide. Into one of these a chimney is fitted, through which the hot-air is conducted from the heating apparatus. The heat is supplied by an alcohol lamp or a gas burner secured to a bracket so that the lamp may be raised or lowered at will. The lids have one or more openings for ventilation of the apparatus. The air is thus constantly in motion, which is important in order to permit evaporation of the perspiration upon the part and to maintain the dryness of the air. A thermometer is also provided with each box for indicating the temperature. Such boxes are made to fit various parts of the body, as the arm, hand, shoulder, foot, knee, hips, etc.

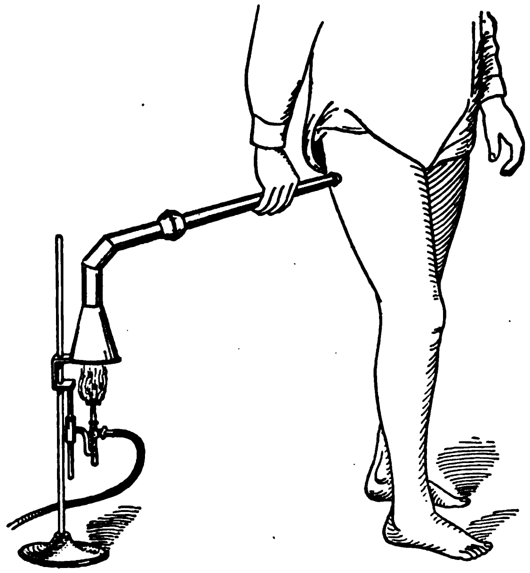


FIG. 230.—The hot-air douche being applied in sciatica. (The nozzle of the apparatus should be shown directed more to the posterior surface of the limb.)

Hot-air douches may also be obtained for use over small areas, as along the course of a nerve, about the ear, etc. The douche consists of a long metal movable chimney, underneath which is the lamp or gas burner (Fig.230).

Temperature.—The degree of heat to which the part is subjected may vary from 150° F. to 212° F. (60° C. to 100° C.) or even higher. The temperature must never be high enough, however, to cause discomfort, and the patient's feelings should be the guide. It should be remembered that the prolonged application of a very high degree of heat lowers the sensibility of a part, and great care must be taken not to burn the patient; the same caution must be observed when applying active hyperemia to tissues with lowered resistance. A moder temperature should be employed at the start, and this should increased gradually as tolerance is attained. The temperatur regulated by raising the lamp nearer the box or moving it far away, and also by the size of the flame.

Duration of Applications.—The heat should be applied from an hour to an hour daily, or on alternate days. In exception stubborn cases it may be applied for the same length of time t daily.

Technic.—The patient assumes a comfortable attitude, ei seated or lying down, with the apparatus close at hand. The p to be baked is then placed in the box and the lid is closed. lighted lamp is placed under the funnel and the temperatu gradually raised until a degree of heat is attained that can be c fortably borne by the patient. The vent in the top of the appar should always be open when it is in use, in order to obtain the ne sary draught for the flame and proper ventilation of the appar When the desired degree of temperature has been reached, it sh be maintained from half an hour to an hour. The light is extinguished and the temperature is allowed to slowly fall be the member is removed. A sudden change of temperature, suc would be occasioned by immediately removing the part to the out atmosphere, is to be avoided. The part, when removed f the baking apparatus, is hot and hyperemic and remains s some little time. Immediately following the treatment, ge massage and passive motion, if indicated, should be pract

THE PRODUCTION OF AN ARTIFICIAL PNEUMOTHORAX

The production of an artificial pneumothorax by the repe injections into the pleural cavity of a slowly absorbable gas fo purpose of collapsing a tuberculous lung, orginated with Forl of Italy in 1894. Independently of Forlanini, the same oper was performed in 1898 by Murphy of Chicago, but at the tir did not excite a great deal of attention in this country, in spi its successful use abroad by Brauer, Spengler, Saugmann and ot Today, however, it is recognized as a therapeutic measure o greatest value for certain cases of pulmonary tuberculosis, a procedure that is reasonably safe if performed under rigid as and with proper precautions.

The aim of the treatment is to collapse a diseased lung and put it at rest on the same theory that a tuberculous joint or other tuberculous process is immobilized. With reduction in the volume of the lung, its contents, such as the pus and cheesy collections in cavities and inflammatory exudates in the alveoli and small bronchial tubes, are gradually evacuated, so that toxic absorption is lessened. At first, while the cavities are undergoing collapse, expectoration may be temporarily increased, but it rapidly decreases in amount if the operation is successfull. As the cavities collapse and become obliterated, the diseased parts are brought into apposition so that cicatrization is favored and the extension of the disease is limited.

The effects of compression on the circulation of the blood and lymph is also important. In a collapsed lung the circulation of the blood is impeded and a condition of venous stasis results, which, as is well known, is an important factor in increasing the resistance of the tissues against the tubercle bacilli. Likewise, through compression of the lymph channels, toxic absorption rapidly decreases, and the fever, nightsweats, general weakness, and other symptoms of toxemia disappear.

The operation is comparatively simple and consists in puncturing the chest with a needle which is connected with a reservoir of nitrogen gas and a water manometer, and allowing the gas to flow into the pleural cavity in small amounts at a sitting. By some operators the parietal pleura is first exposed by an incision as an aid to the proper placing of the needle in the pleural cavity, but this method is formidable in comparison with simple puncture and is generally reserved for those cases when the simpler technic fails.

Indications.—Success in creating an artificial pneumothorax requires that the pleura be permeable, as the lung will not collapse if there are adhesions.

The cases best suited to this treatment are those with an active involvement of a considerable portion of one lung with little or no involvement on the other side. Bilateral involvement, however, is not a contra-indication if less than a third of the good lung is affected. In rapidly progressive cases and in cases that do not improve under the usual hygienic and climatic treatment, it is also indicated. It gives excellent results in those cases where there is persistent and copious hemoptysis if its source can be definitely traced to one or the other lung.

In cases where there are cavities with very rigid walls, the results are often uncertain, as, while healthy parts of the lung may collapse, the lung at the site of the disease does not and outside of a temporary improvement the operation is a failure. In bronchi the same difficulty is met in collapsing the thick walled bronchioles, and, while use of the method has been follow improvement, permanent benefit is doubtful.

Artificial pneumothorax is contra-indicated in the prese extensive involvement of both lungs, dry pleurisy, pleuris effusion, where there is such extensive cavity formation that t danger of the needle entering the lung, in myocarditis or other cardiac, renal, or constitutional disease that would in its sufficient to prevent recovery, and in early favorable cases.

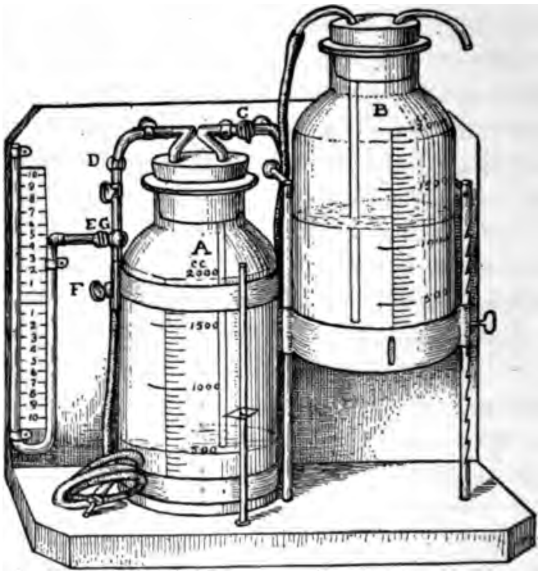


FIG. 231.—Robinson apparatus for artificial pneumothorax.

Apparatus.—There are various makes of apparatus on the m which are all much the same in principle. The manometer most important part of any apparatus, as it demonstrates the lo of the needle during its insertion and registers the pressure thorax before and after the injection.

The Robinson apparatus consists of two bottles with a ca of 2 quarts (2000 c.c.) each, connected with a manometer. bottle "A" is stationary while the other "B" is arranged so be elevated or lowered. The stationary bottle is filled with water containing two drams (8 c.c.) of pyrogallic acid to t any oxygen that may enter with the nitrogen. Nitrogen then forced into bottle "A" forcing the solution into bottle "B". The apparatus is then ready for use, and, on opening the proper cock, the solution in bottle "B" forces the nitrogen out of bottle "A" under pressure regulated by the height of bottle "B". As the water levels in the two bottles approach one another, bottle "B" is elevated to maintain the desired pressure. When cock "D" is closed and "E" & "F" are open a direct connection between the needle and the manometer results. With cock "F" closed and "C" and "D" open connection is established between the manometer and the nitrogen, the pressure recorded being the difference in the water levels of bottles "A" and "B." With cock "E" closed and the other two open the nitrogen passes directly from bottle "A" into the needle.

The needle should preferably be provided with an obturator and arm for connection with the tube to the gas bottle. The needle should be $\frac{1}{25}$ inch (1 mm.) in diameter and about $1\frac{1}{2}$ inches (4 cm.) long.

FIG 232.—Floyd needle for artificial pneumothorax.

Gas Used.—Nitrogen gas is generally employed, as it is claimed to be more slowly absorbed than atmospheric air and is non-irritating. It should be chemically pure and should be filtered through sterile cotton on the way to the chest.

Temperature.—The gas should be at about the temperature of the body. It may be warmed by immersing the tube through which it passes to the patient in a basin of hot water.

Quantity Injected.—The injection of small amounts of gas is preferable. Two hundred to 400 c.c. (12 to 24 cubic inches) are introduced at the first sitting and this is increased to from 300 to 600 c.c. (18 to 36 cubic inches) at the second, and to from 800 to 1000 c.c. (48 to 60 cubic inches) at the third operation.

Frequency of Injections.—Injections are given at intervals of from 2 to 5 days until complete collapse of the lung is obtained, demonstrated by disappearance of the respiratory murmur and X-ray examination. To insure permanency of the pneumothorax, further injections are made once or twice a month depending on the rapidity with which the gas is absorbed.

Point of Puncture.—A point as far away from the seat of the disease as possible should be selected in order to avoid adhesions. For lesions of the apex the needle is inserted in one of the intercostal spaces between the 6th and 9th ribs, between the anterior and posterior axillary lines. For lesions of the lower lobe the third space outside the mamillary line is selected.

Preparation of Patient.—The patient should be given morphin gr. 1/6 (0.0108 grams) by hypodermic half an hour before the operation.

Position of Patient.—The patient should lie on the side with the diseased side uppermost and the arm elevated above the head so as to widen the intercostal spaces as much as possible.

Asepsis.—The bottles, tubing and needles are sterilized and the operator's hands cleansed as carefully as for any operation. The skin at the site of puncture is sterilized by painting with tincture of iodin.

Anesthesia.—A 0.5 per cent. procain-adrenalin solution is used. The skin at the point of puncture is first anesthetized and then the tissues of the intercostal space down to and including the pleura are infiltrated.

Technic.—A point on the skin over the interspace through which the injection is to be made is selected at a little distance from the upper margin of the lower rib bounding the space, and, after being anesthetized, a small nick is made in the skin with a scalpel. The thumb and forefinger of the left hand are used to steady the tissues while the needle is introduced with the right hand, the forefinger being placed on the needle to guard against its being inserted too deeply. The needle is then pushed through the intercostal muscles into the pleura, which is usually entered at a depth of about one inch (2.5 cm.) and is recognized by the added resistence offered to the needle. The needle is now connected with the manometer, the trocar being withdrawn and the connection with the nitrogen bottle remaining closed, as the manometer is the only means of determining whether the needle has entered the pleura. While the needle remains outside the endo-thoracic fascia, the manometer registers zero, but as it reaches this structure there is a slight oscillation between 0 and 3, due to the respiratory movements of the pleura. The entrance of the needle within the two layers of the pleura is indicated by a negative pressure of from 5 to 10 cm., and there will be observed distinct oscillations of the fluid in the manometer corresponding to inspiration and expiration. Should the needle enter a blood vessel or adherent pleura negative pressure and the respiratory oscillations are absent. If the lung is entered respiratory oscillations may be present, but there is no negative pressure. Unless the negative pressure registers 3 cm. or over, the injection of the gas should not be attempted, and another site should be chosen.

When it is certain that the needle is in the pleural cavity, the manometer is closed, and the gas is allowed to enter, which it does under the influence of the negative pressure in the cavity or under positive pressure in the gas reservoir, if necessary. After 100 c.c. (6 cubic inches) of gas has been introduced, the gas is shut off and the pressure in the pleural cavity is taken, and, if the manometer still registers a negative pressure, 100 c.c. (6 cubic inches) more gas may be introduced. The final reading of the manometer should indicate only a slight negative or a positive pressure of from 0.5 to 3 cm. At the completion of the operation the needle is withdrawn, pressure being made over the site of the puncture for a few moments to prevent leakage of gas into the subcutaneous tissues, and the wound is sealed with collodion and cotton. The patient should be kept in bed for twenty-four hours subsequent to the operation, and any tendency to cough should be controlled by small doses of codein.

At subsequent operations the same site is chosen for inserting the needle as at the first operation, and the needle is introduced with the same precautions.

Complications.—Some pain may be felt during the introduction of the needle through insufficient anesthesia. When it occurs during or following the injection of the gas, it is usually the result of breaking up of adhesions. A slight dyspnoea is not uncommon immediately following the injection, but soon passes off. Should severe dyspnoea and pain occur during the inflation, it should be stopped at once.

Occasionally a condition known as "*pleural shock*," which is manifested by an increase in the pulse rate and respirations, pallor, and dyspnoea, is observed. It usually passes off quickly, but may result fatally.

Gas embolism, the result of gas entering a vessel, may occur if the precaution of demonstrating the location of the needle by the manometer before making the injection is not followed. It is characterized by rapid pulse, irregular respirations, faintness, collapse, inequality of the pupils, etc. If a large quantity of gas enters a vessel, it may produce fatal results.

Subcutaneous emphysema is sometimes observed in the neighborhood of the puncture from the escape of the gas into the tissues through the puncture. It is more apt to occur with the open method.

Pleural effusions are a frequent complication. It is serious as it may result in a pyothorax.

Accidental pneumothorax sometimes occurs as the result of injury to the lung by the needle, or from tearing of the lung when adhesions are broken up.

THE DIAGNOSIS AND TREATMENT OF FISTULOUS TRACTS BY MEANS OF BISMUTH PASTE

The injection of a mixture of bismuth and vaselin for the diagnosis and treatment of fistulæ, tuberculous sinuses, and abscess cavities was devised by Beck of Chicago. He originally employed the method for the purpose of determining the size, course, and extent of fistulous tracts. His first injection of a fistula for diagnostic purposes resulted, however, in the prompt closure of the sinus, and led him to extend the use of the injections to curative purposes with most favorable results.

For diagnostic purposes the fistula or abscess cavity is filled with the bismuth mixture and then a radiograph is taken. As the bismuth offers great resistance to the penetration of the X-rays, a clear shadow of the fistula and all its ramifications is obtained. This gives much more information than the usual methods of probing and injecting colored fluids, peroxid, etc.

As a therapeutic measure the method of application is equally simple, the bismuth paste being injected into the fistula or abscess cavity and allowed to remain there. Later it is absorbed. It is claimed that the bismuth has a bactericidal, chemotactic, and astringent action on the tissues. Furthermore, through its mechanical effect, it promotes healing by keeping the walls of the sinus separated and forming a framework for the granulating tissue to work through. The method is applicable to all fistulæ or abscess cavities except biliary or pancreatic fistulæ and those communicating with the cranial cavity or urinary bladder. It is contraindicated in acute processes and new sinuses, as absorption occurs very readily from the fresh lining of the walls. In old sinuses and abscess cavities this is not the case, the thick fibrous walls possessing a greatly diminished power of absorption.

Toxic effects have been observed after the use of bismuth paste, and, in some instances, death has resulted. The symptoms are those of nitrite poisoning: black lines upon the gums, ulcerative stomatitis, vomiting, diarrhea, albuminura, cyanosis, and collapse. To avoid this danger not more than 100 gm. (3 ounces) of the mixture should be injected the first time, and the patient should be carefully watched for the appearance of any toxic symptoms. Should they develop the cavity must be promptly evacuated. This may be accomplished by injecting into the cavity some warm sterile olive oil and removing it within twenty-four to forty-eight hours by aspiration. The cavity should never be curetted, as this simply opens up new channels for absorption.

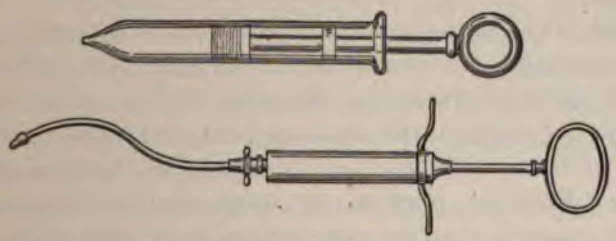


Fig. 233.—Types of syringe for bismuth paste injections.

Apparatus.—There will be required a vessel to heat the bismuth mixture in, a glass rod to stir the mixture, and a large blunt-pointed glass syringe with asbestos packing. For injecting rectal fistulæ Beck has devised a syringe with a nozzle of special shape and curve (Fig. 233).

Formulary.—Two mixtures are used by Beck:

No. I.	Bismuth subnitrate	33%
	Vaselin,	67%
No. II.	Bismuth subnitrate,	30%
	White wax,	5%
	Soft paraffin (120° F. melting point),	5%
	Vaselin,	60%

Formula No. I is used for diagnostic purposes and for early treatments, while No. II is used for late treatments after the discharge from the sinus has ceased. *Only arsenic-free bismuth should be used.* The paste is mixed by melting the vaselin and, while still hot, stirring into it the bismuth. It is claimed that the efficiency of the paste is increased by adding 0.5 to 1 per cent. formalin.

To avoid the dangers of nitrite poisoning, various other substances have been incorporated in the vaselin, such as the subcarbonate, oxychlorid, and subgallate of bismuth, chalk, oxid of iron, etc., but in the opinion of Beck they are inferior to bismuth subnitrate for therapeutic purposes.

Asepsis.—The syringe and receptacle for warming the bismuth mixture and the stirring rod should be sterilized by *dry heat*. If the syringe needs lubricating the packing may be dipped in sterile olive oil. The paste is sterilized by heating over a water bath, care being taken not to allow any water to come in contact with the mixture.

Preparations of the Patient.—No general preparation of the patient is necessary; the sinus or cavity to be injected may be dried out by means of a strip of gauze if this is feasible, but no irrigation should be attempted. The opening of the sinus is carefully wiped off with alcohol.

Technic.—The paste is heated over a water bath and is stirred until thin enough to be drawn into the syringe. The syringe is then filled with the melted mixture, the point of the syringe is pressed closely into the mouth of the sinus, and the mixture is injected under sufficient pressure to distend and penetrate all the ramifications of the sinus. Both for purposes of diagnosis and treatment it is absolutely essential that the paste be made to enter all portions of the tract. When the patient feels a sense of distention from the injection, the latter is stopped and a pledget of gauze is quickly placed over the opening. An ice-bag is then applied to the part and the patient is kept quiet for a few hours.

As a rule, after the first injection, the secretions change in character and become first seropurulent, then serous, and finally cease. Should the discharge continue the injection may be repeated at the end of a week and after that every three to five days until the sinus closes. If any improvement is going to take place it should be noticed inside of a month. Tracts that show no disposition to close should be carefully examined for the presence of dead bone or other foreign body, which, if present, must be removed. A small per cent. of the cases show no results at all from the treatment.

CHAPTER XI

THE COLLECTION AND PRESERVATION OF PATHOLOGICAL MATERIAL

With the present-day refinements of laboratory methods, the aid furnished by an examination of discharges, blood, urine, sputum, etc., is of great importance, and often without the information so obtained a correct diagnosis is impossible. It is not within the scope of this work to enter into the details of laboratory methods—these may be found in books devoted to the subject—but it is the writer's purpose in this section to give brief instructions as to the methods of collecting material and the preparation of specimens for subsequent pathological examination. This work usually falls to the lot of the practitioner or surgeon himself, and often, through faulty technic in the inoculation of a culture, in the preparation of slides, or in the collection of discharges, etc., the results of the pathologist's examination are misleading or useless.

In any case where material is sent to a laboratory for examination, each specimen should be clearly labeled with the name of the patient, or by a distinguishing number, and the clinical diagnosis and a short clinical history of the case, together with a statement of from what part of the body or from what organ the pathological material was obtained, should accompany the specimen. If chemicals have been employed for preserving the specimen, this should also be stated on the slip sent to the pathologist.

METHOD OF MAKING A SMEAR PREPARATION FOR MICROSCOPICAL EXAMINATION

Equipment.—A number of clean glass slides, sterile swabs, and suitable specula for exposing to view deep-seated regions from which the discharge may originate, will be required.

The slides should be absolutely clean and free from grease. Unless the slides are very dirty, the following method of cleansing the glass will suffice: First wash off the slide with soap and water, then wipe with alcohol and ether and rub dry with an old linen or silk cloth; finally pass the slide through an alcohol flame. When once cleansed, care should be taken that the surface of the slide doe not come into contact with the skin, as, if it does, a thin film of greas will be left upon the glass.

The swabs consist of steel wires or applicators about one extremi of which some cotton is wound. They may be obtained steriliz and ready for use, or may be easily extemporized as follows: A tes

FIG. 234.—Roughened wire for making a swab.

tube and a piece of stiff wire, of a length somewhat longer than th of the tube, are obtained. One end of the wire is first roughened wi a file (Fig. 234) and is then tightly wrapped with a small roll cotton (Fig. 235). The swab is then loosely laid in the test-tube a the mouth of the tube is plugged with sterile cotton (Fig. 236), a

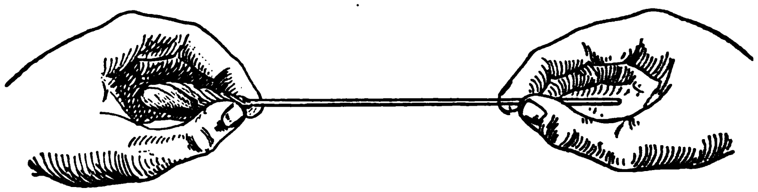


FIG. 235.—Showing the method of wrapping cotton on the end of a wire.

the whole is sterilized by dry heat. A supply of swabs may prepared in this way and be kept ready for use almost indefinite

Technic.—The slides are arranged upon a towel and the tu containing the sterile swabs are placed near at hand. With the s of the disease well exposed, the swab is removed from the gl container and dipped into the pus or the secretion care being tak

FIG. 236.—Sterile swab in a glass test-tuoe.

that it touches nothing but the material from which the specimen to be obtained. The swab is then rubbed over the surface of o of the glass slides so as to spread the material in a thin transpare film (Fig. 237). At least two smears should be made from ea locality, and each slide should be labeled with a distinguishin number. The slides are allowed to dry and are then piled up an secured one upon another, but with their surfaces separated by matches or tooth-picks, as shown in Fig. 238.

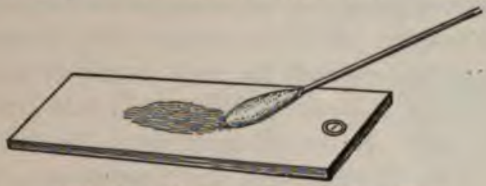


FIG. 237.—Method of making a smear.

From the Mouth and Pharynx. Equipment.—Sterile swabs, glass slides, and a tongue depressor will be required (Fig. 239).

FIG. 238.—Glass slides separated by match sticks and held together with rubber bands ready for shipment to the laboratory. (Ashton.)

Technic.—It should be seen that no antiseptic mouth washes or gargles have been used for at least two hours previous to the time the smear is made. The patient is seated in a good light, with h's

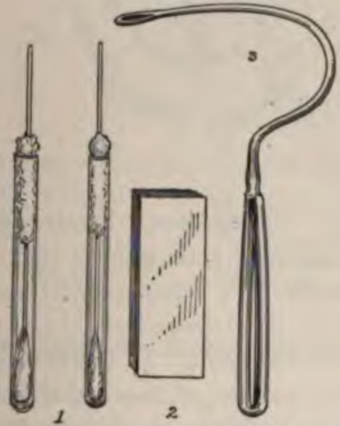


FIG. 239.—Instruments for taking a smear from the pharynx. 1. Sterile swabs; 2, glass slides; 3, tongue depressor.

mouth widely opened, and the tongue controlled by the tongue depressor held in the operator's left hand, so that a good view of the diseased area may be obtained. The sterile swab is then removed from its container, taken in the right hand, and is passed into the mouth, the operator being careful not to allow it to come in contact with the lips or tongue. When in contact with the area from which the material is to be obtained, the swab should be rotated about so as to bring as much as possible of its surface in contact with the secretions (Fig. 240). In removing the swab the same care against contamination from contact with the tongue, etc., should be observed. A thin smear is then made upon a slide in the manner described above, and the swab is returned to its container for future inoculation of culture tubes if necessary.

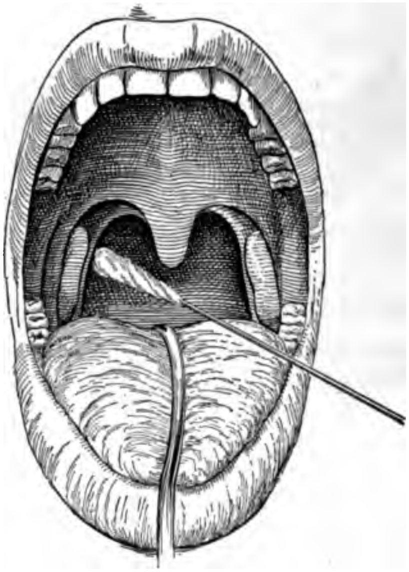


FIG. 240.—Showing the method of taking a smear from the pharynx.

From the Nose. Equipment.—Swabs, slides, a nasal speculum, a head mirror, and an angular pipette (Fig. 241) will be required.

Technic.—Ordinarily, for microscopical examination, a smear made in the usual way from secretions blown from the nose into a piece of sterile gauze is sufficient. If, however, it is desired to obtain a smear from any one locality, the secretion should be first removed by means of a pipette (page 294), and from this the smear is made.

From the Eyes. Equipment.—Slides, a sterile swab, a platinum needle, and an alcohol lamp (Fig. 242) will be necessary.

Technic.—There should be no preliminary cleansing of the eyes. The platinum needle is first sterilized by passing it through the flame, and when it has cooled the lids are separated, the loop is brought into contact with the pus and some of it is transferred to a slide. A smear is then made by means of the swab.

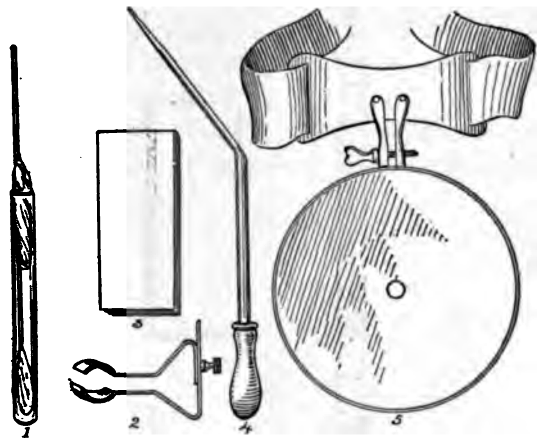


FIG. 241.—Instruments for taking a smear from the nose. 1, Sterile swab; 2, nasal speculum; 3, glass slides; 4, angular pipette; 5, head mirror.

From the Urethra. Equipment.—Slides and sterile swabs (Fig. 243) should be provided.

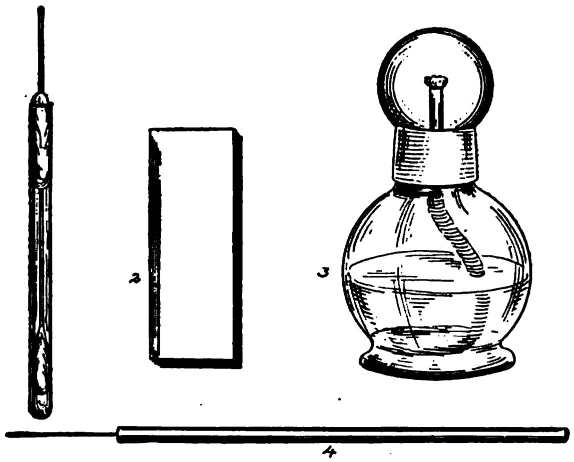


FIG. 242.—Instruments for taking a smear from the eyes. 1, Sterile swab; 2, glass slides; 3, alcohol lamp; 4, platinum needle.

Technic.—In a male, the meatus should be cleansed, and a drop of pus is expressed by stripping the urethra with the finger from behind forward. The swab is then dipped in the pus and a thin smear is made upon a slide in the usual way.

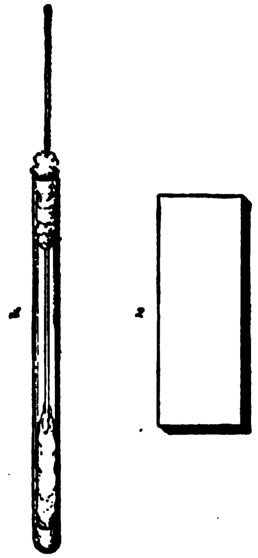


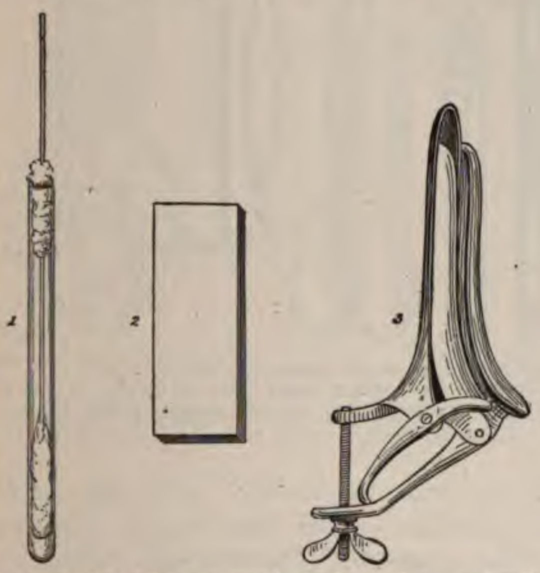
FIG. 243.—Instruments for taking a smear from the urethra. 1, Sterile swab; 2

FIG. 244.—Forcing the discharge out of the urethra by pressure against the c
with the tip of the finger in the vagina. (Ashton.)

female, the labia are held apart by an assistant, the index nserted in the vagina, and the urethra is stripped from ward (Fig. 244). The swab is then brought into contact lrop of pus that is thus expressed, and a smear is made the usual way.

:he Vagina. **Equipment.**—Swabs, slides, and a vaginal (Fig. 245) are needed.

c.—The labia are separated and the speculum is introduced tain a good view of the parts. The swab is then introduced



nstruments for taking a smear from the vagina. 1, Sterile swab; 2, glass slides; 3, vaginal speculum.

uching the vulva and is rubbed in the discharge, mucous whatever it may be. A smear is then made from the hus obtained.

the Cervix. Equipment.—A long swab, a speculum, ula, a sponge holder, and glass slides (Fig. 246) should be

c.—The speculum is introduced so that the cervix is well view, and, by means of a tenaculum placed in each lip, is drawn as far down as possible. The swab is then passed ervical canal (Fig. 247), but care is taken that it does not uterus for fear of carrying infection to what may be a gan from a diseased cervix. The swab is then withdrawn, ar is made in the usual way.

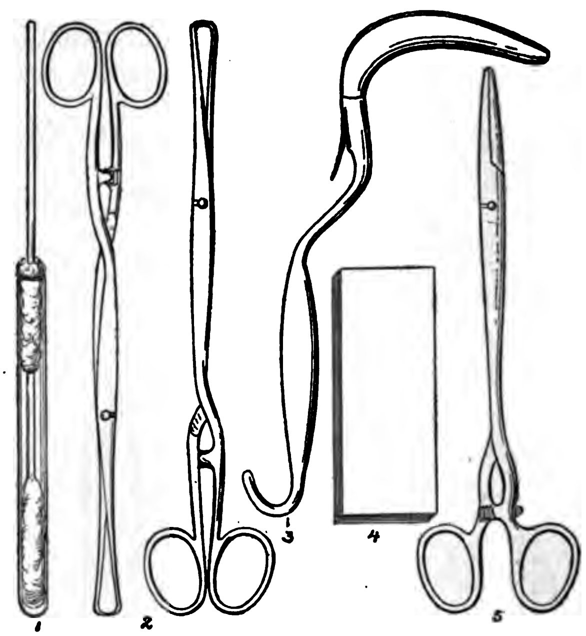


FIG. 246.—Instruments for taking a smear from the uterus. 1, Sterile swa cula; 3, Simon's speculum; 4, glass slides; 5, sponge holder.

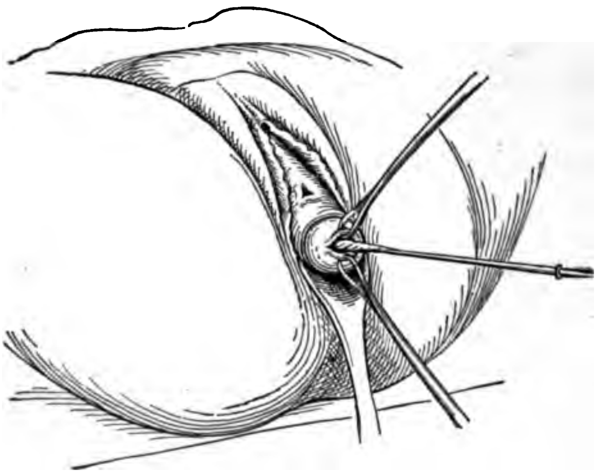


FIG. 247.—Method of collecting the secretions from the uterus. (Ash

METHOD OF INOCULATING CULTURE TUBES

Equipment.—Culture tubes, sterile swabs, platinum needles, thumb forceps, and an alcohol lamp (Fig. 248) will be required.

A variety of media are employed for the growth of bacteria, such as broth, agar-agar, gelatin, and blood serum, according to the kind

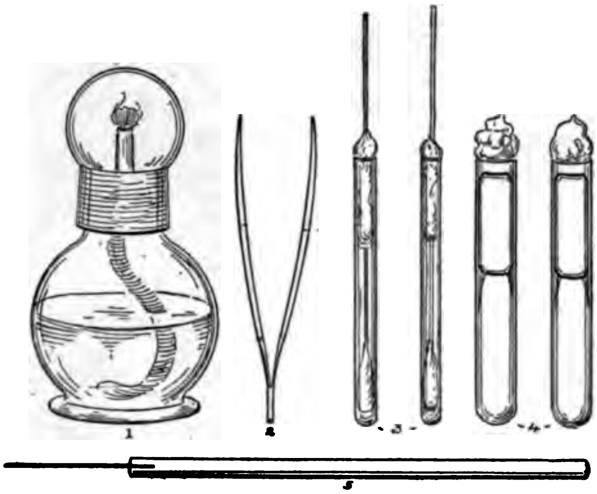


FIG. 248.—Instruments for making a culture. 1, Alcohol lamp; 2, thumb forceps; 3, sterile swabs; 4, culture tubes; 5, platinum needle.

of bacteria to be cultivated. The culture media are sold in sterile test-tubes, generally plugged with cotton. When they are to be kept for any length of time, the tubes should, in addition, be sealed with rubber caps or oiled paper to prevent their contents from drying out.

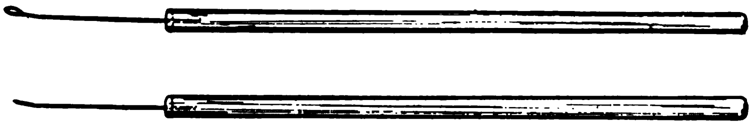


FIG. 249.—Platinum needles.

The inoculation of the tubes is performed by means of a swab or a platinum needle. The method of making and sterilizing the former has been described above (page 280). The needle consists of a platinum wire, 3 to 4 inches (7.5 to 10 cm.) long, which is inserted into the end of a glass rod 6 to 8 inches (15 to 20 cm.) long, which serves as a handle. The free end of the wire may be made into the form of a loop or it may be simply left straight (Fig. 249), according to whether a streak or a stab culture is to be made. Before use, the wire should be sterilized by passing it back and forth through a flame for a few seconds.

Technic.—In making a culture the greatest care must be exercised as to the asepsis and the avoidance of contamination. The culture tubes, platinum needles, etc., are arranged upon a towel within easy reach, and the alcohol lamp is lighted. The end of the culture tube containing the cotton plug is first passed through the flame, the cotton being singed so as to destroy any germs that may be deposited upon it (Fig. 250). The culture tube is held between the thumb and forefinger of the left hand, with the mouth of the

FIG. 250.—Singeing the cotton stopper of a culture tube preparatory to its inoculation.

tube pointing downward, if it contains a solid medium, so as to prevent the entrance of any dust. A pair of thumb forceps, after being passed through the flame, are used to remove the cotton plug which is then transferred to the left hand where it is held between the index and second fingers while the culture is being made.

If a streak culture is to be made, a looped platinum needle is sterilized by passing it through the flame, including the portion of glass handle that will enter the tube, and, after permitting it to cool, the tip of the needle is dipped into the secretion or pus—care being taken that it touches nothing else—and is passed to the bottom of the culture tube and then gently withdrawn over the culture medium so as to spread the material in a thin streak upon its sloping surface (Fig. 251). The platinum needle is again passed through the flame and is then laid aside. The tube is finally closed with the cotton plug, first singeing the cotton, however, in the flame while held with the thumb forceps.

FIG. 251.—Method of making a streak culture. (Levy and Klemperer.)

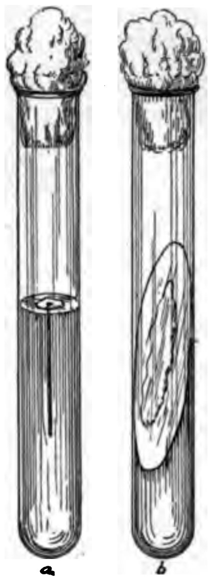


FIG. 252.—Showing "*a*" stab culture, and "*b*" smear culture.

When a stab culture is to be made, a straight needle is employed stead of a looped one. The technic is precisely the same as for a reak culture except that the needle is inserted straight into the ulture medium and is then withdrawn.

A smear culture with a swab is made as follows: The culture tube and the tube containing the sterile swab are held side by side between the thumb and the index finger of the left hand. The cotton plugs are removed with sterile forceps, the ends of the tubes and the exposed cotton being first singed, as described above. The cotton plugs are held between the ring and little finger and the ring and middle fingers of the left hand, while, with the right hand, the swab is withdrawn from its tube, dipped in the secretion, and is then inserted into the culture tube and is rubbed thoroughly over the surface of the culture medium (Fig. 253). The swab is then replaced in its container and the cotton plug is singed and reinserted into the mouth of the culture tube.

FIG. 253.—The method of making a smear culture.

When a number of cultures are being made, care should be taken to immediately number each tube as it is inoculated.

COLLECTING DISCHARGES AND SECRETIONS FOR BACTERIOLOGICAL EXAMINATION

When in the absence of culture tubes or for other reasons it is necessary to send fluid material to a laboratory for bacteriological examination it is best collected in sterile glass pipettes which are then hermetically sealed. This insures against leakage as well as any chance of contamination during transportation.

Equipment.—A number of glass pipettes, a rubber suction bulb or a suction syringe, an alcohol lamp, scissors, and suitable specula (Fig. 254) will be required.

The pipettes may be easily made from thin glass tubing of an external diameter of about ¼ inch (6 mm.). The center of a piece of such tubing about 6 inches (15 cm.) long is heated over a flame, the

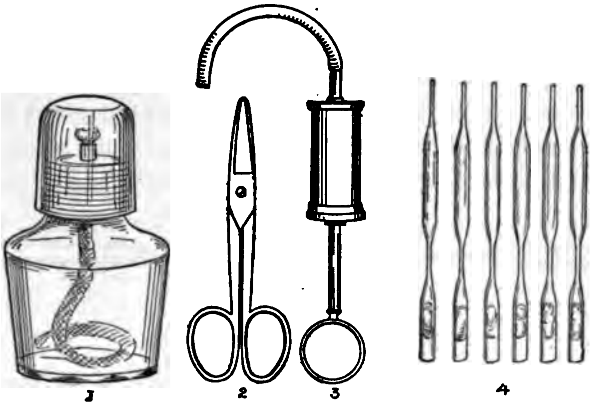


FIG. 254.—Apparatus for collecting discharges for bacteriological examination. 1, Alcohol lamp; 2, scissors; 3, suction syringe; 4, pipettes.

tube continually being turned the while, until the glass is softened over about ½ inch (1 cm.) of space (Fig. 255). The tubing is then removed from the flame, and, while the glass is still soft, the two ends are drawn apart so that the softened central portion is stretched out

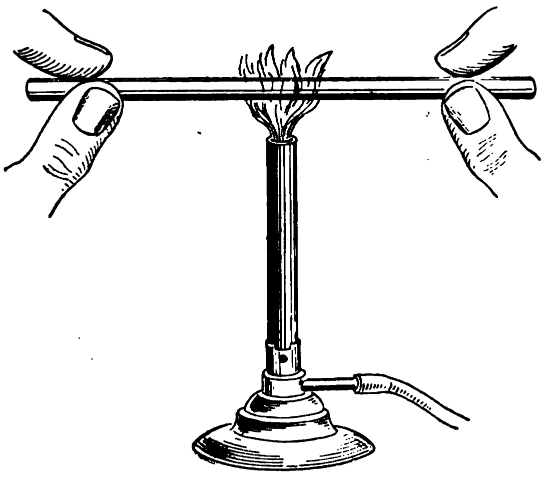


FIG. 255.—Heating the glass tube at its center over a Bunsen flame. (Ashton.)

into a capillary tube several inches long Fig. (256). The center of this capillary tube is again heated in the flame until it melts, and, by drawing upon the ends, it parts in the center, leaving two pipettes, each with one sealed end (Fig. 257). The center of the thick portions of each of these pipettes is then melted in the same way and is drawn out into a capillary tube an inch (2.5 cm.) or more long, so

FIG. 256.—The glass tube is shown drawn out at its center. (Ashton.)

that we have as a result two pipettes each drawn to a point at one end, wide at the other, and between the two ends a bulb separated from the wide end by a capillary constriction (Fig. 258). The pipettes are

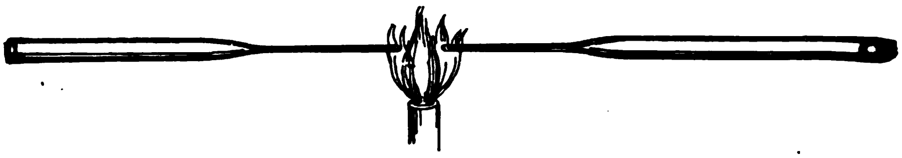


FIG. 257.—Fusing apart the center of the drawn-out portion of the tube. (Ashton.)

sterilized, after inserting a piece of cotton wool in the wide ends, by passing the whole tube through the flame until it is hot (Fig. 259), but not so hot as to melt the glass or burn the cotton plug. Thus

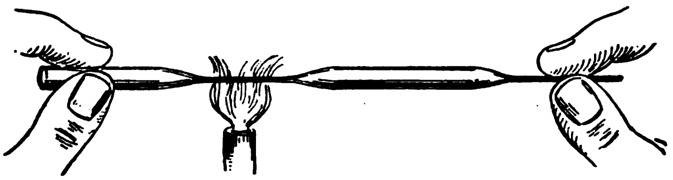


FIG. 258.—Making a bulbous pipette by heating the thick portion and drawing it out to a thin tube. (Ashton.)

sterilized, the pipettes may be kept on hand ready for use almost indefinitely.

The suction for drawing up secretions into the pipettes may be

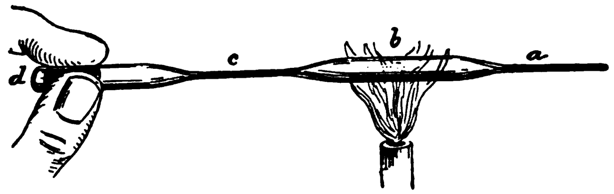


FIG. 259.—Sterilizing the interior of the bulbous portion (*b*) and the slender end (*a*) of the pipette; (*d*) plug of cotton. (Ashton.)

furnished by the bulb of a medicine dropper, or by attaching a piece of rubber tubing to the pipette and applying the lips or a small suction syringe to the free end of the rubber tubing.

Technic.—The pipettes are arranged near at hand upon a towel, ınd the alcohol lamp is lighted. The sealed end of the pipette should e cut off with scissors (Fig. 260) and should be then rounded off

IG. 260.—Snipping off the fused point of the slender end (*a*) of the pipette with scissors. (Ashton.)

FIG. 261.—Rounding off the rough edges of the glass in the flame. (Ashton.)

nooth in the flame, so as to avoid producing any injury to the tissue 'ig. 261).

The pipette is then slowly passed through the flame so as to erilize the entire outer surface of the tube (Fig. 262). When the

FIG. 262.—Sterilizing the outer surface of the slender end (*a*) of the pipette. (Ashton.)

FIG. 263.—Hermetically sealing the secretions in the bulbous portion of the pipette by fusing it in the flame at *a* and *c*. (Ashton.)

tube has cooled, the rubber nipple or tubing is placed upon the large end, and the small end is inserted in the discharge or secretion, which is then drawn up into the pipette by suction. The suction bulb is then removed, and the small end of the pipette is sealed by melting it in the flame. The constricted portion is likewise melted in the flame, and the portion of the pipette containing the cotton wool is removed, and the remaining end of the pipette is sealed (Fig. 263). In this way the discharge is hermetically sealed in small glass tubes (Fig. 264) and can be sent to any distance for later bacteriological examination. Each tube as it is prepared should be carefully labeled with a distinguishing number.

FIG. 264.—Showing the bulbous portion of the pipette sealed and containing the secretion. (Ashton.)

From an Abscess Cavity.—Care must be taken that no antiseptic irrigating fluid is used before the discharge is secured. A specimen should be obtained free from blood, if possible. To avoid contamination, the first portion of the pus should be allowed to

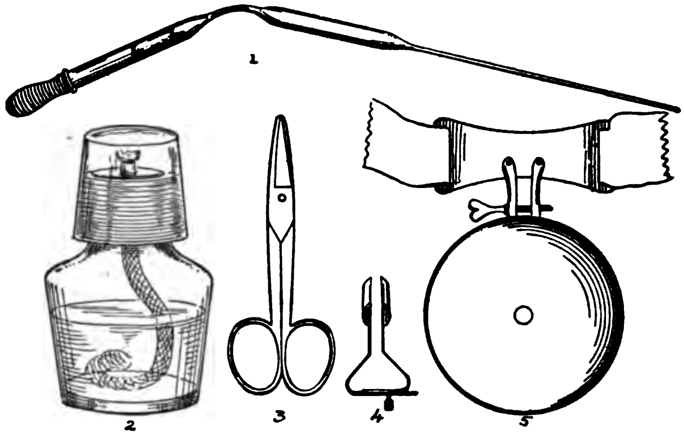


FIG. 265.—Instruments for obtaining secretions from the nose for bacteriological examination. 1, Sterile angular pipette; 2, alcohol lamp; 3, scissors; 4, nasal speculum; 5, head mirror.

escape; the edges of the incision are then separated while the pipette is inserted into the cavity, and a specimen is withdrawn from its depths.

From Serous Cavities.—The method of obtaining fluid from serous cavities is described under exploratory punctures (Chapter XII).

From the Nose and Accessory Sinuses. Equipment.—An angular pipette will be required, as well as an alcohol lamp, scissors, a ıl speculum, suitable illumination, and a head mirror (Fig. 265). The angular pipette may be made by taking a straight pipette ı a long capillary tube, heating the latter at a distance of about ches (7.5 cm.) from its extremity and, when soft, bending it to ıngle of 135 degrees. The end should be well smoothed off in a e before using.

Technic.—The same general principles as outlined above are wed. The patient is seated as for an anterior rhinoscopic examion (page 366), the nasal speculum is introduced, and the light is

266.—Method of sucking secretion into a pipette from the female urethra. (Ashton.)

cted so that the interior of the nose can be clearly observed. tip of the pipette is then inserted until it comes in contact with discharge, care being taken not to have it touch the mucous memne or the vibrissæ about the vestibule. The point of the instrut is moved about in the secretion while suction is exerted and e of the discharge will thus be withdrawn. The pipette is then oved, sealed, and properly labeled.

From the Eyes.—The technic is not different from that already cribed for collecting discharges from other regions, and no special ms of pipettes are necessary. Any preliminary cleansing of the s should, course, be avoided.

From the Urethra. Equipment.—Pipettes and the other apatus necessary for collecting discharges (see Fig. 254) will be uired.

Technic.—The urine should not be voided for several hours prior to obtaining the specimen. The urinary meatus is first exposed, and, after the end of the pipette has been inserted into the canal, the secretion is sucked into the pipette (Fig. 266). When the discharge is scanty, sufficient may be obtained by expressing the pus from the posterior portion of the urethra by drawing the finger along the urethra from behind forward. In the female the same method may be employed with the index finger in the vagina (see Fig. 244). When a specimen has been obtained, the ends of the pipette are sealed and the tube is properly labeled.

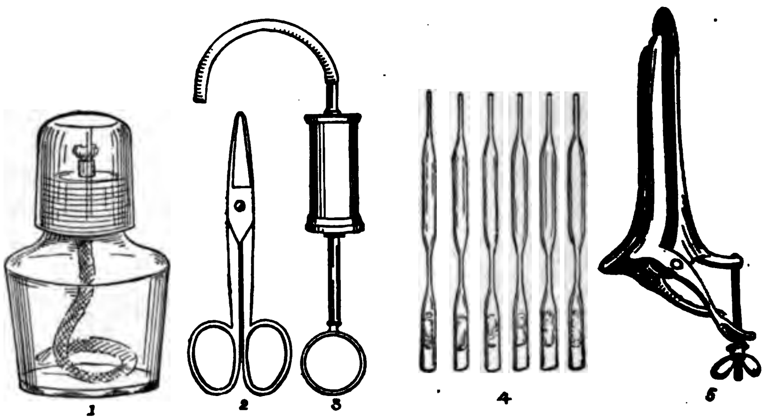


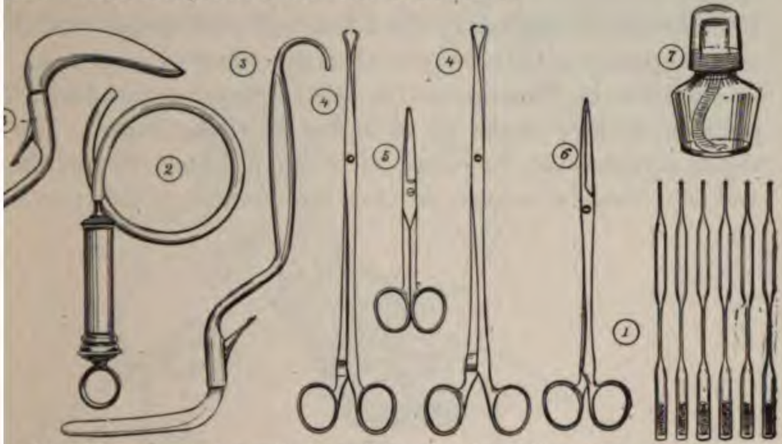
FIG. 267.—Instruments for obtaining secretions from the vagina for bacteriological examination. 1, Alcohol lamp; 2, scissors; 3, suction syringe; 4, sterile pipettes; 5, vaginal speculum.

From the Vagina. Equipment.—Pipettes, a suction syringe and rubber tubing, scissors, an alcohol lamp, and a vaginal speculum (Fig. 267) will be required.

Technic.—The labia are separated and the speculum is introduced into the vagina, so that the posterior cul-de-sac is exposed to view. The distal end of the pipette is then carefully introduced into the discharge, and sufficient secretion for the purposes of the examination is withdrawn by means of suction. The pipette is then removed, both ends are sealed, and the specimen is properly labeled.

From the Uterus. Equipment.—Pipettes, a suction syringe and rubber tubing, scissors, an alcohol lamp, vaginal specula, two tenacula, and sponge holders (Fig. 268) will be required.

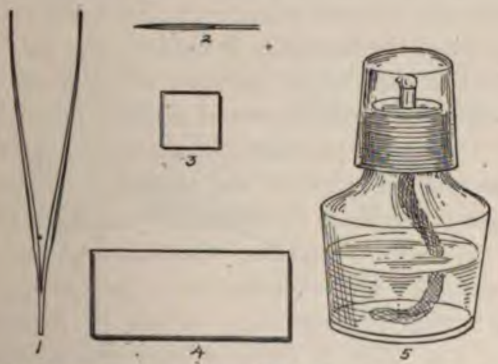
Technic.—The speculum is introduced into the vagina and the cervix is well exposed to view. Any vaginal secretions are removed by means of sponges on holders, tenacula are inserted in the anterior osterior lips of the cervix, and the latter is drawn well down, ipette is then inserted into the cervical canal, care being taken push it into the uterus, and the secretion is sucked into it. hen withdrawn, and both ends are sealed.



. 268.—Instruments for collecting discharges from the uterus for bacterio-examination. (Ashton.) 1, Pipettes; 2, suction syringe; 3, Simon's speculum; cula; 5, scissors; 6, sponge holder; 7, alcohol lamp.

COLLECTION OF BLOOD FOR MICROSCOPICAL EXAMINATION

ood may be examined microscopically either from a fresh nen or from a dried smear. The former procedure is suitable



. 269.—Instruments for collecting blood for microscopical examination. 1, forceps; 2, spear-pointed needle; 3, cover-glasses; 4, glass slides; 5, alcohol lamp.

when the blood can be examined promptly—say within half an A smear is made when the morphology of the cellular ele- is to be studied after being properly stained.

Equipment.—Slides, cover-glasses, an alcohol lamp, thumb forceps, and a spear-pointed needle or a lancet (Fig. 269) are necessary. The cover-glasses and slides should be of the best material. The former should be very thin and about 7/8 inch (22 mm.) square. Both should be absolutely clean and free from grease; the cleansing may be performed after the method described on page 279.

Location of Puncture.—The blood may be withdrawn from a prick in the lobe of the ear or in the tip of the finger. The former region is preferable, however, as it is not so sensitive as the finger, and it is usually cleaner, so that the chances of infection are less.

FIG. 270.—Making a fresh blood smear. First step, puncturing the ear.

Furthermore, when the puncture is made in the ear, the operation is removed from the view of the patient, which is an important consideration in the case of childern and nervous individuals.

Asepsis.—The site of puncture should be cleaned by first rubbing it with a wipe wet with alcohol, and then drying it with ether. The needle or lancet is sterilized by boiling or passing it through a flame.

Technic. 1. *Fresh Specimen.*—Care should be taken to avoid chilling the specimen and exposing it to the air any longer than is necessary; accordingly, everything should be in readiness for the examination. The slide is warmed over the alcohol lamp or by vigorously rubbing it with a piece of linen, and is then laid on a sterile towel. The cover-glass is likewise warmed and placed near at hand. The lobe of the ear is grasped between the thumb and forefinger of the left hand and with a quick stab the lowest portion of the lobe is punctured (Fig. 270). The blood should be allowed to flow *without pressure or rubbing*, as these maneuvers produce a hyperemia and the constituents of the blood may be changed in character or the blood cells may be deformed. The first drop is wiped away and a second drop is allowed to flow. The cover-glass is then taken up in the thumb forceps and is applied by its under surface to the

FIG. 271.—Making a fresh blood smear. Second step, collecting the drop on a cover-glass.

apex of the drop (Fig. 271), but is not allowed to touch the skin. The cover-glass is then gently lowered upon the warmed slide (Fig. 272) and the drop of blood is thus caused to spread out in a thin circular layer between the slide and the cover-glass. If the drop is not too large, the blood will not spread beyond the margins of the

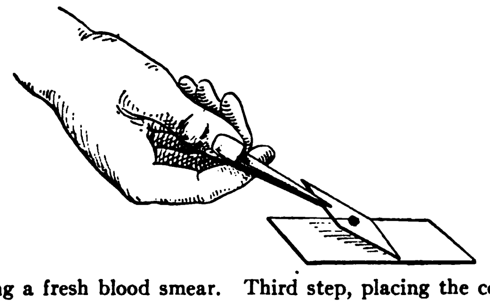


FIG. 272.—Making a fresh blood smear. Third step, placing the cover-glass holding the blood drop on a slide.

cover-glass. The cover-glass should not be pressed down upon the slide, as this will injure the corpuscles.

2. *Dried Specimen.*—A puncture is made in the lobe of the ear in the manner described above, and, after the first drop of blood has

been wiped away, the second drop is received upon a slide near on end. As quickly as possible the edge of another slide is dippe into the drop thus collected and is drawn along the surface of th first slide, spreading out the drop in a broad thin smear (Fig. 27 To be of any value the smear must be spread out evenly and thin

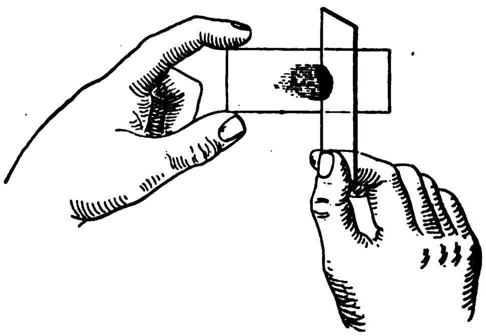


FIG. 273.—Method of making a dry blood smear with two slides.

A second method is to employ cover-glasses. Two cover-gla are thoroughly cleansed and are placed conveniently at hand. ear is punctured in the way described above (see Fig. 270), and first drop of blood is removed. One cover-glass is then held by

FIG. 274.—Making a dry blood smear with two cover-glasses. Second step, collecti the drop on a cover-glass.

sides between the thumb and forefinger of the right hand, while t second one is grasped by its sharp angles in the fingers of the l hand. The under surface of the first cover is then applied to the ap of the drop of blood (Fig. 274), and is quickly placed upon the seco glass, with the angles of the two not coinciding (Fig. 275), so that t drop spreads out by its own weight in a thin film between the two covers (Fig. 276). If too large a drop is taken, the upper cover will simply float around upon the lower. The upper cover is finally seized between the thumb and forefinger of the right hand and, still

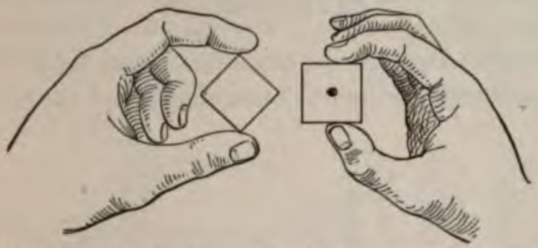


FIG. 275.—Making a dry blood smear with two cover-glasses. Third step, the method of holding the two cover-glasses preparatory to placing the one holding the drop upon the second one.

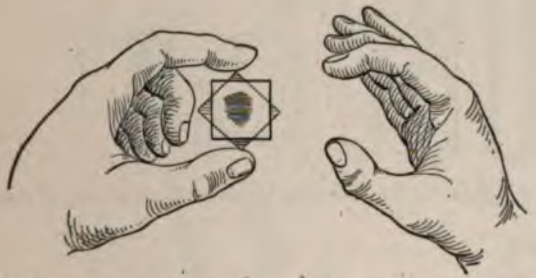


FIG. 276.—Making a dry blood smear with two cover-glasses. Fourth step, showing the two covers with their surfaces in contact and the drop of blood spread out in a thin layer between them.

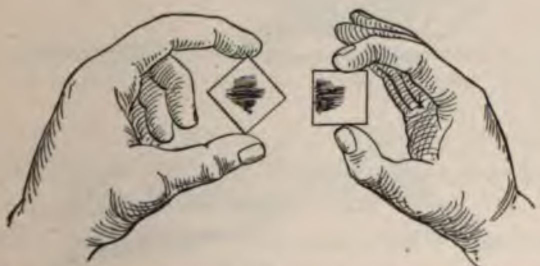


Fig. 277.—Making a dry blood smear with two cover-glasses. Fifth step, showing the method of drawing the two covers apart.

holding the lower cover in the left hand, the two covers are drawn apart in the same plane (Fig. 277). Unless too small a drop has been taken, this is readily accomplished. The films thus obtained are then allowed to dry, and later they may be fixed and properly stained.

It is always well to make three or four of these smears, as some of the films may be poorly spread, or may be broken in handling.

THE COLLECTION OF BLOOD FOR BACTERIOLOGICAL EXAMINATION

The best method of securing blood for culture is by a venous puncture. The ordinary method of obtaining blood through a prick of

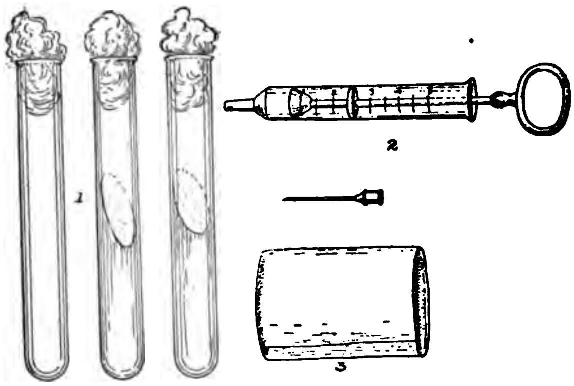


FIG. 278.—Apparatus for collecting blood for bacteriological examination.

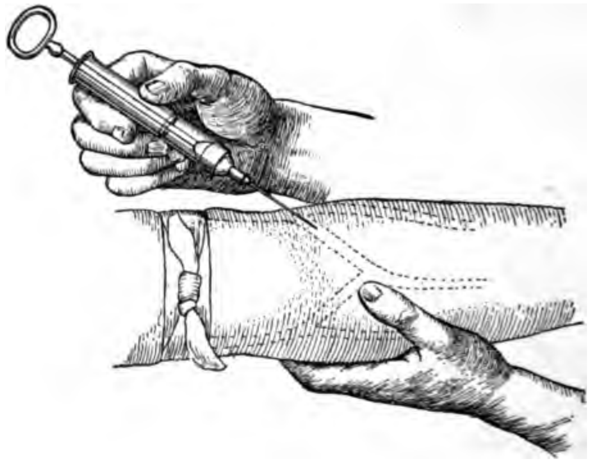


Fig. 279.—Showing the method of making a venous puncture.

the ear or of the finger is worthless for bacteriological purposes on account of the small amount of blood obtained and the chances of contamination, especially from the skin. If properly performed, a venous puncture is harmless and gives the patient but little discomfort.

Equipment.—A glass syringe with a capacity of 2½ drams (about 10 c.c.), a moderately large needle with a sharp point, broth and agar-agar culture tubes, and a bandage (Fig. 278) are necessary.

Site of Puncture.—The median cephalic or median basilic vein is usually chosen (see Fig. 127), but, if these are not available, the internal saphenous vein in the leg or any of the smaller veins about the wrist may be made use of.

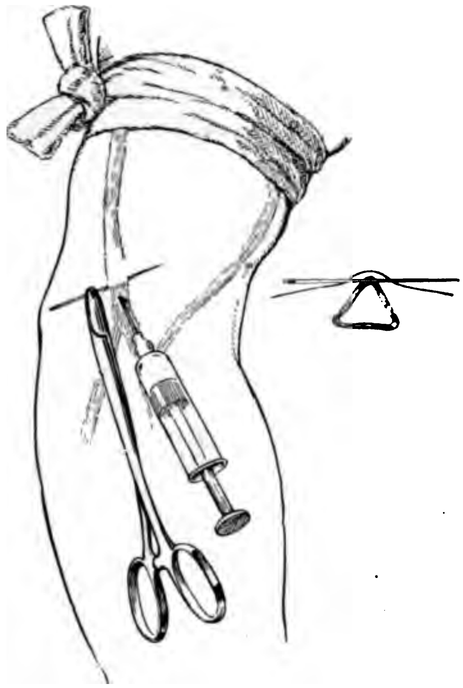


FIG. 280.—Method of transfixing wall of vein with sewing needle to steady it and enlarge its lumen to receive an aspirating needle. (Warbasse.)

Asepsis.—The skin at the site of puncture is painted with iodin, the hands of the operator are as carefully sterilized as for any operation, and the instruments are boiled.

Anesthesia.—In ordinary cases anesthesia is unnecessary. If it is necessary to expose the vein by an incision, as in the case of an individual with much fat or whose tissues are edematous, infiltration with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution is employed.

Technic.—A bandage is wound about the arm between the seat of puncture and the heart with sufficient tension to produce a slight venous stasis and cause the veins to stand out prominently, but with not enough compression to cut off the arterial flow. By gently forcing the blood along toward the seat of constriction by means of the forefinger or thumb, the vein may be made to stand out more prominently. In stout persons, however, it may be necessary to expose the vein by an incision.

The needle with the syringe attached is then passed obliquely through the skin into the vein (Fig. 279), and the blood is gently sucked into the syringe by slowly withdrawing the piston. If too great an amount of suction is exerted, the wall of the vein will be forcibly collapsed and will act as a valve against the further withdrawal of blood. About 1¼ drams (5 c.c.) of blood may be taken from a child, and about 2½ drams (10 c.c.) from an adult. The needle is then withdrawn, the constriction being first removed from the arm to avoid subcutaneous hemorrhage from the punctured vein. Moderate pressure should be made over the site of puncture by a piece of gauze held in place by the patient or by an assistant while the culture tubes are being inoculated.

Watson (*Journal of the American Medical Association*, July 29, 1911) describes the following method as an aid in introducing the needle into the vein: A fine sewing needle is passed through the skin overlying the vein so as to transfix the anterior wall of the distended vein transversely to its long axis. This is then lifted forward, and the vein needle is introduced into the vein just behind the transfixion needle (Fig. 280).

During the inoculation of the tubes the greatest care should be taken to avoid contamination; the needle is removed from the syringe as it is very apt to be contaminated with staphylococci from the skin, no matter how carefully the sterilization may have been carried out, and the inoculation is made through the sterile end of the syringe. In doing this, the same technic described on page 287 should be followed. Inoculations are usually made with 16♏ (1 c.c.) of blood into definite quantities of media. At the completion of the operation the seat of puncture is sealed with collodion.

THE COLLECTION OF SPUTUM

Sputum should be collected in absolutely clean, wide-mouth, ounce (30 c.c.) glass bottles, provided with a water-tight cork (Fig. 281), so that there can be no leakage during transportation. Suitable bottles may be obtained from any laboratory or from most drug stores. The specimen should be obtained from the sputum coughed up early in the morning before any food has been taken, and it should be seen that the material *is coughed up* from the lungs and that it is not simply an accumulation from the mouth and pharynx. As an added precaution against contamination from particles of food, tobacco, vomitus, etc., the mouth and pharynx should first be thoroughly rinsed out. When there is not sufficient sputum from one collection, the whole amount for the day, or for twenty-four hours, should be preserved. The specimen thus collected should be sent to the laboratory promptly, that it may be examined in as fresh a condition as possible.

Fig. 281.—Sputum bottle.

In the case of infants and young children it may be next to impossible to obtain sputum in the ordinary way. A method sometimes employed is to pass a stomach tube into the esophagus and then examine the mucus found adhering to the tube upon its withdrawal. Holt advises (*Archives of Internal Medicine*, May 15, 1910) the following method: The child is made to cough by irritating the pharynx with a bit of gauze or cotton held in the jaws of an artery clamp, and any secretion which is brought into view is then secured on this swab.

Fig. 282.—Chapin's urine collector.

THE COLLECTION OF URINE

When a simple chemical examination of urine is called for, it is only necessary to collect the specimen in some perfectly clean receptacle, the first portion as it comes from the meatus being received in another vessel and then rejected; but if a culture is to be made, the urine must be obtained by catheter under rigid asepsis. The catheter must be boiled and the hands of the operator must be sterilized as for any operation. The meatus and surrounding parts are then washed with an antiseptic solution, and the catheter is gently inserted into the bladder without touching the adjacent parts (see also page 741). The first portion of the urine is to be discarded, and then from 1¼ to 2½ drams (about 5 to 10 c.c.) are collected in a sterile test-tube, which is immediately plugged.

When it is desired to obtain a separate specimen from each kidney, the ureters may be catheterized (see page 759) or a urinary separator may be employed (see page 775).

To obtain a twenty-four-hour specimen, as, for example, when it is desired to determine the total daily amount of urine secreted or to estimate the total solids, it is necessary to begin and end with an empty bladder. The patient is therefore instructed to empty the bladder at a certain hour and to discard this specimen. All the urine passed for the following twenty-four hours, including that voided at the end of this period, is saved in a large clean bottle. For cases of incontinence, a retained catheter must be used (see page 743). or else a rubber urinal devised for such cases may be employed.

When considerable time must elapse before a specimen can be examined, some preservative, such as boric acid in the proportion of 1 grain (0.065 gm.) to each ounce (30 c.c.), formalin in the proportion of 1 drop to each 4 ounces (120 c.c.), or a few drops of chloroform to each 4 ounces (120 c.c.) may be added to the specimen. If cultures or inoculations are to be made, preservatives should be avoided.

In the case of infants there are several methods for collecting urine. With male infants, for an ordinary examination, the specimen may be collected by means of a condom which is secured to the body by adhesive plaster, and into which the penis and scrotum are passed, or a bottle may be employed, in the neck of which the penis is placed. Chapin has devised a urine collector (Fig. 282) that may be employed for both males and females. A method sometimes employed with females is to place absorbent cotton over the vulva, and after the child has saturated the cotton, to express the urine into a bottle; or the child may simply be placed upon a rubber sheet from which the urine is collected as often as it is voided. If it is necessary to obtain an uncontaminated specimen, catheterization must be resorted to, employing a small catheter (9 to 11 French).

THE COLLECTION OF GASTRIC CONTENTS

For a microscopical examination of the stomach contents a test meal is not necessary, the vomitus or a portion removed by the stomach tube (see page 529) being all that is required. The specimen should be received in a clean glass receptacle.

For a complete chemical examination and to test the condition of the stomach, the gastric contents an hour after a test-meal will be required (see page 527).

THE COLLECTION OF FECES

Ordinarily a small amount should be received in a sterilized wide-mouth glass jar and the examination made as soon as possible.

When examining for the ameba, it becomes necessary to collect the stools in a clean *warm* receptacle and to make the examination immediately upon a warmed slide, or else to provide some means for keeping the specimen warm until the examination can be conveniently made.

THE REMOVAL OF A FRAGMENT OF SOLID TISSUE FOR EXAMINATION

The excision of pieces of tissue for microscopical examination may be required in cases where it seems probable that a tumor is

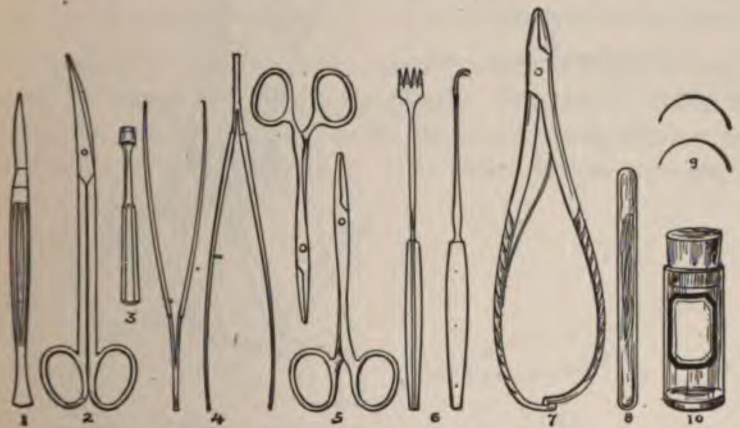


FIG. 283.—Instruments for excising a fragment of solid tissue for examination. 1, Scalpel; 2, curved sharp-pointed scissors; 3, skin punch; 4, thumb forceps; 5, artery clamps; 6, retractors; 7, needle holder; 8, No. 2 catgut; 9, curved cutting-edge needles; 10, specimen bottle.

malignant but where the clinical signs and symptoms are not pronounced enough to make a positive diagnosis. The information thus obtained is especially valuable in growths of recent development, as in these the evidence of malignancy is often not apparent from a gross examination.

Instruments.—In ordinaly cases there will be required: a scalpel, scissors, a cutaneous punch, artery clamps, plain thumb forceps, mouse-toothed forceps, small sharp retractors, a needle holder, No. 2 catgut sutures, curved needles with cutting-edges, and a wide-mouth clean bottle provided with a water-tight cork and containing a 4 per cent. aqueous solution of formalin (Fig. 283).

For regions which are not readily accessible, as, for example, the female genitals, volsellum forceps and suitable specula are necessary.

For collecting material from the interior of the uterus, curettage instruments, etc., will be required (see page 868).

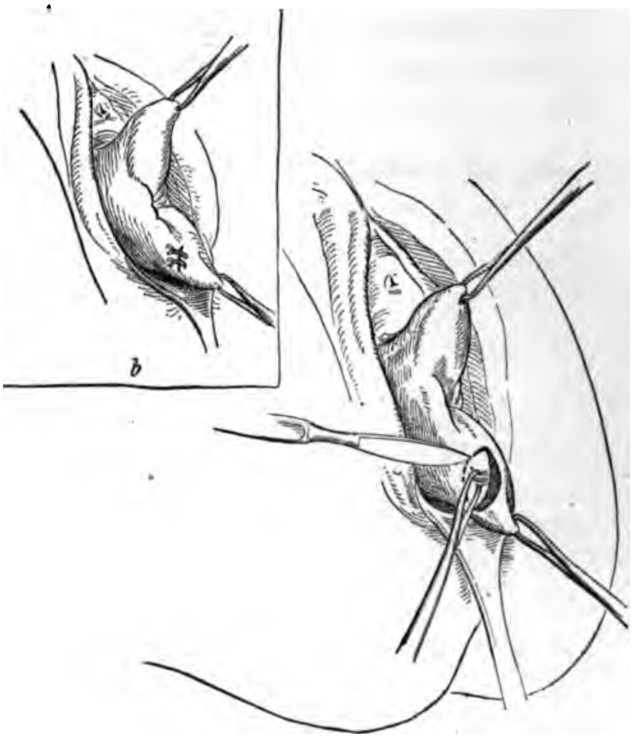


FIG. 284.—Excision of a piece of tissue from the cervix. (Ashton.)

Asepsis.—The instruments are boiled, the hands of the operator are sterilized, and the site of operation is cleaned as for any operation.

Anesthesia.—As a rule, local anesthesia by infiltration with a 0.2 per cent. solution of cocain or 1 per cent. solution of procain in normal salt solution is sufficient. For skin tumors, freezing with ethyl chlorid usually suffices.

Technic.—The line of proposed incision is first anesthetized. Then, with the tissues well retracted so as to expose the growth, a wedge-shaped piece of tissue is removed by means of a scalpel from the portion of the growth where the pathological changes are most marked or the tumor is nodular (Fig. 284). The tissue is then transferred to the bottle containing the 4 per cent. formalin solution, and a proper label is applied. Any hemorrhage is controlled, the incision is closed, and a sterile dressing is finally applied.

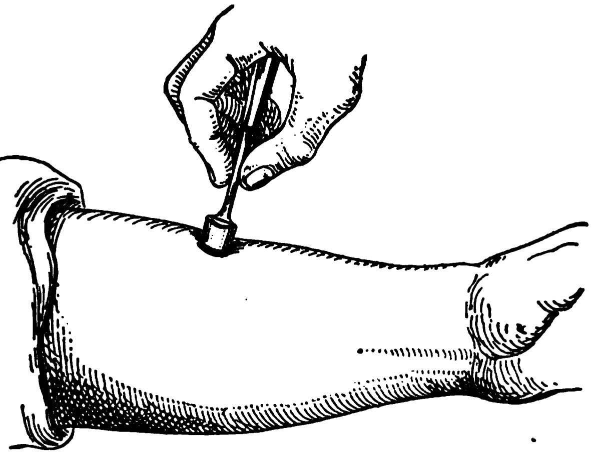


FIG. 285.—Removal of a fragment of a superficial growth with a skin punch.

A fragment of a very superficial tumor or of a skin growth may be removed by means of a punch if desired. The skin is frozen with ethyl chlorid, and by a rotary motion the punch is made to cut out a circular piece of tissue (Fig. 285). The punch is then removed and

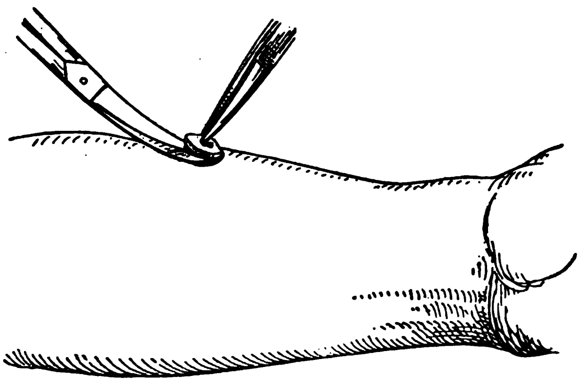


FIG. 286.—Removal of a fragment of a superficial growth with a skin punch. Second step, cutting loose the base of the section.

the circular core is seized in thumb forceps and is freed from its base by cutting with a pair of curved scissors (Fig. 286). The punch may be employed in the same way, if desired, for removal of deeper seated growths after first exposing the tumor by an incision.

When tissue is removed by curettage for examination, the uterus should be scraped systematically, and, as soon as collected, the fragments thus obtained should be placed in a bottle containing the preserving fluid. The bottle is then carefully labeled. Care should be taken to avoid rough handling of the tissues and to preserve for examination all the fragments removed. For the technic of curettage see page 870.

CHAPTER XII

EXPLORATORY PUNCTURES

An exploratory puncture consists in the introduction of a hollow ·edle attached to an aspirating syringe into a diseased region, and a ·sequent aspiration. This comparatively simple operation may performed for the purpose of determining the presence or absence fluid in any particular area, or to obtain a specimen of fluid for : purpose of determining its character by subsequent examination. addition, exploratory punctures are made prior to therapeutic ıctures to determine the exact location of the fluid to be evacuated. deeply seated processes, as suppuration and fluctuating tumors, ccessible to other means of diagnosis, this method of exploration en gives most valuable information. The liver, the lungs, the ural and pericardial cavities, the spinal canal, and other organs l regions difficult of access may thus be tapped and explored with nparative safety.

When fluid is detected, a quantity sufficient for examination uld be withdrawn. Frequently by a gross examination of the d sufficient information may be obtained as to its character. th the naked eye, one can often make a diagnosis between a serous, ody, or purulent fluid, by carefully noting the color, clearness, and sistency of the material withdrawn. Valuable information can ·wise be obtained from the odor.

For more definite and exact information, a chemical, microscopi- , and bacteriological examination will be necessary. In prepara- ı for such an examination a few drops of the liquid should be ·cted into culture tubes, and the remainder placed in a sterilized t-tube, previously provided, and kept in readiness for this purpose. times the aspirated fluid may be so thick that only a few flakes or ·cules of purulent matter can be obtained. Such material, or any gments of tissue adhering to the needle point should be carefully ınsferred to a glass slide for later microscopical examination. ven specimens from solid growths large enough for microscopical amination may at times be obtained by rotating the needle and oving it back and forth sufficiently to detach a small fragment, hich may then be secured by producing a strong vacuum in the ringe and very carefully withdrawing the needle.

The laboratory examination of the fluid, the technic of which ma be found fully described in manuals on clinical laboratory method should be made along the following lines and with reference to tl special points mentioned.

1. *Physical Characteristics.*—The color, odor, clearness, consis ency, reaction, coagulability, and specific gravity of the fluid, ar the character of the sediment should be noted.

2. *Chemical examination* should include tests for albumin, seru globulin, sugar, bile, urea, blood, pus, etc.

3. *Microscopical examination* is made for the purpose of detecti the presence of blood-corpuscles, epithelial cells, hematoidin a cholesterin crystals, specific tumor cells or fragments, necrotic tiss ameba, hydatid hooklets, ray fungi, etc.

4. *Bacteriological Examination.*—Smear preparations are ma and examined for pathogenic bacteria, while organisms susceptil of culture are inoculated upon suitable media and later examin microscopically. Thus organisms may be indentified which are r readily detected by direct examination.

5. *Cytodiagnosis.*—By this is understood the determination the cause of an effusion from the relative number and the charac of its cellular constituents.

EXPLORATORY PUNCTURE OF THE PLEURA

This is a safe and simple operation employed to confirm t diagnosis of a pleural effusion or to as certain the nature of the flu The danger of injuring the lung and producing a pneumothorax ne not be considered if reasonable care be observed in performing t puncture.

Apparatus.—Aspirating needles and a syringe of appropriate s should be provided. It will be found convenient to have an asso ment of needles of different lengths and diameters. They shou measure in length 2½ inches (6.5 cm.), 3 inches (7.5 cm.), 3 inches (9 cm.), and 4 inches (10 cm.); and in diameter 1/50 inch (mm.), 1/25 inch (1 mm.), 1/18 inch (1.5mm.), and 1/12 inch mm.). For ordinary use the needle should be at least 3 inches (cm.) long and about 1/25 inch (1 mm.) in diameter, so that it readily give passage to fluids of heavy consistency.

It is preferable to have a syringe with a capacity of from 1 t drams (4 to 8 c.c.), though an ordinary hypodermic syringe may employed if the large needles are made to fit. The syringe should capable of exerting a strong suction, and the joint between it and the needle should be absolutely air-tight. The best form of syringe consists of a solid glass barrel and a tight-fitting piston provided with an asbestos or rubber packing (Fig. 287). Such a syringe is simple in mechanism, easy to clean, and can be readily sterilized by boiling. If confirmation of the diagnosis of fluid is to be immediately followed

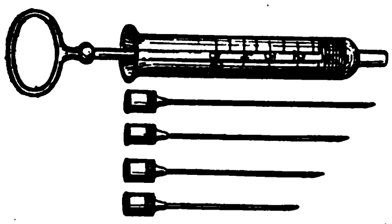


FIG. 287.—Aspirating syringe and needles.

by its evacuation, the aspirating apparatus of Potain or Dieulafoy (see page 340) may be used for the exploration, thus sparing the patient a subseqeunt operation.

In addition there should be provided a scalpel and a cocain syringe or tube of ethyl chlorid for anesthetizing the point of puncture.

Before making a puncture the syringe should always be tested by withdrawing the piston with the finger held over the end, to see if

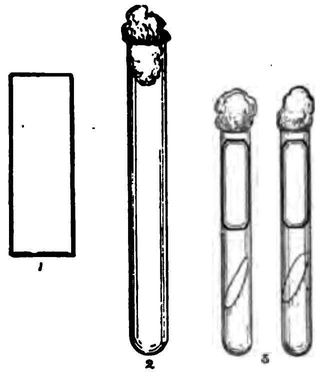


FIG. 288.—Apparatus for making smears and cultures from fluids removed by exploratory puncture. 1, Glass slides; 2, sterile test-tube; 3, culture tubes.

it will exert proper suction. The syringe should likewise be tested with the needle fitted in place. After use, the syringe should be taken apart, and both it and the needle should be thoroughly cleansed. To guard against rusting, the lumen of the needle should be cleansed with alcohol and ether and a wire of suitable size inserted.

In cases where a complete chemical, microscopical, and bacteriological examination is desired, sterilized test-tubes for collecting and transporting the material aspirated, glass slides, and agar-agar culture tubes (Fig. 288) should be at hand.

Location of the Puncture.—No fixed rule can be laid down, the point chosen for the puncture depending upon the physical examination. The needle should enter a spot where there is dullness and an absence of respiratory sounds, voice, and fremitus, and, at the same time, the point of puncture should lie well below the upper level of the effusion. If it is made too high, the point of the needle may

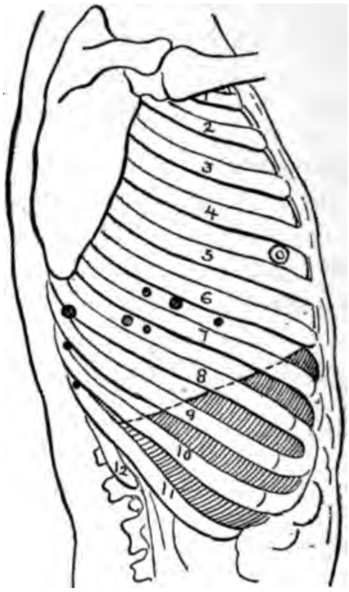


FIG. 289.—Showing the points for inserting the needle in exploratory puncture of the pleura. (Large dots represent points of election.)

lacerate the lung; or, if too low, injury to the diaphragm, liver, or spleen may result. As general thing, entrance of the needle in the sixth interspace in the anterior axillary line, in the sixth or seventh interspace in the midaxillary line, or the eighth interspace below the angle of the scapula will reveal the presence of fluid if such exists (Fig. 289).

Position of the Patient.—If too weak to sit upright, the patient may lie semirecumbent for a lateral puncture, and for a posterior puncture in a lateral prone position, with the body curved forward and the arm of the affected side elevated (Fig. 290). In uncomplicated cases, an upright sitting posture should be assumed, with the of the affected side elevated for the purpose of widening the rcostal spaces (Fig. 291).

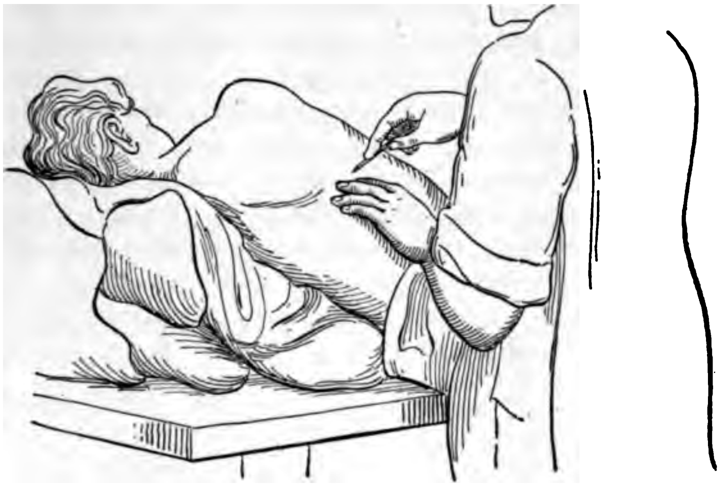


FIG. 290.—Lateral position for exploratory puncture of the pleura.

IG. 291.—Exploratory puncture of the pleura with the patient sitting upright.

Asepsis.—The strictest regard to asepsis must be observed in making any exploratory puncture, otherwise there is great risk of inion and of converting a simple serous exudate into a purulent one.

The site chosen for the puncture should be well painted with ture of iodin. The operator's hands should also be thoro scrubbed, followed by immersion in an antiseptic solution. needles, syringes, and other instruments employed are ste by boiling.

Anesthesia.—Local anesthesia by freezing with ethyl chlc salt and ice, or infiltrating with a 0.2 per cent. solution of or a 1 per cent. solution of procain, will be all that is require employing cold as an anesthetic, if the patient is poorly nou or the skin is edematous, care should be taken not to freeze tl too thoroughly, on account of the danger of local necrosis.

Technic.—To avoid injury to the upper intercostal arte needle is inserted near the upper margin of the rib which fon

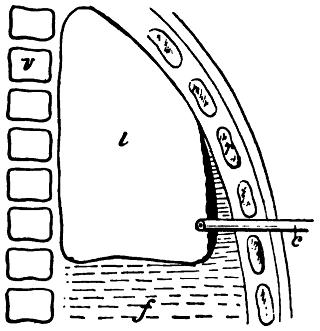


Fig. 292.

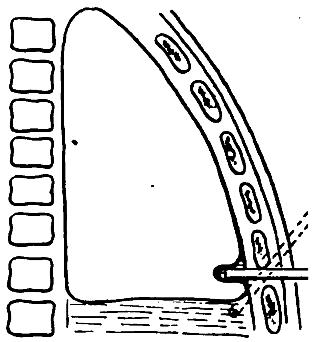


Fig. 293.

Fig. 292.—Showing the failure to withdraw fluid from the needle being : too far. (After Gumprecht.)

Fig. 293.—Showing the failure to withdraw fluid from the needle ente pleura at too high a level. (After Gumprecht.)

lower boundary of the space chosen for the puncture. The p puncture is anesthetized and a small nick is made in the The thumb and forefinger of the left hand steady the tissues, the needle is slowly and steadily inserted upward and inward its point enters the pleural sac. From 1 to 1 ½ inches (2. cm.) under ordinary conditions, and more in fat subjects or ir with very thick pleura, may be estimated as the thickness thoracic wall through which the needle will have to pass bef tering the pleural cavity. The lack of resistance and the m of the needle will demonstrate its entrance into a cavity.

If fluid is not immediately obtained, the direction of the may be changed slightly, or it may be entirely withdrawn and ir in other locations before the attempt is abandoned. Failure to withdraw fluid may be due to the needle entering the lung (Fig. 293) or to the fluid being encapsulated in a space not entered by the aspirating needle. Again, the point of the needle may become buried in adhesions or a thickened pleura (Fig. 294), or its caliber may become blocked by coagulated material. In addition to determining the presence of fluid, any unusual thickness or density of the pleura may be appreciated by the operator through the amount of resistance offered to the entrance of the needle. Upon completion of the aspiration, the needle is quickly withdrawn, and the site of the puncture is closed with collodion and cotton.

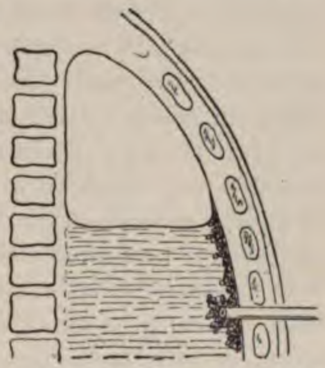


FIG. 294.—Showing the failure to withdraw fluid from the point of the needle becoming imbedded in a thickened pleura. (After Gumprecht.)

EXPLORATORY PUNCTURE OF THE LUNG

Previous to undertaking any operative procedure upon a pulmonary cavity, such as a tubercular, bronchiectatic, echinococcic, or abscess cavity, an exploratory puncture will be of great service, not only as an aid to a physical examination in detecting such a cavity, but likewise in determining its size and exact location, and its character by an examination of the fluid withdrawn.

There is considerable risk of infecting the pleura or of producing a cellulitis if aspiration of a pulmonary cavity without immediate drainage be performed, hence the exploratory puncture should only be performed on the operating-table with the patient ready to be anesthetized, and with all preparations to incise and drain the cavity completed beforehand, in case pus is obtained.

Apparatus.—Exploring needles and a glass aspirating syringe, a scalpel, ethyl chlorid or a cocain syringe, test tubes, and culture tubes will be required (see page 312).

Location of the Puncture.—This will depend entirely upon the approximate situation of the cavity, as determined by the physical signs.

Asepsis.—The instruments should be boiled, the operator's hands sterilized as for any operation, and the site of puncture painted with iodin.

Anesthesia.—Infiltration of the site of puncture with a 0.2 p cent. solution of cocain or a 1 per cent. procain solution, or freezi by means of ethyl chlorid or salt and ice will be sufficient.

Technic.—A fair-sized aspirating needle, at least 4 inches (10 cm long, will be required. The point of puncture is anesthetized a the skin is nicked with the point of a scalpel. Then, while the patie holds the breath to limit movement of the lungs, the needle is i serted in the direction of the supposed cavity, close to the upp margin of the rib, in the same manner as already described for e ploratory puncture of the pleura (page 316). As the needle is slow advanced, attempts to withdraw fluid are made at successive deptl The abscess may be superficial, and even adherent to the chest w where it can be easily reached, but more often it will be necessary insert the needle a distance of 3 to 4 inches (7.5 to 10 cm.) before t cavity is entered. Failing to withdraw pus, the needle should removed and reinserted at another spot. It may even be necessa to make a number of punctures before being successful, as the loca zation of a pulmonary cavity is at times a most difficult matt When a needle enters a cavity, some idea of its size may be obtain from the range of motion of the needle and from the quantity secretion withdrawn, though, if there has been considerable expe toration previous to the puncture, little or no fluid will be obtaine even though the needle enter a cavity.

When pus is obtained, the needle should be left in place as guide for the incision and drainage, and, while the patient is bei anesthetized, great care should be taken to see that the needle is n displaced.

EXPLORATORY PUNCTURE OF THE PERICARDIUM

An exploratory puncture may be required as a means of makin positive diagnosis of the presence of fluid within the pericardium for the purpose of choosing a route through which such fluid may reached and evacuated. Puncture of the pericardium should not undertaken lightly, and the dangers of injuring the internal ma mary vessels or pleura, or of puncturing the thin-walled auricles the heart, should impress upon the operator the necessity of extre care when performing this operation.

Apparatus.—A fine exploring needle and a glass aspirating syrin a scalpel, ethyl chlorid or a cocain syringe, test-tubes, and cult tubes will be required (see page 312).

Location of the Puncture.—To eliminate as far as possible the dangers of the operation, special sites for puncture have been recommended, as follows: (1) In the fourth or fifth interspace, either close to the sternal margin or 1 inch (2.5 cm.) to the left of it. Either of these points will avoid the internal mammary artery and veins which run vertically downward ½ inch (1 cm.) from the sternal margin. (2) In the fifth intercostal space, close to the right of the sternum. It is claimed that from this point it is impossible to injure the heart, but this avenue of approach is only suitable when the amount of fluid is large. (3) Inserting the needle directly upward

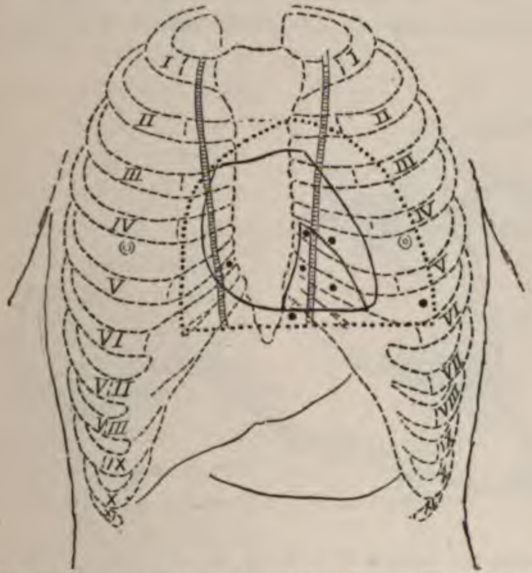


FIG. 295.—Points for puncturing the pericardium. The dotted line indicates a distended pericardial sac. The course of the internal mammary vessels is also shown.

and backward close to the costal margin in the space between the ensiform cartilage and the seventh costal cartilage on the left side. (4) When it is possible to outline accurately the shape of the pericardium and locate the position of the apex beat by means of pulsation or friction rubs, the method recommended by Curschman, Romberg, Kussmaul, and others, may be employed. The puncture is made in the fifth or sixth left interspace outside the nipple line between the apex beat and the outer limit of dullness (Fig. 295).

The selection of one of these sites over the others will be made according to the degree of distention of the pericardium and its shape, which is determined by outlining the area of dullness.

Asepsis.—All aseptic precautions must be observed. The instruments are boiled and the hands of the operator are prepared as for any operation. If the patient be a male, the chest should be shaved, and, in any case, the skin must be sterilized by painting with tincture of iodin before making the puncture.

Anesthesia.—Infiltration cocain or procain anesthesia or freezing with ethyl chlorid will suffice.

Position of the Patient.—The operation may be performed with the patient semirecumbent or in the upright sitting posture.

Technic.—The area of dullness is accurately mapped out and the point for puncture thereby determined upon. This point is anesthetized and a small nick is made in the skin. The thumb of the left

FIG. 296.—Showing the method of inserting the needle in an exploratory puncture of the pericardium.

hand is placed as a guide upon the lower rib bounding the intercostal space selected, and the needle point is inserted just above the margin of the rib so as to avoid the upper intercostal artery (Fig. 296). The needle should be introduced slowly and with great care almost in the sagittal plane and directed slightly toward the median line. Entrance into the pericardial sac is recognized when resistance to the progress of the needle is no longer encountered, or when the heart is felt striking against the needle point. The needle should not be inserted a greater distance than 1 inch (2.5 cm.), and, if fluid is not reached at this depth from one location, the other points of entrance above mentioned may be employed. Should the fluid obtained be purulent in character, prompt incision and drainage is indicated.

When the purpose of the puncture is accomplished, the needle is slowly withdrawn, and the point of puncture is sealed with collodion and cotton.

EXPLORATORY PUNCTURE OF THE PERITONEAL CAVITY

Aspiration of small quantities of peritoneal fluid and examination of the specimen obtained may be required to determine the type of an effusion into the peritoneal cavity—whether it be serous, inflammatory, hemorrhagic, or chylous. Puncture of solid or fluctuating masses within the abdomen may likewise be performed as a diagnostic measure, but the dangers of producing serious complications through puncture of the intestine or other organs, or from leakage of fluid, especially if it be purulent, into the peritoneal cavity stamps it as an unsafe method except in those cases where the tumor is in close relation to the abdominal wall. When the presence of pus is suspected, it is not wise to perform an exploratory puncture unless everything is in readiness for an immediate operation. The comparative safety of an exploratory laparotomy and the fact that much more valuable information can be thus obtained renders this the operation of choice.

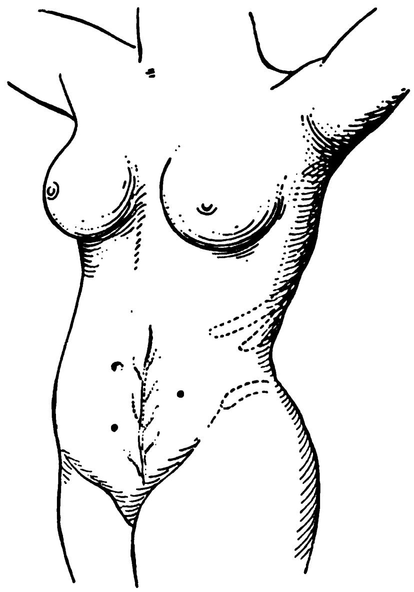


FIG. 297.—Points for puncture of the peritoneal cavity.

Apparatus.—A long exploring needle, a glass aspirating syringe, a scalpel, a cocain syringe, test-tubes, etc., should be provided (see page 312).

Asepsis.—The instruments and the hands of the operator are sterilized as for any operation.

Location of the Puncture.—For puncture of the peritoneal cavity, a point midway between the umbilicus and the pubes in the median line or a point at the junction of the outer and middle thirds of a line between the anterior superior spine and the navel should be chosen for the insertion of the needle. Both these sites will escape the deep epigastric artery (Fig. 297).

Position of the Patient.—The patient either sits upright, in order to allow the gravitation of the fluid to the lowest level, or he may be propped up in a semireclining position. For a lateral puncture the patient should lie upon his side.

Anesthesia.—Infiltration cocain or procain anesthesia or freezing with ethyl chlorid will suffice.

Technic.—The point chosen for the puncture is anesthetized, and a small nick is made in the skin. The needle is inserted directly backward until the resistance of the abdominal wall is no longer felt and the point of the needle moves freely within the abdominal cavity. Sufficient fluid is withdrawn for examination, and, after removal of the needle, the site of entrance is closed with a thin layer of collodion and cotton.

EXPLORATORY PUNCTURE OF THE LIVER

Exploration of the liver by means of an aspirating needle may be required for the purpose of making a positive diagnosis in cases of suspected amebic or pyogenic abscess, or hydatid cyst. Exploratory puncture should not be performed, however, unless the preparations for an immediate operation, if such be necessary, are completed beforehand, for no matter how small the puncture may be, leakage of fluid is liable to occur and cause serious damage.

Apparatus.—An exploring syringe, needles, a scalpel, test-tubes, etc., such as is required for any exploratory puncture (see page 312), should be provided.

Location of the Puncture.—This will depend upon the symptoms and physical signs in each individual case. If at any one point there be localized pain, tenderness on palpation, peritoneal crepitation, or distinct bulging, such spot should be chosen for the puncture. In the absence of signs pointing to localization, the fact that most liver abscesses are situated in the upper posterior portion of the right lobe should be borne in mind and the puncture made accordingly, the needle being inserted in the midaxillary line on the right side through the ninth, tenth, or eleventh interspace, or below the angle of the scapula through the tenth interspace (Fig. 298). Puncture may also be made anteriorly directly into the area of liver dullness below the line of the pleura.

Asepsis.—The operation is performed under all aseptic precau-s (see page 315).

Anesthesia.—The puncture may be made under local anesthesia, if it is likely that a number of punctures will be necessary and an ation is to be performed, it is better to give a general anesthetic he start.

Technic.—After making a small nick in the skin with a scalpel at site chosen for the puncture, the needle is slowly introduced ard and slightly upward to its extent, and suction is attempted. luid is not obtained, the needle is wly withdrawn, a vacuum being intained in the syringe in the mean-e, so as to withdraw pus in case point of the needle has previously sed through a cavity into healthy ue. Near the surface of the liver direction of the needle is altered, l it is inserted again in a different ne. In this manner a large area the liver may be explored in all ections from one external punc-e, provided care is exercised not to re the pleura and lung above, or gall-bladder and intestines below. needle should not be inserted to reater depth than 3¾ (9.5 cm.) hes from the surface of the body fear of injuring the inferior vena a. To avoid lacerating the liver, the exploring needle must be wed to move freely with the liver as it rises or descends during iration. If fluid is not immediately found, a number of punc-s should be made before the operation is abandoned. Failure draw pus into the syringe does not necessarily signify absence an abscess, for at times the material forming the abscess is so k that it will not pass into the needle, and only a drop or two of will be discovered on close examination, clinging to the needle nt.

FIG. 298.—Points for puncture of the liver.

Having located an abscess, the needle should be left *in situ* as a le, for it is not an uncommon experience, when pus is discovered by aspiration and the needle removed, to fail to locate the abscess at a subsequent operation.

EXPLORATORY PUNCTURE OF THE SPLEEN

As a diagnostic measure, puncture of the spleen may be performed without danger if the organ is hard, as is found in chronic malaria, but in infectious diseases with a large, soft, and friable spleen it is an unjustifiable procedure. Laceration of the capsule followed by hemorrhage, suppuration in the spleen, and peritonitis have been known to result. Likewise puncture of the spleen in suspected cases of typhoid fever is no longer warranted, since we have other methods of diagnosis, such as Widal's test, which are both safe and adequate. When fluctuation has been demonstrated, as in splenic abscess or hydatid disease, examination of the fluid obtained by aspiration may give conclusive information; but here again, as in exploratory punctures of the liver or lungs, preparations for incision and drainage, in case such should be necessary, should be completed before the puncture is made.

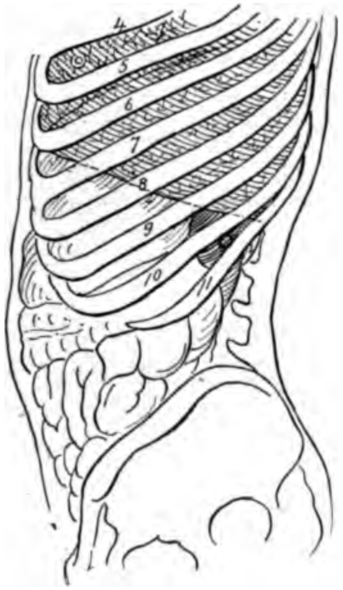


FIG. 299.—Point for puncturing the spleen.

Apparatus.—Exploring needles, an aspirating syringe, and other instruments necessary for any exploratory puncture (see page 312) should be provided.

Location of Puncture.—The spleen can be reached by inserting the needle through the tenth intercostal space in the midaxillary line on the left side (Fig. 299). If the organ is markedly enlarged, some point below the left costal margin, determined by percussion of the spleen, may be chosen.

Position of the Patient.—The patient may assume either the sitting posture with the left arm elevated and the hand on the opposite shoulder, or the recumbent position, depending upon which gives the most ready access to the region of operation.

Asepsis.—The same as for any exploratory puncture (see page 315).

Anesthesia.—Local infiltration anesthesia or freezing will suffice.

Technic.—A fine and fairly long aspirating needle should be employed. The patient is instructed to hold his breath, to lessen the danger of lacerating the organ, and the operator makes a small nick in the skin, quickly inserts the needle at the chosen site, and makes the aspiration with as little delay as possible. The needle is then withdrawn, and the site of puncture is closed with a thin covering of collodion and cotton.

EXPLORATORY PUNCTURE OF THE KIDNEYS

Exploratory aspiration may be employed to detect collections of pus or other fluids in the region of the kidney. An exploratory

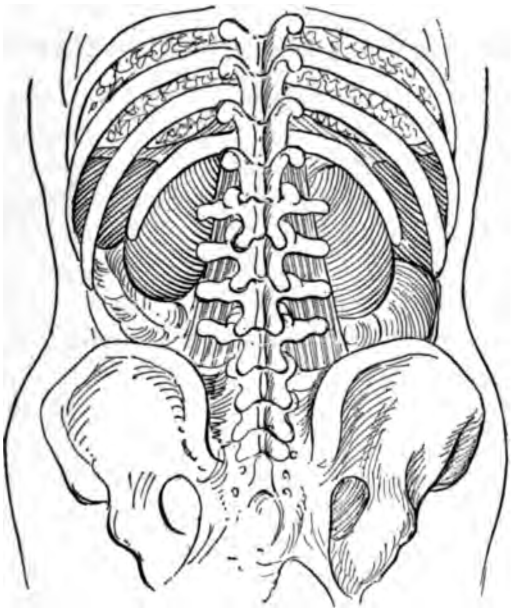


FIG. 300.—Showing the relations of the kidneys from behind.

incision, however, and subsequent aspiration after exposure of the mass is a far more satisfactory method of diagnosis.

Apparatus.—An aspirating syringe, exploring needles, and other apparatus necessary for making an exploratory puncture (see page 312) should be at hand.

Location of the Puncture.—The needle should be introduced at a point about 2 ½ inches (6 cm.) from the median line, to avoid the erector spinæ muscles, and a little below the last rib on the left side, and, on the right side, between the last rib and the crest of the ilium.

Position of Patient.—The patient may sit up, with the back bent forward; or he may lie partly upon the unaffected side and partly upon the abdomen, with the body bent forward in a curve.

Asepsis.—The usual aseptic precautions are to be observed (see page 315).

Anesthesia.—Local infiltration anesthesia or freezing will suffice.

Technic.—A long fine needle should be employed. After nicking the skin with a scalpel at the site chosen for the puncture, the needle is slowly introduced forward and slightly inward toward the median line, frequent tests at aspiration being made as the needle is advanced. When fluid is discovered, a sufficient quantity for diagnosis is withdrawn, and the site of puncture is sealed with a cotton and collodion dressing.

EXPLORATORY PUNCTURE OF JOINTS

This constitutes a most valuable aid in ascertaining the character of a joint effusion. Therapeutic puncture of joints for the purpose of injecting fluids in the treatment of tuberculous synovitis and acute infections involving joints is also becoming a frequent operation. Puncture of a joint is not difficult if the joint is distended with fluid. Care should be exercised not to insert the needle at a point where blood-vessels or important nerves would be encountered and to avoid producing any injury to the cartilage of the joint, lest serious complications result.

Apparatus.—Exploring needles, a glass aspirating syringe, a scalpel, a cocain syringe, etc., should be provided (see page 312).

Asepsis.—Puncture of a joint, as all exploratory punctures should be made under all aseptic precautions. The instruments are to be sterilized by boiling, the operator's hands are as carefully prepared as for any operation, and the site of puncture is painted with tincture of iodin.

Anesthesia.—Local infiltration anesthesia is employed.

Technic.—The skin over the site of puncture is infiltrated with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution and the deeper tissues down to the joint capsule are similarly anesthetized. A small nick is then made in the skin at the point chosen for insertion of the needle, and the needle is inserted into the joint in the same manner as for any exploration puncture.

The sites for puncture of those joints to which the method is most often applied are as follows:

The Shoulder-Joint.—Entrance to the joint best effected by introducing the needle from the side through the groove between the acromion process and the head of the humerus. The direction of the needle should be somewhat downward and backward (Fig. 301), if it is inserted straight in from the side it is apt to enter the subacromial bursa.

The Elbow-Joint.—Puncture of the joint may be made from behind or from the outer side.

To enter the joint behind, the forearm is flexed to an angle of 135 degrees, and the needle is inserted downward and forward behind the olecranon (Fig. 302).

To puncture the joint from the outer side, the arm is flexed and the radial head is identified by the finger as the forearm is rotated.

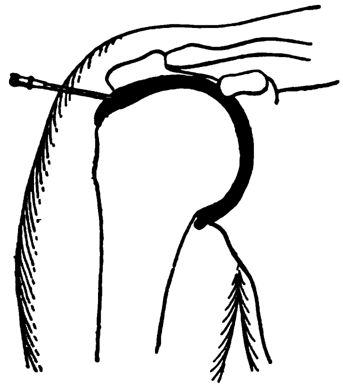


FIG. 301.—Point for puncturing the shoulder-joint.

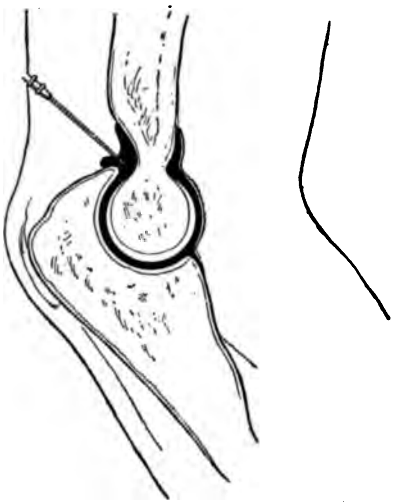


FIG. 302.—Point for puncturing the elbow-joint.

The needle is then inserted into the joint between the external condyle of the humerus and the head of the radius.

The Wrist-Joint.—The joint is best entered from the dorsal surface, inserting the needle near the radius between the tendons of the extensor indicis and the extensor longus pollicis at the level of a line joining the styloid process of the radius and that of the ulna.

The Hip-Joint.—The hip may be readily entered by the exploring needle from in front, at what is known as Büngner's point, or from the side.

Anterior puncture is performed as follows: A spot is chosen midway on a line joining the point at which the femoral artery emerges from under Poupart's ligament and the tip of the great trochanter (Fig. 303), and, with the femoral artery identified by the forefinger of the left hand to avoid injuring it, the needle is pushe directly back into the joint.

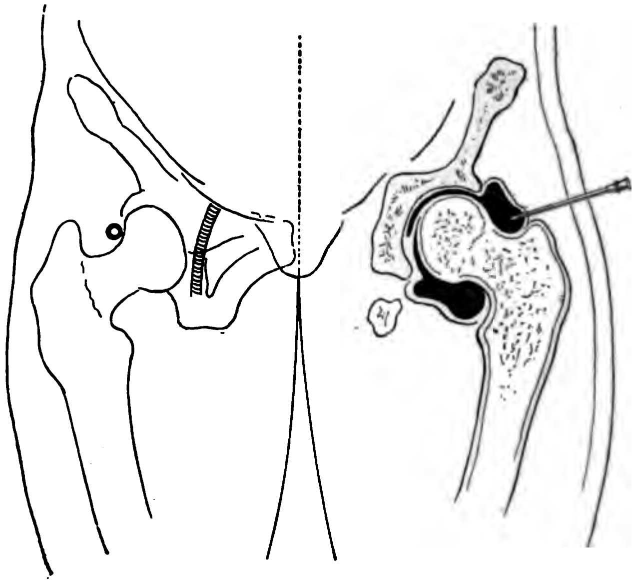


FIG. 303.—Points for puncturing the hip-joint (modified from Pels-Leusden).

For a lateral puncture the leg should be slightly adducted. T needle is then pushed into the joint toward the median line of t body from the side just above the great trochanter (see Fig. 303).

The Knee-Joint.—The needle may be inserted into either side the joint—but preferably in the outer side—beneath the patella at

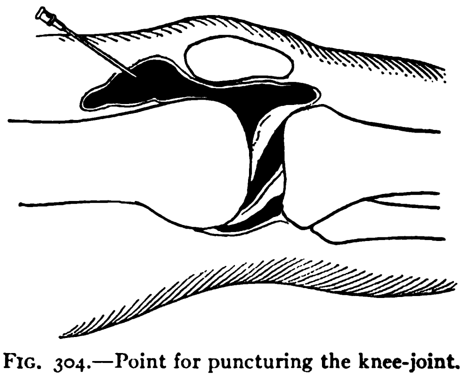


FIG. 304.—Point for puncturing the knee-joint.

point where fluctuation or distention is most in evidence. When t swelling is more marked above the patella, the needle may be int duced from above downward behind the bone (Fig. 304), the ope tor's left hand grasping the joint below the patella and forcing the intraarticular fluid upward into the suprapatellar recess.

The Ankle-Joint.—To avoid injuring the vessels and nerves which lie opposite the middle of the joint, the needle should be introduced from in front midway between the bundle of tendons which pass in front of the joint and the corresponding malleolus. On the inner side the needle is inserted ½ inch (1 cm.) above the malleolar process in a direction obliquely outward and backward; on the outer side the needle enters ¾ of an inch (2 cm.) above the malleolar process in a direction obliquely inward and backward.

SPINAL OR LUMBAR PUNCTURE

Lumbar puncture, an operation first proposed by Quincke for the withdrawal of cerebrospinal fluid from the spinal canal, has both diagnostic and therapeutic value. This procedure is of diagnostic importance in cerebro-spinal lues, intracranial hemorrhage, tumors of the cord, meningitis, poliomyelitis, etc. through the information that may be obtained in estimating the pressure of the cerebrospinal fluid and determining its characteristics by physical, chemical, microscopical, and bacteriological examination.

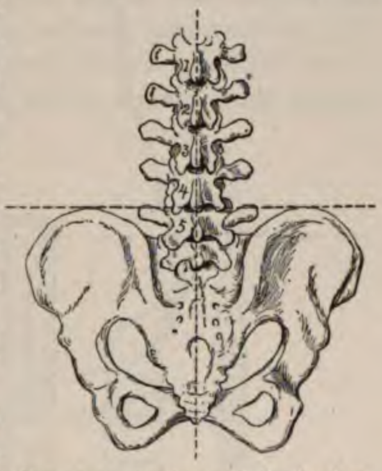


FIG. 305.—Anatomy of the lumbar vertebræ.

Among its therapeutic uses is its employment as a "decompressive agent," in cases of meningitis, hydrocephalus, intracranial tumors, cerebral abscess, uremia, delirium tremens, etc., etc. On account of the continuity of the spaces in the brain and spinal column, temporary relief of intracranial and intraspinal pressure may be obtained in the above cases by the withdrawal of small amounts of fluid from the spinal canal. Lumbar puncture should be employed with great caution, however, in cases of brain tumor, for sudden death may follow removal of a large amount of fluid, the increased intracranial tension causing the medulla to be forced against the foramen magnum when the intraspinal pressure is relieved. In cerebrospinal meningitis, drainage by lumbar puncture is often followed by good results, as not only is the pressure upon the cord and cere-bral centers lessened, but pus is withdrawn, and the toxicity of the spinal fluid is thereby diminished.

It is in the administration of antitetanic serum and antiserum in cerebrospinal meningitis, the treatment of cerebral syphilis, and the production of spinal anesthesia, however, that lumbar puncture finds its chief therapeutic applications.

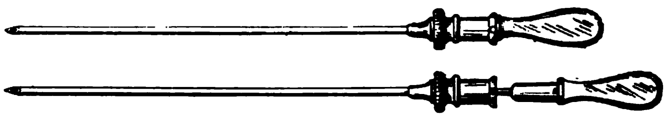


FIG. 306.—Stylet needle for spinal puncture.

Anatomy.—In the lumbar portion of the vertebral column the spinous processes do not project downward to such a degree as in other portions, and there is a distinct space (about 7/8 inch (22 mm.) in the transverse and 3/5 inch (15 mm.) in the vertical diameter between the vertebral arches filled with ligaments through which

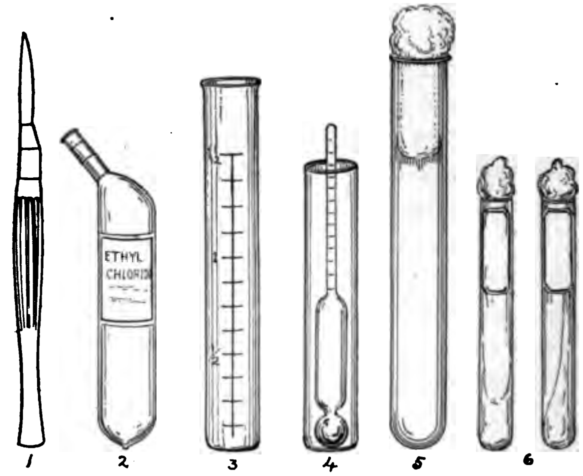


FIG. 307.—Apparatus for spinal puncture. 1, Scalpel; 2, ethyl chlorid tube; 3, small glass graduate; 4, hydrometer; 5, sterile test-tube; 6, culture tubes.

needle may be readily passed into the spinal canal (Fig. 305.) The spinal cord reaches only to the second lumbar vertebra, so if the puncture be made below that point, and the introduction of the needle be carried out under rigid asepsis the operation is practically harmless.

The Needle.—The puncture is best made with a special stylet needle devised for the purpose. It should be of platinum or nickel, at least 3½ inches (9 cm.) long and about 1/25 of an inch (1 mm.) in diameter, and the point should be short and ground almost squarely across (Fig. 306). In addition, a scalpel, a sterilized graduated test-tube, culture tubes, and an ordinary hydrometer (Fig. 307) will be required. When it is desired to estimate accurately the cerebrospinal pressure, a small mercury manometer will also be required.

Location of the Puncture.—The space between the third and fourth or that between the fourth and fifth lumbar vertebræ is usually chosen (Fig. 308), though, if the puncture is performed for diagnostic purposes, it may be made lower—between the fifth lumbar and first sacral vertebræ in order to withdraw any sediment that

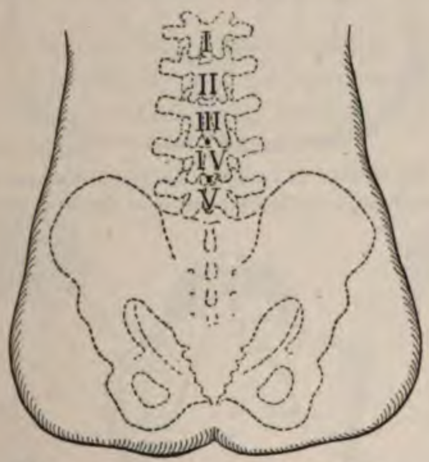


FIG. 308.—Points for spinal puncture.

may be present. A point just below the tip of the spinous process of the vertebra forming the upper boundary of the chosen interspace at a distance of about ½ inch (1 cm.) to one side of the median line is selected for the insertion of the needle. In children, however, the spinous processes being short, the needle may be inserted in the median line.

The spinous processes may be readily identified by counting down from the seventh cervical vertebra, unless the individual be very stout. If, however, any difficulty is experienced in locating this vertebra, the landmarks may be quickly determined by passing a transverse line between the highest points of the iliac crests with the patient standing erect, and it will be found that such a line passes through the tip of the spinous process of the fourth lumbar vertebra (Fig. 309).

Position of the Patient.—The operation may be performed with the patient sitting in a chair, with the body bent well forward in the

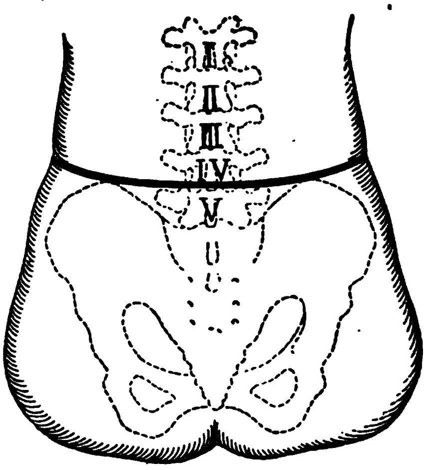


FIG. 309.—Showing the method of locating the fourth spinous process by passing a line through the highest points of the iliac crests.

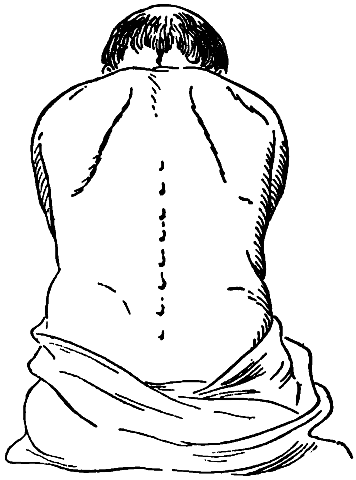


FIG. 310.—Sitting posture for spinal puncture.

form of a curve (Fig. 310), so as to widen the intervertebral spaces as much as is possible. If this is impracticable, the patient may lie on his left side with his knees drawn up, shoulders forward, and body bent forward in an arch (Fig. 311).

The Needle.—The puncture is best made with a special stylet needle devised for the purpose. It should be of platinum or nickel, at least 3½ inches (9 cm.) long and about 1/25 of an inch (1 mm.) in diameter, and the point should be short and ground almost squarely across (Fig. 306). In addition, a scalpel, a sterilized graduated test-tube, culture tubes, and an ordinary hydrometer (Fig. 307) will be required. When it is desired to estimate accurately the cerebrospinal pressure, a small mercury manometer will also be required.

Location of the Puncture.—The space between the third and fourth or that between the fourth and fifth lumbar vertebræ is usually chosen (Fig. 308), though, if the puncture is performed for diagnostic purposes, it may be made lower—between the fifth lumbar and first sacral vertebræ in order to withdraw any sediment that

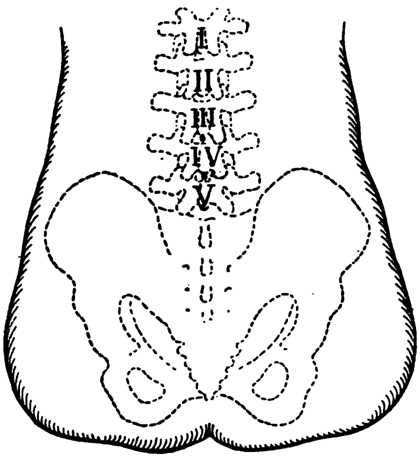


FIG. 308.—Points for spinal puncture.

may be present. A point just below the tip of the spinous process of the vertebra forming the upper boundary of the chosen interspace at a distance of about ½ inch (1 cm.) to one side of the median line is selected for the insertion of the needle. In children, however, the spinous processes being short, the needle may be inserted in the median line.

The spinous processes may be readily identified by counting down from the seventh cervical vertebra, unless the individual be very stout. If, however, any difficulty is experienced in locating this vertebra, the landmarks may be quickly determined by passing a transverse line between the highest points of the iliac crests with the patient standing erect, and it will be found that such a line passes through the tip of the spinous process of the fourth lumbar ve (Fig. 309).

Position of the Patient.—The operation may be performe the patient sitting in a chair, with the body bent well forward

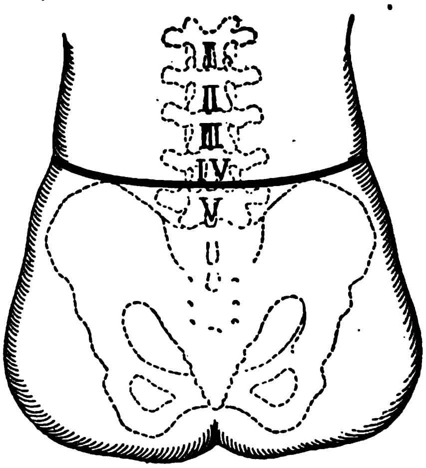


FIG. 309.—Showing the method of locating the fourth spinous process by p line through the highest points of the iliac crests.

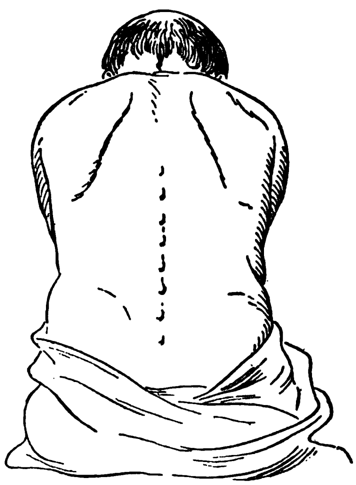


FIG. 310.—Sitting posture for spinal puncture.

form of a curve (Fig. 310), so as to widen the intervertebral sp much as is possible. If this is impracticable, the patient may his left side with his knees drawn up, shoulders forward, anc bent forward in an arch (Fig. 311).

Asepsis.—The site for the puncture should be painted with iodin, and thorough asepsis must be observed during the entire operation. The needle should be boiled and the operator's hands should be properly sterilized.

FIG. 311.—Lateral position for spinal puncture.

Anesthesia.—With children general anesthesia may be necessary. In other cases, local anesthesia with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution, or by freezing, as for any puncture, will answer all purposes.

FIG. 312.—Spinal puncture. First step, nicking the skin at the point of puncture.

FIG. 313.—Spinal puncture. Second step, inserting the needle.

Technic.—To avoid contaminating the needle by the bacteria of the skin as well as to make the insertion of the rather blunt needle easier, a puncture should be made with a scalpel through the skin at the chosen spot (Fig. 312). The operator's left thumb or index finger is then placed between the two spinous processes as a guide, and the point of the needle is inserted on the same level as the finger about ½ inch (1 cm.) from the median line, in an upward and inward direction (Fig. 313), until it enters the spinal canal. In a child this will usually occur at a depth of from ¾ to 1 ½ inches (about 2 to 4 cm.) and in an adult from 2½ to 3 inches (about 6 to 7.5 cm.). If the needle strikes bone, it should be slightly withdrawn and then reinserted, its direction being changed somewhat.

As soon as the canal is entered, the stylet is withdrawn, and the fluid, as it oozes from the needle drop by drop, is collected in a sterile test-tube (Fig. 314). The first few drops are usually blood stained, and, if so, they should be discarded. Not more than 1¼ drams (about 5 c.c.) of fluid should be withdrawn from the spinal canal of a

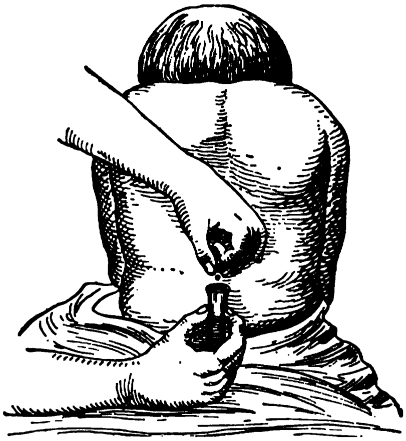


FIG. 314.—Spinal puncture. Third step, collecting the cerebrospinal fluid.

child, nor more than ½ ounce (15 c.c.) from an adult, at one time for diagnostic purposes. When, however, the puncture is performed to relieve intracranial pressure, from 1 ounce to 1½ ounce (30 to 45 c.c.) of fluid may be removed, according to the tension, and even more if no ill effects are observed. Withdrawal of too much fluid may cause dizziness, pallor, sweating, and vomiting and later a sharp headache. A dry puncture is sometimes encountered and may be due to the needle not entering the canal, to its being plugged by blood clot, or from the fluid being too thick to flow through its lumen.

At the completion of the operation, the site of puncture is sealed with collodion and cotton and the patient is kept recumbent in bed for 24 hours.

Normal Cerebrospinal Fluid and its Pathological Variations. ɔrmally, the cerebrospinal fluid escapes slowly, while in certain seased conditions with increased pressure, as meningitis, tumor of e brain, uremia, paresis, hydrocephalus, etc., and in certain infec- ous diseases, it may spurt out. The pressure may be roughly timated by the strength of the flow from the needle, a strong spurt fluid indicating an increased amount of pressure, and very slow- ming drops the reverse. It may be more accurately measured by taching to the needle a small mercury manometer by means of a nall rubber tube, 8 to 16 inches (20 to 40 cm.) long, filled with a 1 r cent. solution of carbolic acid. This, of course, is to be done be- re any of the fluid is permitted to escape. According to Sahli, the rmal dural pressure in the horizontal position is 60 to 100 mm. of ater (5 to 7.3 mm. of mercury), and 200 to 800 mm. of water (15 60 mm. of mercury) in certain pathological conditions.

Normal cerebrospinal fluid is colorless and water-like in clearness, es not change color on standing, and shows no sediment. It is erile and gives a negative Wassermann reaction. It has an al- line reaction, a specific gravity of from 1001 to 1008, a freezing int of $-56°$ to $-58°$, and exists in the spinal canal in but small nounts, varying between ½ and 2 ounces (15 and 60 c.c.) in adults d in infants between 2½ and 5 drams (10 and 20 c.c.). The total antity in the ventricles and subarachnoid space is estimated by ferent observers as anywhere from 2 to 5 ounces (60 to 150 c.c.). contains traces of protein (0.013 to 0.07 per cent.), the greater oportion of which is globulin, some chlorides (0.7 per cent.) a pper-reducing body claimed to be glucose (0.07 to 0.1 per cent.), d traces of urea (0.035 to 0.04 per cent.). Some endothelial cells d small lymphocytes are present in the fluid, but these cellular ments normally do not exceed 5 per cubic. mm.

Under pathological conditions the fluid may undergo marked odifications. In certain infectious diseases, intracranial tumor, eningitis, hydrocephalus, general paresis, etc., the amount may be eatly increased. In nephritis and uremia the urea is largely in- eased and there may be a rise in the chlorides; in hydrocephalus ere may likewise be an increase in the urea. Sugar is increased in abetes, but is usually absent in cases of meningitis. In apoplexy, eningitis, paresis, hydrocephalus, and brain tumor, the quantity globulin may be markedly increased. Both the globulin content nd the cell count are increased in cerebrospinal syphilis, but by the action to the colloidal gold test it is possible to differentiate between general paresis and other forms of syphilis. A bloody o blood-stained fluid will be found in intrameningeal cranial hemor rhages and in injuries of the skull extending through the dura, but i extradural injuries the fluid will be clear; bloody fluid may als occur in meningitis. In jaundice it may be greenish-yellow i color. A cloudy, purulent fluid indicates inflammation of th meninges, as does a rise in the specific gravity. In tuberculous men ingitis, however, the fluid is clear and limpid. The cell count is i creased in all inflammations of the meninges, but the character the cells will differ according to the type of inflammation. Poly nuclear cells predominate in acute inflammations, while, as a rul in the subacute and chronic forms lymphocytes are found. It only possible to determine the specific form of infection by bacteri logical examination. Identification of the diplococcus intracell laris, pneumococcus, streptococcus, staphylococcus, bacillus influenza, or tubercle bacilli will definitely settle the nature of t infection.

Lumbar Puncture as a Means of Administering Therapeu tic Sera.—When lumbar puncture is employed for the purpose of a ministering therapeutic sera in tetanus and cerebrospinal meni gitis, a fairly large syringe, one with a capacity of at least 1 oun (30 c.c.), is required in addition to the other instruments necessa for spinal puncture.

Meningococcus Meningitis.—The value of the administratio of antimeningococcus serum intraspinously in meningococc meningitis is now generally recognized. The early administratio of the serum is of prime importance and in suspected cases, if t cerebro-spinal fluid drawn by the first puncture shows any tu bidity, it is advisable to give the serum at once without waiting f the results of a bacteriological examination. Much valuable time ma be thus saved without doing the patient any harm. One to 1½ ounces (30 to 45 c.c.) of serum are injected into the third or fourt lumbar space after a like amount of cerebrospinal fluid has been eva uated. Subsequent injections are given at intervals of twelve twenty-four hours, according to the severity of the case, for three or fo days. If after a lapse of several days the symptoms return, anoth series of injections is given. In place of a syringe, a glass funn or small glass reservoir holding about 2 ounces (60 c.c.) attached the needle by rubber tubing may be employed, the serum bei allowed to flow into the subarachnoid space by gravity (Fig. 31

It takes usually from 10 to 15 minutes to administer the required amount in this manner.

Tetanus.—Antitetanic serum may be given intramuscularly or intravenously, but the best results seem to follow large doses given by intraspinous injection—16000 units of high potency serum may be administered at a dose and repeated at 24 hours intervals for several days. The puncture is made in the manner described above, and a quantity of cerebrospinal fluid equal to the amount of serum to be injected is allowed to escape from the canal; the serum is then warmed and is allowed to flow by gravity or is slowly injected through the same needle employed for the puncture.

Rogers (*Journal of the American Medical Association*, July 1, 1905), injects 2 ½ to 5 drams (10 to 20 c.c.) of antitetanic serum into

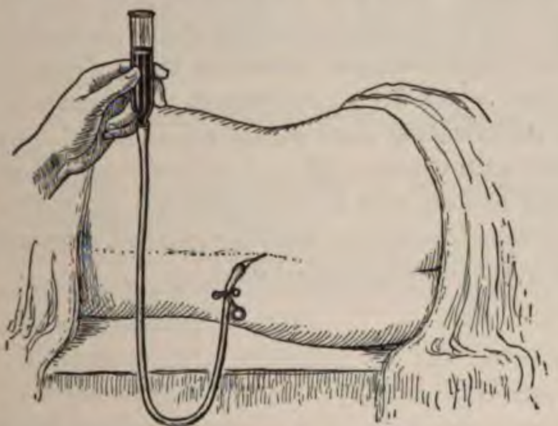


FIG. 315.—Gravity method of administering serum by lumbar puncture.

the nerves of the cauda equina, as well as subcutaneously in the neighborhood of the wound, intravenously, and into the nerves of the brachial plexus if the site of infection is upon the upper extremity, and into the sciatic and anterior crural nerves if the wound is in the lower extremity. In making the spinal injection the needle is inserted in the space between the second and third lumbar vertebræ, so as to strike the cauda equina, and is manipulated back and forth with the object of wounding some of the nerves, which is manifested by twitching of the legs; 2 ½ to 5 drams (10 to 20 c.c.) of serum are then injected into and around these injured nerves.

Poliomyelitis.—Favorable reports have followed the treatment of epidemic poliomyelitis with a serum prepared by Nuzum and Willy. There is some difference of opinion, however, as to its

22

value and further trial will be necessary before this can b mined. When administered early, it is apparently cap preventing and arresting paralysis, but is of questionable clearing up paralysis already present.

Cerebral Syphilis.—Recently, Swift and Ellis of the Ro Institute have developed a new line of treatment for syphili central nervous system, employing intraspinous injections varsanized (arsphenaminized) serum. The results in the far reported have been most encouraging, and it would seem some cases of tabes and paresis a cure may be effected and well-marked cases the disease may be checked by the intra serum treatment.

The technic is briefly as follows; salvarsan (arsphen given intravenously, usually in a maximum dose, and an hc 10 drams (40 c. c.) of blood are withdrawn from the patient by puncture into a bottle-shaped centrifuge tube. This is all coagulate, after which it is centrifuged. The next day (12 c.c.) of the resulting clear serum are removed by mea pipette, mixed with 5 drams (18 c.c.) of sterile normal salt s and heated for half an hour at a temperature of 132° F. (This serum is then injected by lumbar puncture, after withdr small quantity of the cerebrospinal fluid.

CHAPTER XIII

ASPIRATIONS

ASPIRATION OF THE PLEURAL CAVITY

Paracentesis thoracis, also spoken of as thoracentesis and pleurocentesis, consists in the evacuation of fluid from the pleural cavities by means of a hollow needle or trocar to which an aspirator is attached.

Indications.—When the presence of fluid has been made out by the physical signs and the diagnosis verified by an exploratory puncture, thoracentesis is indicated in sero-fibrinous effusions under the following conditions:

1. When the fluid is sufficient to produce dyspnea, cyanosis, and cardiac weakness.

2. In very large effusions whether or not pressure symptoms are present, especially if bilateral.

3. When the heart is displaced by the presence of fluid.

4. When the fluid is not absorbed within a week or ten days in spite of medical treatment.

The advantages of early aspiration are that adhesions may be prevented and the course of the disease considerably shortened. Long continued pressure upon the lung by an effusion may prevent its subsequent full expansion, and reappearance of the fluid is more apt to occur when the operation has been delayed.

Apparatus, Etc.—Evacuation of the fluid is accomplished by means of suction; for this purpose a hollow needle or a trocar connected with either an aspirator or a syphonage apparatus may be employed. In addition, a scalpel, and collodion and cotton, or a pad of sterile gauze and adhesive plaster for the dressing, should be supplied.

The Aspirating Needle.—Whether an ordinary aspirating needle or trocar and cannula be employed does nor make any material difference, though the latter has some advantages. Where the trocar form of needle is employed, the point of the cannula may be moved about without danger after the stylet is removed, and, should the lumen of the cannula become plugged, the obstacle may be removed without the necessity of withdrawing the cannula by simply reinserting the stylet. With an aspirating needle, on the other hand, the unprotected point of the needle may injure the lung or diaphragm, and, furthermore, should the lumen of the needle become blocked, it may be necessary to withdraw it entirely in order to clear out the obstruction. If an aspirating needle is used, one should be chosen at least 3 inches (7.5 cm.) long and from 1/25 inch (1 mm.) to 1/12 inch (2 mm.) in diameter depending upon the consistency of the material to be evacuated.

In a properly made trocar the stylet should fit the point of the cannula accurately, and the cannula and stylet should gradually taper to a point, as if in one piece. The cannula is provided with a stopcock near the proximal end to prevent leakage of air when the stylet is withdrawn, while a lateral opening, for connection with the aspirator, is placed at a point distal to this stopcock, so that the stylet may be moved back and forth without disturbing the connections (Fig. 316).

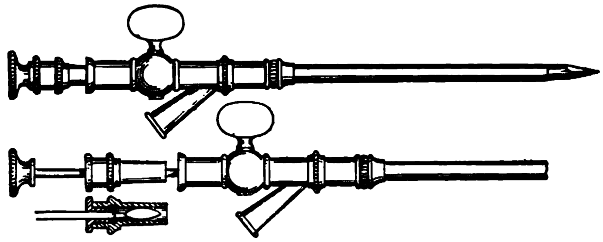


FIG. 316.—Aspirating trocar.

Aspirators.—The Potain, the Dieulafoy, or the heat vacuum apparatus is most commonly employed, though the aspiration may be satisfactorily made in a large proportion of cases by simple syphonage. The Dieulafoy instrument is most convenient for evacuating small collections of fluid and when it is desirable to be exact in the quantity removed, while for large effusions the Potain or the heat vacuum apparatus is best.

The Potain instrument (Fig. 317) consists of an exhausting pump, a large glass bottle, a rubber stopper through which passes the long arm of a Y-shaped metal tube with a stopcock in each limb, and two pieces of heavy rubber tubing, one connecting the needle or trocar with one arm of the Y, and the other joining the second arm and the exhausting pump. The instrument is assembled by inserting the stopper firmly into the glass receptacle and attaching one end of a piece of tubing to the stopcock *a* and the other to the needle or trocar. By means of the second tubing the exhausting syringe is connected with stopcock *b*. The instrument should be carefully tested before using to see that all the connections are air-tight. To produce a vacuum, stopcock *a* is closed and stopcock *b* is opened,

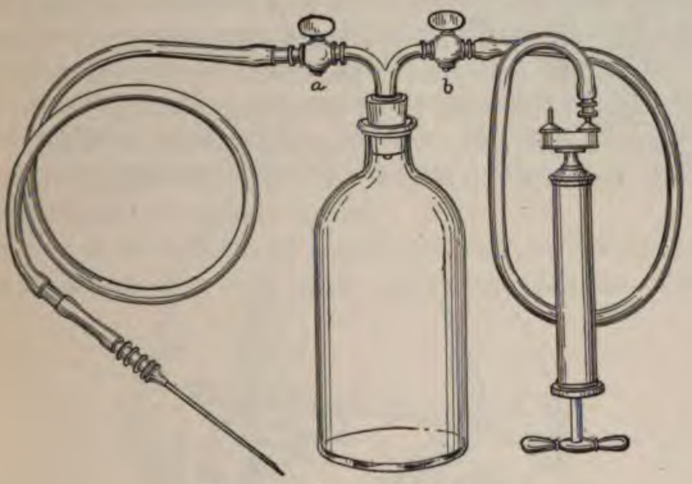


FIG. 317.—Potain aspirator.

when, by pumping from thirty to fifty strokes, the air will be sufficiently exhausted. Stopcock *b* is then closed, and the needle is inserted into the chest. As soon as its point enters the tissues, the vacuum is extended to the point by opening stopcock *a*, so that the

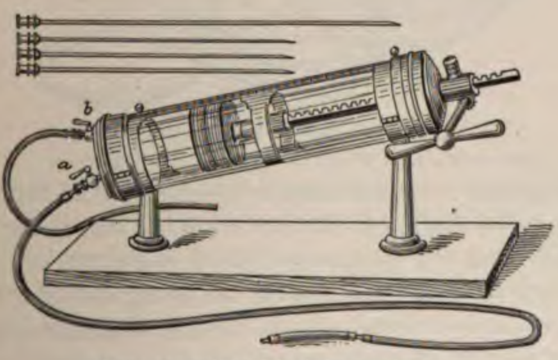


FIG. 318.—The Dieulafoy aspirator.

moment fluid is reached it will be drawn by suction into the bottle. If the trocar is employed, the stylet is not withdrawn until the trocar enters the chest, as this is done the stopcock on the cannula is closed, so as to exclude air.

The Dieulafoy apparatus (Fig. 318) consists of a glass syringe, with a capacity of 3 to 4 ounces (90 to 120 c.c.), provided with two outlets, each furnished with a stopcock, and to which are fitted heavy rubber tubes. To the extremity of one tube a trocar or aspirating needle is attached, and at a distance of about 4 inches (10 cm.) from the needle end a piece of glass tubing is inserted as an index. The other piece of tubing leads from stopcock *b* to a basin to carry off the fluid discharged from the cylinder. To use the instrument both stopcocks are closed, and the piston is fully withdrawn and fixed in place by a spring. This produces the vacuum. The

FIG. 319.—Connell's heat vacuum aspirator.

aspirating needle is then introduced into the skin at the chosen site and, as soon as the needle point is buried in the tissues, the stopcock *a* is opened, allowing the vacuum to extend to the needle. The needle is then pushed on in until it enters the chest, the presence of fluid being first demonstrated as it passes through the glass index. When the aspirator is filled, stopcock *a* is closed and stopcock *b* opened, and the fluid is discharged from *b* by driving the piston back in place. This process of aspiration may be repeated as often as necessary without removing the needle or disconnecting the aspirator.

A very excellent form of aspirator and one that is frequently employed is the vacuum bottle described by Connell (*Medical*

Record, July 4, 1903). It consists of a strong glass bottle with a capacity of about 5 pints (2.5 liters), having a mouth 1 inch (2.5 cm.) wide, fitted with a rubber stopper through which passes a glass tube with a heavy piece of rubber tubing attached, ending in an aspirating needle. Three drams (12 c.c.) of 95 per cent. alcohol are poured into the bottle which is so manipulated that its inner surface is entirely coated, when the excess of alcohol is poured off. The alcohol is then ignited, and, as the flame reaches the bottom of the bottle, the cork is quickly inserted, the rubber tubing having been previously clamped (Fig. 319). A vacuum is thus produced which is amply sufficient to aspirate a chest.

Removal of an effusion by syphonage may be readily accomplished by means of a very simple apparatus. A piece of heavy

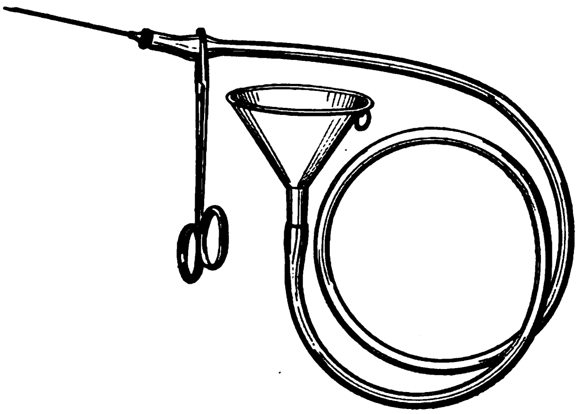


FIG. 320.—Syphonage aspirator.

tubing about 3 feet (90 cm.) long, a clamp to close one end of the tubing, a funnel, sterile water or saline solution to fill the tubing, and a receptacle to collect the fluid are the necessary requisites. One end of the tubing is fastened to a *large caliber* needle or the side outlet of the trocar and the other to the glass funnel (Fig. 320).

Site of Aspiration.—The needle should be inserted at a point where the physical signs or an exploratory puncture demonstrate the presence of fluid and at the lowest level of the fluid, that its withdrawal may be facilitated as far as possible by the action of gravity. The sixth intercostal space in the anterior axillary line, the sixth or seventh space in the midaxillary line, and the eighth space below the angle of the scapula are the points of election (Fig. 321).

Quantity Withdrawn.—It is not essential to empty the chest en-tirely at one sitting. The amount of fluid evacuated should be deter mined more by the manner in which the patient bears the operation the condition of the pulse, and signs of impending collapse rather tha by the quantity of fluid present. In very large effusions as much a 3 pints (1500 c.c.) may be removed, but it is better to withdra too little than too much, for what remains may be evacuated at subsequent period; and it not infrequently happens that spontaneou absorption of the effusion follows the removal of even sma quantities.

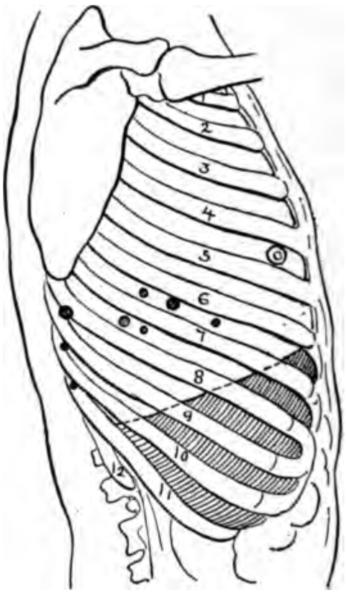


FIG. 321.—Sites for aspiration of the pleura. (The large dots represent the p of election.)

Position of the Patient.—The aspiration is preferably perforn with the patient on a bed so as to avoid the extra exertion of movi after the operation. When possible, an upright sitting positi should be assumed, with the arm of the affected side raised, and t hand placed on some support or on the opposite shoulder to increa the breadth between the intercostal spaces (Fig. 322). If this is in practicable, the patient may lie near the edge of the bed, upon th back for a lateral puncture, or rolled slightly to the opposite side wit the arm extended over the head for a posterior puncture (see Fig. 290

Asepsis.—The skin at the site of operation should be painted wit tincture of iodin; the operator's hands should also be proper cleansed, and the needle or trocar sterilized by boiling.

Anesthesia.—Local anesthesia by freezing with ethyl chlorid or by infiltration with a few drops of a 0.2 per cent. solution of cocain or a 1 per cent. solution of procain at the point of puncture will be sufficient.

FIG. 322.—Position of patient for aspiration of the pleura.

Technic.—A vacuum is first produced in the aspirator and the needle or trocar attached. A point is then selected in the chosen interspace at a little distance from the upper margin of the lower rib bounding the space, so as to avoid the upper intercostal artery, and the skin is nicked with a scalpel. The thumb and forefinger of the

FIG. 323.—Method of holding the trocar.

left hand are used to steady the tissues overlying the intercostal space, while the needle or trocar is introduced with the right hand, the forefinger being placed on the needle to guard against its being inserted too deeply (Fig. 323). As soon as the point of the needle enters the tissues, the vacuum already present in the aspirator is extended to the needle point by opening the proper stopcock, and the needle is steadily pushed in until it enters the pleural sac, which will usually be at a depth of 1 to 1½ inches (2.5 to 3.5 cm.). The fluid should be withdrawn rather slowly in order that the structures may have time to adjust themselves to the changed conditions in the chest; at least twenty minutes to half an hour should be consumed in removing 2 pints (1000 c.c.).

Should the patient feel faint or suffer from vertigo or dyspnea the operation should be temporarily interrupted and the patient's head lowered. Complaints of severe pain, persistent cough, or expectoration of blood also demand that the aspiration be discontinued.

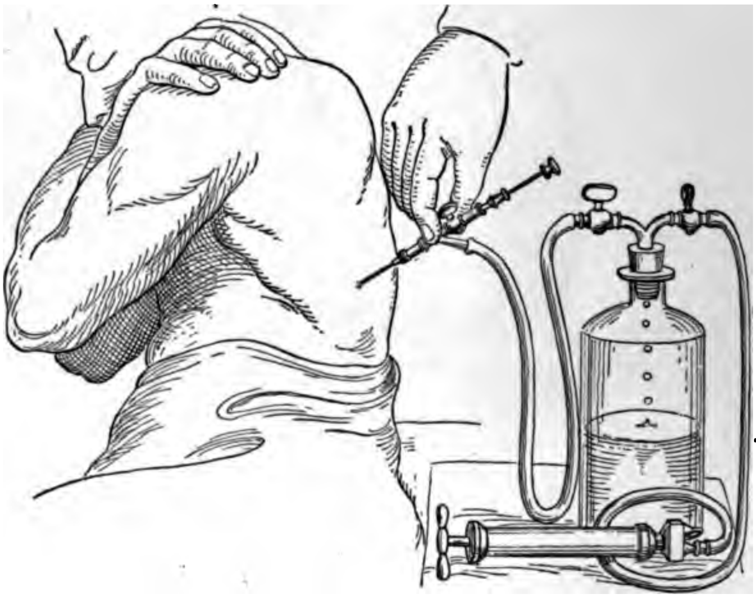


FIG. 324.—Aspiration of the pleura with the Potain apparatus.

At the completion of the operation the tissues are pinched up around the shaft of the needle which is quickly withdrawn. The site of puncture is then dressed with collodion and cotton, or with a sterile pad of gauze held in place by adhesive strips.

In employing the syphonage apparatus the tubing is first filled with sterile solution, and the clamp is placed near the end of the tube to prevent the solution escaping. The needle is then introduced into the chest, while the free end of the tube is placed under water in the receptacle provided for the collection of the fluid. On removing the clamp from the tube the column of water is released and the fluid withdrawn by a process of syphonage.

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osis, and a weak pulse. This condition usually begins
withdrawal of the fluid, or comes on shortly afterward.
ined on the supposition that the rapid withdrawal of fluid
removes the pressure from the lung, which as a result
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by the aspirating needle.

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ccurrence of these complications may be reduced to a
by the employment of rigid aspesis, the observance of
in the use of the needle or trocar, and the removal of only
amounts of fluid without haste.

ASPIRATION OF THE PERICARDIUM

ntesis pericardii, or pericardicentesis, consists in the evacu-
he contents of the pericardial sac through aspiration by
a needle or a fine trocar attached to a vacuum apparatus.

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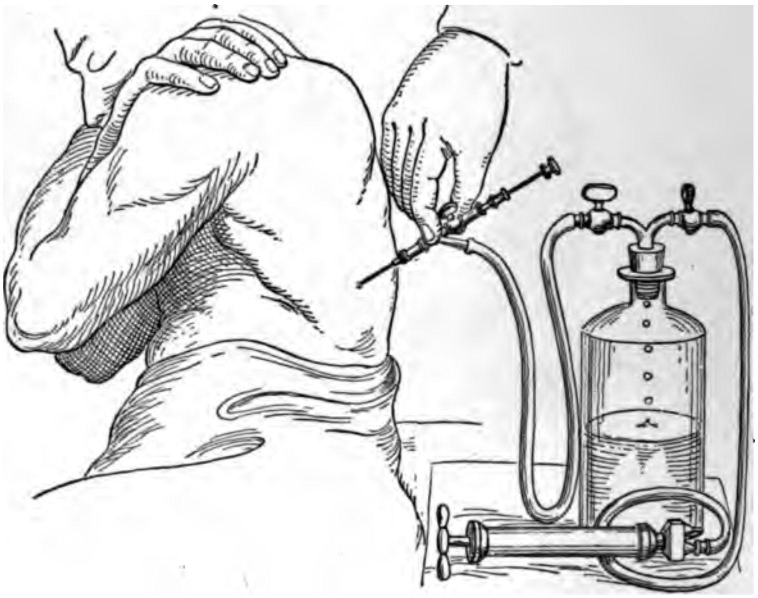

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omplications and Dangers.—*Sepsis* is not to be feared if the ary aseptic precautions are observed.

neumothorax may follow injury to the lung by the aspirating e or trocar, or be due to the rupture of adhesions or a cavity expansion occurs, or to the entrance of air along the trocar.

lbuminous expectoration has been observed as a sequel to the en withdrawal of large quantities of fluid. The expectoration sts of a yellowish, frothy fluid, and it is accompanied by dysp- cyanosis, and a weak pulse. This condition usually begins g the withdrawal of the fluid, or comes on shortly afterward. explained on the supposition that the rapid withdrawal of fluid enly removes the pressure from the lung, which as a result nes congested, and transudation into the air cells follows.

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ASPIRATION OF THE PERICARDIUM

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ndications.—Paracentesis of the pericardium should be per- ed:

If the effusion is sufficiently large to endanger life through und disturbance in the cardiac action indicated by severe nea, small, rapid, and irregular pulse, and cyanosis, *the indicatio* , as death may result from syncope if the condition be not ed without delay.

When a large effusion does not show any tendency to absorp- fter a prolonged and fair trial of medical means.

the presence of a purulent exudate, though *temporary* relief may be obtained by aspiration, the condition is one that should be treated by incision and free drainage, as in empyema.

Apparatus, Etc.—In tapping the pericardium a Potain or Dieulafoy aspirator to which is attached a fine needle or trocar and cannula may be employed in the same way as used in the pleural cavity; a scalpel, collodion and cotton, or gauze and adhesive plaster for the purpose of dressings, should also be at hand.

Site of Aspiration.—The point for making the aspiration should be determined upon after having first detected the presence of fluid

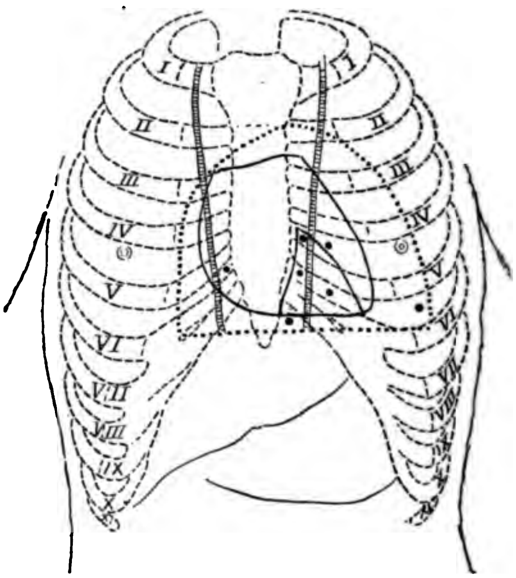


FIG. 325.—Points for aspiration of the pericardium. The dotted line indicates a distended pericardial sac. The course of the internal mammary vessels is also shown.

by an exploratory puncture (page 318). For the introduction of the needle there are four sites recommended:

1. In the fourth or fifth intercostal space close to the left sternal margin, or else 1 inch (2.5 cm.) to the left of it, thus passing either internal or external to the internal mammary artery.

2. In the fifth interspace close to the right of the sternum.

3. Close to the costal margin in the angle between the ensiform cartilage and seventh costal cartilage on the left, inserting the needle upward and backward.

4. In the fifth or sixth left interspace outside the nipple line between the apex beat and outer border of dullness (Fig. 325).

Quantity Withdrawn.—In small effusions the fluid may be re-oved at one sitting; but in large effusions, in order to avoid suddenly moving the extracardial pressure, it is preferable to withdraw ot more than 3 to 4 ounces (90 to 120 c.c.) at the first sitting. This ay be followed by absorption of the rest of the fluid, as is often the se in pleurisy. If there is no improvement at the end of a day or ro, however, it will be necessary to perform a second tapping.

Position of Patient.—The operation may be performed either with e patient recumbent or sitting upright.

Asepsis.—The greatest regard to aseptic precautions should be served. The area of operation should be shaved, if necessary, and e skin painted with tincture of iodin. The operator's hands are oroughly cleansed, and the apparatus to be used in the operation is iled.

Anesthesia.—Local anesthesia by freezing with ethyl chlorid other freezing agents, or by injecting a few drops of a 0.2 per cent. lution of cocain or a 1 per cent. solution of procain into the skin ll be found useful.

Technic.—A nick is made through the skin with a scalpel at a int not far from the upper margin of the rib forming the lower undary of the space previously determined upon for aspiration. ne tissues are steadied between the thumb and forefinger of the t hand, and the needle is held in the right hand, the index finger ing placed on its shaft as a guide to the proper depth of insertion, shown in Fig. 323. The direction of the needle as it is introduced ould be at first backward, until it enters the thorax, and then ghtly inward into the pericardium; but if the approach is made the left seventh costoxyphoid angle, the needle is introduced rectly upward and backward. The introduction of the needle ust be performed slowly, steadily, and with great care. The cuum previously produced in the aspirator is extended to the edle, by opening the proper valve, as soon as the needle point enters e tissues, so that fluid will be withdrawn at the earliest possible oment and thus injury to the heart, through inserting the needle o deeply, will be avoided. Usually at a depth of 1 inch (2.5 cm.) e pericardium will be entered. Care must be taken not to produce o great a vacuum in the aspirator lest the fluid be withdrawn too pidly—it should simply trickle into the aspirator.

As soon as the desired quantity is removed, the aspirating needle quickly withdrawn, and the seat of puncture is occluded with cotton and collodion, or else by a pad of sterile gauze held in pla by adhesive plaster.

Complications and Dangers.—It should be remembered th aspiration of the pericardium is no simple procedure, but is an ope tion attended by danger. Infection of the pericardium, injury the internal mammary vessels, puncture of the pleura, and lace tion of the coronary artery and the heart itself by the aspirati needle have all been observed. Strict attention to asepsis, extre care in introducing the aspirating needle or trocar, and observance the various points in technic that have been emphasized will much in preventing such accidents.

ASPIRATION FOR ASCITES

Paracentesis of the abdomen consists in puncturing the pe oneal cavity by means of a trocar and cannula and withdrawing t fluid therein contained. It is an operation attended by practically risks and can safely be repeated many times in the same individu when necessary.

Indications.—The abdomen may be aspirated in cases of ascit when the physical signs show the presence of fluid, and distenti

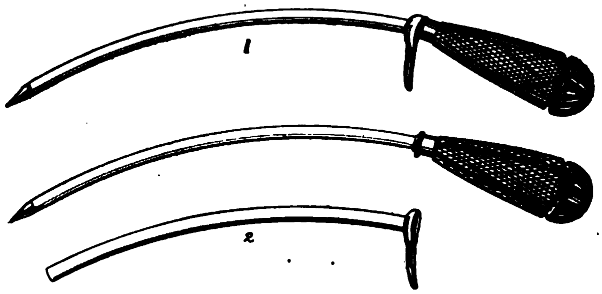


FIG. 326.—Trocar and cannula for aspirating the peritoneal cavity. 1, Trocar a cannula assembled; 2, showing trocar removed from the cannula.

becomes distressing from pressure upward upon the diaphragm. should also be performed when the fluid reaccumulates after previous tapping and gives rise to pressure symptoms.

Instruments, Etc.—A straight or slightly curved cannula a trocar of fair size—about 1/16 to 1/8 inch (1.5 to 3 mm.) in diame —should be used. The trocar is spear-pointed and should fit t cannula perfectly so as to prevent the point of the latter catchi in the tissues during its introduction (Fig. 326). An excellent form cannula, and one frequently used, contains a lateral opening ab

1/8 inch (3 mm.) from its end, for the purpose of avoiding stoppage of the escaping fluid, should the intestines or omentum obstruct the end opening of the instrument.

If desired, the aspirating apparatus of Potain or Dieulafoy (page 340) may be used in place of the simple trocar.

In addition, a scalpel to make a small preliminary incision, a sterile abdominal binder, a many-tailed bandage or large towel, and collodion and cotton or sterile gauze and adhesive plaster for the dressing should be provided.

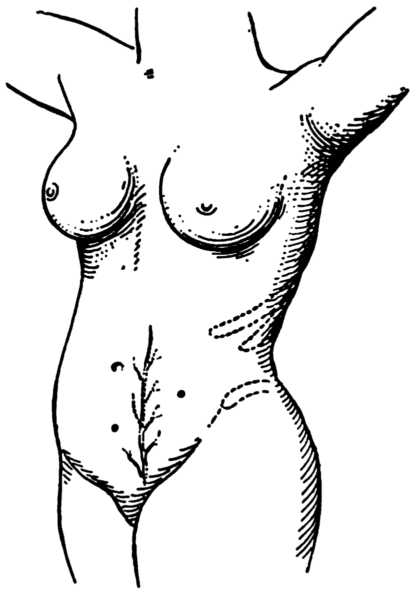


FIG. 327.—Sites for aspiration of the peritoneal cavity.

Site of Puncture.—The selection of a location free from vessels and where the abdominal wall is thin is desirable. Usually a point in the linea alba midway between the umbilicus and pubes is selected, but the puncture may be at a point in the linea semilunaris just outside the rectus muscle at the junction of the outer and middle thirds of a line between the umbilicus and the anterior superior iliac spine (Fig. 327). A puncture at either of these sites will avoid the deep epigastric vessels. Should repeated punctures be made, it will be of advantage to change the site a little each time so as to avoid entering adhesions which may have been produced by a previous puncture.

Quantity Withdrawn.—Whether all the fluid should be removed at once will be determined by the condition of the patient and the manner in which he bears the operation. As a general thing there is no harm in removing all the fluid, provided it is not evacuated too rapidly.

Position of Patient.—The patient should sit upright on the edge of the bed, if possible, or, if unable to do this, he may lie propped up in a semirecumbent position so as to favor gravitation of the fluid to the lowest level of the peritoneal cavity. When the puncture is made in the linea semilunaris, the patient should lie upon the side on which the puncture is made.

Fig. 328.—Aspiration of the peritoneal cavity. First step, application of the abdominal binder.

Preparations.—*The bladder and bowels should always be empty before operation.* The abdominal wall is shaved and the site of puncture is painted with tincture of iodin. The operator's hands should likewise be sterilized, and the trocar is to be boiled.

Anesthesia.—Local anesthesia with ethyl chlorid, ether, ice and salt, or infiltration with a few drops of a 0.2 per cent. solution of cocain or a 1 per cent. solution of procain may be used.

Technic,—A broad abdominal binder, or a Scultetus bandage with a central slit corresponding to the point where the trocar is to be introduced, is first fitted about the patient's abdomen (Fig. 328) and is to be tightened at intervals during the operation, so that uniform pressure may be applied while the fluid is flowing off and a sudden overfilling of the abdominal vessels with blood prevented. With a scalpel the skin is incised for a distance of ¼ inch (6 mm.) at the spot chosen for the puncture (Fig. 329), and the trocar is slowly and steadily inserted, with the index finger held along the instrument as a guide to the depth it is to enter, and to prevent it from being suddenly forced in too far (Fig. 330). As soon as it is judged that the peritoneal cavity has been reached, the trocar is withdrawn and the fluid is permitted to escape.

The fluid should be evacuated slowly, and, if it flows too freely, it is well to stop the flow at intervals by placing the finger over the end of the trocar, in order to allow the abdominal contents to adapt themselves to the changed conditions. If the stream is suddenly

FIG. 329.—Aspiration of the peritoneal cavity. Second step, nicking the skin at the point of puncture.

stopped by the intestines or omentum occluding the end of the instrument, a slight turn of the cannula or a change in its position may be sufficient to relieve the obstruction; if not, it may be necessary to clear the lumen by passing a sterile probe through it. As the fluid is withdrawn, and the distention of the abdomen decreases, necessary support is given to the lax abdominal walls by drawing the binder tighter. Syncope may be thus avoided; should it occur, however, the escape of the fluid must be temporarily stopped by placing the finger over the end of the trocar and the patient's head must be lowered, care being taken to see that air does not enter the cannula while this is being done.

When fluid ceases to flow, the cannula is quickly removed and, if a large opening has been made by the trocar, the skin may be drawn together by a subcutaneous stitch and the line of incision sealed with collodion and cotton. If there seems to be a good deal of oozing of fluid along the track of the trocar, however, a sterile gauze dressing, held in place with rubber adhesive plaster and changed as often as necessary, will be found more satisfactory. After the aspiration the patient should be kept in bed for at least twenty-four hours.

FIG. 330.—Aspiration of the peritoneal cavity. Third step, showing the method inserting the trocar.

ASPIRATION OF THE TUNICA VAGINALIS

This operation is employed for the cure of hydrocele. It consists in introducing an aspirating needle or trocar and cannula into the tunica vaginalis and removing the contained fluid. It may be performed simply to withdraw the hydrocitic fluid or as part of the radical cure by injection of carbolic acid. The former is rarely more than a palliative measure, as the fluid usually promptly recurs.

The treatment by a combination of aspiration and the injection of 95 per cent. carbolic acid is, however, successful in more than 80 per cent. of cases (Bevan). It is especially applicable to hydroceles with thin sacs; in the old, chronic cases with thick sacs it is not often successful.

The operation is practically without danger, if performed with proper technic and care is taken to prevent injury to the structures of the cord and the testicle. The latter usually lies posterior to the tumor, though in rare cases it may be in front. Its position should always be ascertained first, if possible, by palpation and transillumination.

FIG. 331.—Trocar and syringe for aspirating and injecting a hydrocele.

Instruments.—A medium size trocar and cannula, or a large aspirating needle, to which may be attached a small aspirating syringe, will be required (Fig. 331).

Site of Puncture.—The trocar should be introduced at the junction of the lower and middle thirds of the anterior surface of the scrotum, at a spot where visible blood-vessels are scarce.

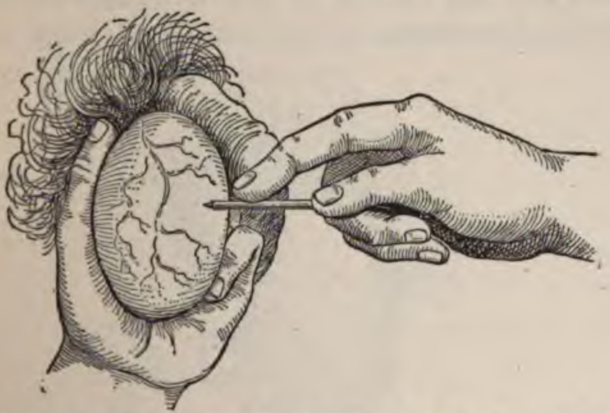


FIG. 332.—Aspirating a hydrocele. Showing the method of grasping the scrotum and the trocar being inserted.

Asepsis.—The usual aseptic precautions should be observed. The skin at the site of puncture should be shaved and then painted with tincture of iodin. The operator's hands should be prepared as for any operation, and the instruments boiled.

Anesthesia.—The spot of intended puncture may be anesthetized by the injection of a few drops of a 0.2 per cent. solution of cocain or a 1 per cent. solution of procain, or frozen by ethyl chlorid.

Technic.—The operator places his left hand behind the scrotum and grasps the neck of the hydrocele between the thumb and forefinger, thus making the tumor tense by compression. Holding the

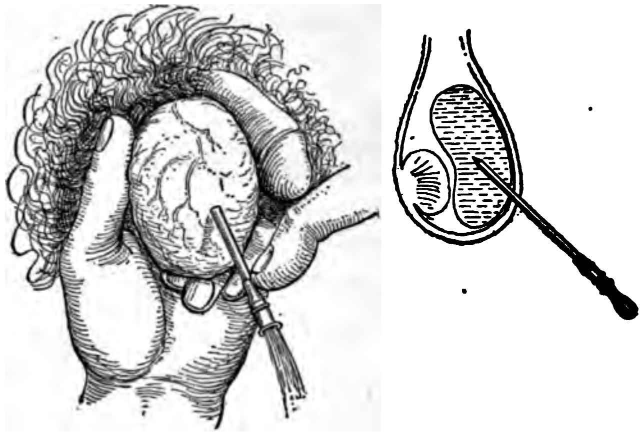


Fig. 333.—Aspirating a hydrocele. Showing the cannula in place.

trocar and cannula in the right hand with the index finger placed about 1 inch (2.5 cm.) from its tip so as to prevent the instrument being introduced too deeply, the operator thrusts it into the tunica

Fig. 334.—Method of injecting a hydrocele.

vaginalis in an upward and backward direction (Fig. 332). As soon as the trocar enters the sac, indicated by a lack of resistance to its further progress, the point of the instrument is turned upward thus

ng the free end and the trocar is removed (Fig. 333). All the
:hen allowed to escape, and, to make sure the sac is empty,
rator may be attached and suction employed.
cannula is left in site and from 5 to 30 drops (0.3 to 2 c.c.)
: cent. (deliquescent) carbolic acid, depending upon the size
ydrocele, are injected through the cannula (Fig. 334). If a
:annot be attached directly to the cannula, the injection may
: by means of a hypodermic syringe and a long needle in-
rough the cannula. The skin is then pinched up around the
which is quickly removed, and the scrotum is manipulated
smear the acid over the whole interior. The puncture is
lly sealed with collodion and cotton.
patient should remain in bed twenty-four to forty-eight
ter the operation with a supporting dressing applied to the
Some swelling follows the injection, but it usually sub-
thin a week or ten days. During this time the patient
rear a well-fitting suspensory.

ASPIRATION OF THE BLADDER

:ation of the bladder will be considered under the section
to that organ (see page 746).

CHAPTER XIV

THE NOSE AND ACCESSORY SINUSES

Anatomic Considerations

The Nose.—For purposes of description the nose is divided into an external and an internal portion.

The external nose forms a prominence upon the face resembling a triangular pyramid, made up chiefly of bone and cartilage and covered with muscles and integument. The bony portion, or bridge, is composed of the nasal portions of the superior maxilla and the two nasal bones. The arch forming the forepart of each side of the nose is composed of two large lateral cartilages which converge to form the ridge and tip. These are supplemented usually by three smaller cartilages bound together by connective tissue, which aid in forming the wings or alæ.

The interior of the nose is divided by the septum into two chambers, or fossæ, narrow above and more expanded below. These open anteriorly by the anterior nares, two pear-shaped apertures measuring about 1 inch (2.5 cm.) vertically and ½ inch (1 cm.) transversely at their widest points. Posteriorly, the nasal fossæ communicate with the nasopharynx by two corresponding openings, the posterior nares. Each fossa also communicates with air spaces situated in the frontal, ethmoid, sphenoid, and superior maxillary bones. The roof is formed by the nasal bones, the cribriform plate of the ethmoid, and the body of the sphenoid. The floor, concave from side to side, is formed by the palatal process of the superior maxilla and the horizontal process of the palate bones. It separates the nose from the mouth. The inner wall, or septum, is formed posteriorly by the perpendicular plate of the ethmoid and the vomer, and anteriorly by the triangular cartilage. The septum is seldom exactly in the median line, but is usually more or less deflected, so that it is unusual to find the two fossæ of equal size. The outer walls of the nose are formed by the superior maxillary, the lachrymal, the ethmoid, the palate, and the sphenoid bones. They are very irregular, due to the presence of the turbinate bodies which project into the fossæ and partly divide them into three separate recesses, the superior, the middle, and the inferior meatus (Fig. 335).

The superior meatus lies between the superior and middle turbinates. It is narrow and groove-like, and is the smallest of the three. The orifices of the posterior ethmoidal cells open upon the upper and forepart of its outer wall.

The middle meatus lies between the middle and inferior turbinates, and is more capacious than the superior, extending along the pos-

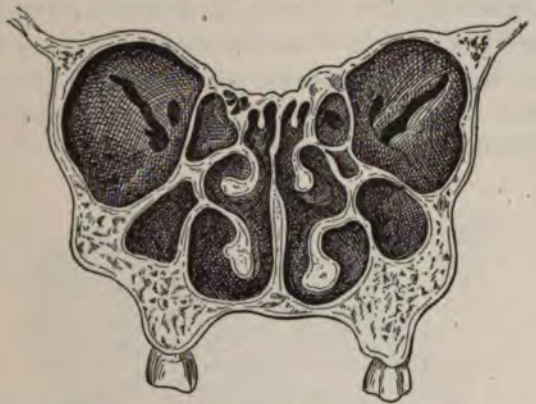


FIG. 335.—Transverse section of the nasal cavities. (After Zuckerkandl.)

terior two-thirds of the outer wall of the nose. Opening into the middle meatus on the outer wall is a crescentic slit-like aperture, the hiatus semilunaris. Just above it, and at times partly occluding this opening, is a protuberance, the bulla ethmoidalis, which marks the situation of the anterior ethmoidal cells. Upon the lateral wall

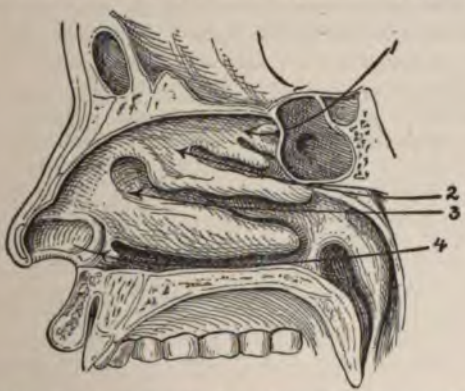


FIG. 336.—Showing the structures in the outer wall of the nasal cavity. 1, Opening of the sphenoidal sinus; 2, superior meatus; 3, middle meatus; 4, inferior meatus.

of the middle meatus and extending from the hiatus semilunaris upward and forward, is a curved groove bounded internally by the uncinate process of the ethmoid, known as the infundibulum. From this a closed duct leads into the frontal sinus. At the deepest portion of the infundibulum near the posterior end, is the opening of the maxillary sinus, and behind this at times is found an accessory opening. The anterior ethmoidal cells also open into the infundibulum on the upper part of the outer wall or else they communicate with the frontonasal duct.

From the anatomical relation of these openings, it can be understood how readily infection of the maxillary sinus may follow a suppurative condition of the anterior ethmoidal cells or frontal sinus, discharges from the latter being very apt to find their way into the ostium of the maxillary sinus.

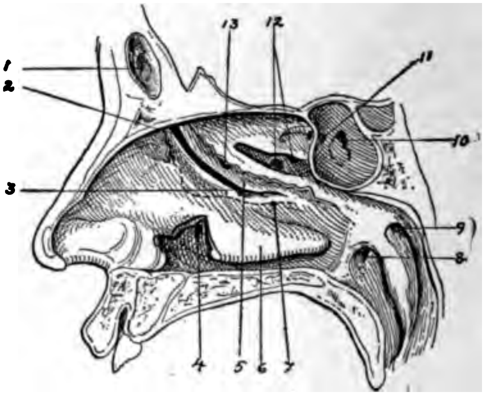


FIG. 337.—Lateral wall of the right nasal cavity showing the orifices of the accessory sinuses. (After Schultze and Stewart.) The dotted line indicates the outline of the middle turbinate, which has been removed to show the structures beneath. A portion of the inferior turbinate has also been removed. 1, Frontal sinus; 2, infundibulum; 3, hiatus semilunaris; 4, orifice of the nasal duct; 5, bulla ethmoidalis; 6, inferior turbinate; 7, accessory orifice of the maxillary sinus; 8, orifice of Eustachian tube; 9, fossa of Rosenmüller; 10, sphenoidal sinus; 11, orifice of the sphenoidal sinus; 12, orifice of the middle and posterior ethmoidal cells; 13, orifice of the anterior ethmoidal cells.

The inferior meatus, the largest of the three, lies between the inferior turbinate bone and the floor of the nasal cavity, extending along the entire length of the outer wall of the nose. The nasal duct, leading from the orbit, opens into the inferior meatus at the junction of the anterior third with the posterior two-thirds.

The mucous membrane lining the nasal cavity is continuous anteriorly with the integument and also with the mucous membrane of the pharynx, Eustachian tubes, and accessory sinuses In the upper portion of the nose the mucous membrane is of the columnar variety. In this region it is thin and closely bound to the periosteum and perichondrium beneath, and contains the endings of the olfactory nerves. The remainder of the nasal cavity is lined with ciliated epithelium. Over the inferior turbinates, the lower portion of the middle turbinates, and corresponding parts of the septum the mucous membrane is thick and very vascular, containing numerous thin-walled venous channels capable of becoming so enormously distended with blood that they may even occlude the nares. On the floor of the nose the mucous membrane again becomes thinned out.

The Accessory Sinuses.—Hollowed out of the bones surrounding the nasal fossæ are four cavities filled with air, known as the maxillary, frontal, ethmoid, and sphenoid sinuses. These accessory sinuses are lined with a thin, pale, mucous membrane continuous with that of the meatus into which each sinus respectively opens.

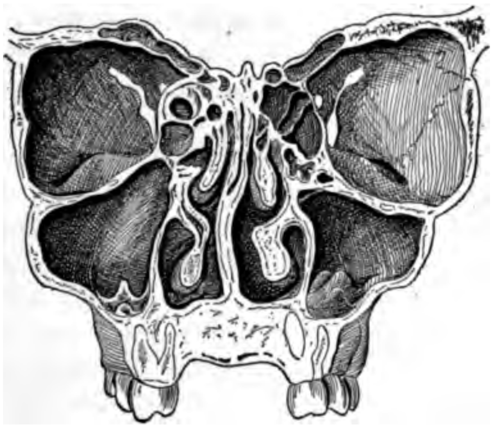


Fig. 338.—Cross-section of the maxillary sinuses, showing the close relation of the roots of the molar teeth to the floors of the sinuses. (After Zuckerkandl.)

The function of the sinuses is to give resonance to the voice and at the same time add to the lightness of the skull.

The maxillary sinus, or antrum of Highmore, lies to the outer side of the nasal fossa, occupying the greater portion of the superior maxillary bone. It is the largest of all the accessory sinuses. In shape it resembles a three-sided pyramid, with the apex at the zygomatic process of the maxilla, and the base directed toward the nasal cavity. The roof of the antrum is very thin and forms the floor of the orbit. The anterior wall is directed toward the face and corresponds to the canine fossa externally. The floor, which is directed toward the mouth, is formed by the alveolar margin and outer portion of the hard palate. The roots of the molar teeth almost protrude through the floor into the antrum (Fig. 337), being often separated from the cavity by a thin shell of bone, or merely mucous membrane, so that ulceration of the teeth may readily lead to infection of the sinu This anatomical arrangement is sometimes taken advantage of i draining the antrum, a tooth being extracted and the sinus open through the alveolus.

Ordinarily, the antrum has a capacity of about 4 drams (15 c.c but its size varies greatly, and in the same individual the two sid are frequently disproportionate. The antrum communicates wi the middle meatus by an ostium opening into the infundibulum, a thence through the hiatus semilunaris. This aperture cannot seen until the middle turbinate has been removed. In a small p centage of cases an accessory ostium is found lying posterior to t main opening.

The Frontal Sinus.—The frontal sinuses are two air spaces se rated from each other by a septum, lying between the tables of t frontal bones above the orbits. Each consists of a vertical porti passing upward on the forehead and a horizontal portion extendi backward over the roof of the orbit. Their size is variable and th are often unequal through deflection of the septum to one si Cases have been observed with one sinus entirely absent. The fl of the sinus forms by its external portion the roof of the orbit, and its inner portion the roof of some of the anterior ethmoidal ce The latter part of the floor is extremely thin, so that suppuration the frontal sinus is liable to extend to the anterior ethmoidal ce The posterior wall separates the sinus from the frontal lobes of t brain by an extremely thin plate of bone. The anterior wall is thi and is represented externally by the superciliary ridge. In t posterior portion of the floor of the sinus is the rounded or o aperture leading into the infundibulum and thence to the mid meatus by means of the hiatus semilunaris.

The ethmoidal cells lie in the lateral masses of the ethmoid bo These cells vary in size and number. They are divided into t sets, anterior and posterior. The anterior open into the mid meatus, generally by the infundibulum, while the posterior set op into the superior meatus. These cells are separated from the cran cavity and orbit by extremely thin plates of bone.

The sphenoidal cells are situated in the body of the sphenoid bo close to the base of the skull. They are quadrilateral in shape a variable in size, and, like the frontal sinuses, they may be asymmet cal from deviation of the septum. The anterior wall looks downwa and forward and forms a part of the roof of the nasal cavity. T upper wall is very thin and separates the sinus from the cran cavity. The cells communicate with the nasal cavity through an opening situated above and behind the superior turbinate.

Diagnostic Methods

Prior to making an internal examination of the nasal cavities, careful notes should be taken of the patient's history and symptoms, for future reference, and a thorough inspection should be made of the external nose. On general inspection one should note the shape of the nose, with reference to signs of cretinism, syphilis, new growths, deviations, or deformities. The shape of the jaws also should be observed; likewise the presence or absence of any prominences or bulging in the neighborhood of the accessory sinuses; the presence or absence of enlarged cervical glands; the presence of excoriations, herpes, or crusts about the anterior nares and upper lip, as indications of nasal discharge. It should be ascertained whether the patient breaths through the mouth, and the patency of the nose should be tested by alternately closing each nostril with the finger while the patient breaths through the opposite one. The odor of the breath, the presence or absence of marked movement of the alæ nasi, or any sounds produced during nasal breathing, and the character of the voice should also be carefully noted. Having completed this preliminary examination, that of the interior of the nose may be proceeded with.

For an examination of the nasal cavity and accessory sinuses five methods are available: namely, (1) inspection or rhinoscopy; (2) probing; (3) palpation; (4) transillumination; and (5) skiagraphy.

RHINOSCOPY

Inspection of the interior of the nose may be performed by anterior and by posterior rhinoscopy. In anterior rhinoscopy the examination is made through the anterior nares with the aid of a suitable speculum and a strong light. Posterior rhinoscopy consists in an examination of the nose from within the pharynx by the aid of reflected light and a rhinoscopic or small laryngeal mirror. The former is simple and requires no great skill, but the latter is by no means an easy procedure for one not specially trained, and at times requires considerable patience on the part of the operator to complete successfully and satisfactorily.

Illumination.—To obtain a satisfactory view of the interior of the nose, it is necessary to have good illumination. Strong sunlight

may be utilized for anterior rhinoscopy, but it is not suitable
examination of the posterior nares. A Welsbach burner fitted
mica chimney, over which is placed a Mackenzie condenser
excellent illumination (Fig. 339). Electric light from a
lamp is also much used and has an advantage in that it do
give out much heat.

Whatever the form of light, it should be so arranged
suitable bracket that it may be raised, lowered, or turned fro

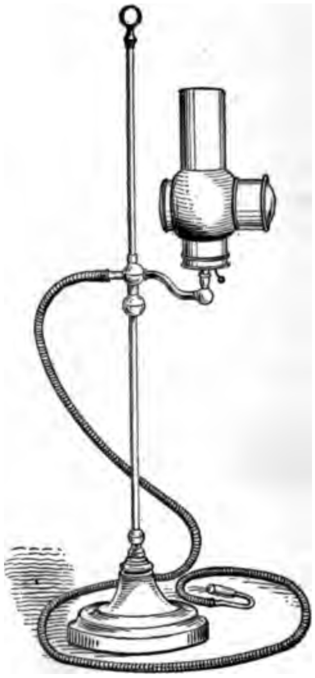


FIG. 339.—Gas lamp upon an adjustable stand fitted with a Mackenzie cond

to side without inconvenience to the operator. The light sho
placed upon the patient's right, somewhat behind him, and
on a level with the tip of his ear.

Many operators prefer an illumination furnished by an ele
head light (Fig. 340). Such a light, with the current furnishe
a small pocket storage battery will be found a great conve
outside the examining room.

Instruments.—In addition to a suitable light, there will
quired: a concave head mirror, about 3½ to 4 inches (9 to 1
in diameter, with a large central eye-hole, and secured to
leather headband by a ball-and-socket joint; a rhinoscopic

½ inch (1 cm.) in diameter, set at an angle of 100 to 110 degrees with the shaft, which is curved to follow the line of the tongue; a Myles solid-blade nasal speculum; a Fraenkel tongue depressor; a White palate retractor; and a nasal applicator with a triangular-tipped shaft (Fig. 341).

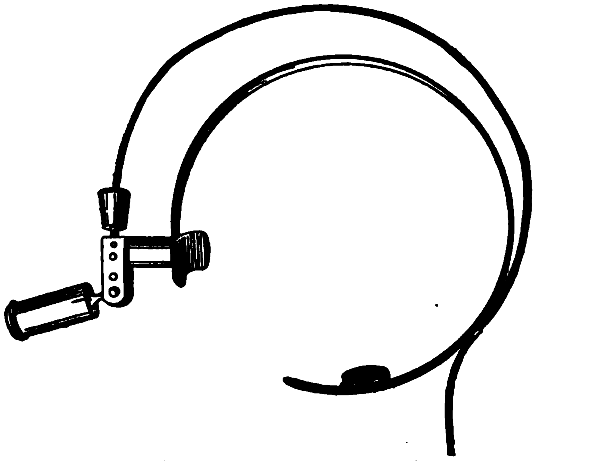


Fig. 340.—Electric head light.

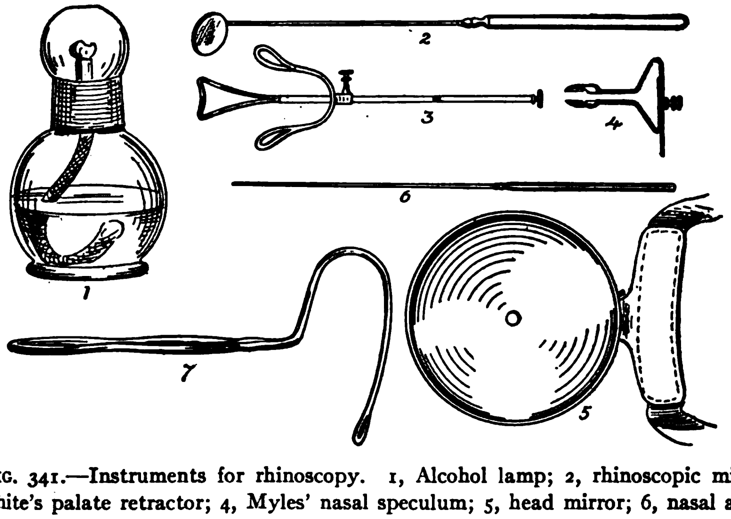


Fig. 341.—Instruments for rhinoscopy. 1, Alcohol lamp; 2, rhinoscopic mirror; 3, White's palate retractor; 4, Myles' nasal speculum; 5, head mirror; 6, nasal applicator; 7, Fraenkel's tongue depressor.

Asepsis.—Instruments, such as tongue depressors, specula, applicators, etc., may be sterilized by boiling. The rhinoscopic mirrors, however, which are soon destroyed by boiling, may be sterilized by immersion in a solution of 1 to 20 carbolic acid and then wiped dry before using.

Position of the Patient.—The patient is seated upright upon a firm, straight-backed chair. The examiner sits, facing the patient, upon an adjustable seat, such as a piano stool, which may be readily raised or lowered according to the height of the patient.

Technic.—1. *Anterior Rhinoscopy.*—The operator adjusts the head mirror in such a way that the central opening is opposite his left eye and the light is reflected into the nostrils of the patient. The outline of the anterior nares is then brought into view, and the relative size of the two fossæ may be appreciated. Care should be taken to look for fissures, abrasions, or pimples on the inner surface of the vestibule of the nose, contact with which would make the introduction of the speculum painful, without preliminary cocainization. The speculum is then introduced with the blades closed, and, upon sliding them apart, the necessary amount of dilatation is obtained (Fig. 342).

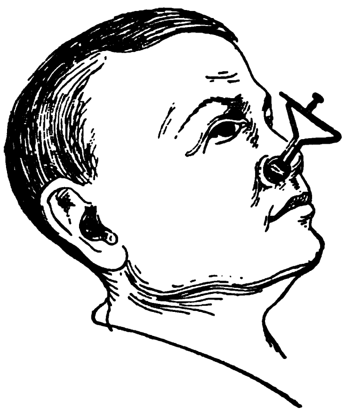


FIG. 342.—Myles' speculum in place.

The inspection of the cavity should proceed from before backward, the light being thrown into all recesses. By slightly elevating the tip of the nose, the floor of the nose, the inferior turbinate, and the inferior meatus are brought to view. In some cases where the nose is very broad or the inferior turbinate small or shrunken, it may even be possible to see as far back as the posterior wall of the nasopharynx. By bending the patient's head backward and raising the chin, the middle meatus and the middle turbinate may be seen; only when the latter has been removed, or is very much atrophied, however, is it possible to obtain a view of the apertures leading to the accessory sinuses. Tilting the patient's head still further backward exposes to view the upper portion of the middle turbinate and the roof of the nose. Occasionally the opening of the sphenoidal sinus may be made out, but only in exceptional cases is it possible to see the superior turbinate.

By the direct application of cocain or adrenalin to the mucous membrane with cotton pledgets or by spraying, the membrane may be caused to shrink and a more satisfactory view of the structures within the nose may be obtained. This is especially useful where the nasal cavity is narrow or the turbinates are hypertrophied.

Secretions that obstruct the view are gently wiped away by means of a cotton-wrapped nasal probe or applicator. The appearance and general condition of the mucous membrane are thus inspected and the apparent source of any discharge noted. In general, pus in the middle meatus means that the frontal or maxillary sinus or anterior ethmoidal cells are involved, as they all drain into this recess; while a discharge seen in the space between the middle turbinate and septum signifies infection of either the sphenoidal or posterior ethmoidal cells. To ascertain exactly which sinus is involved,

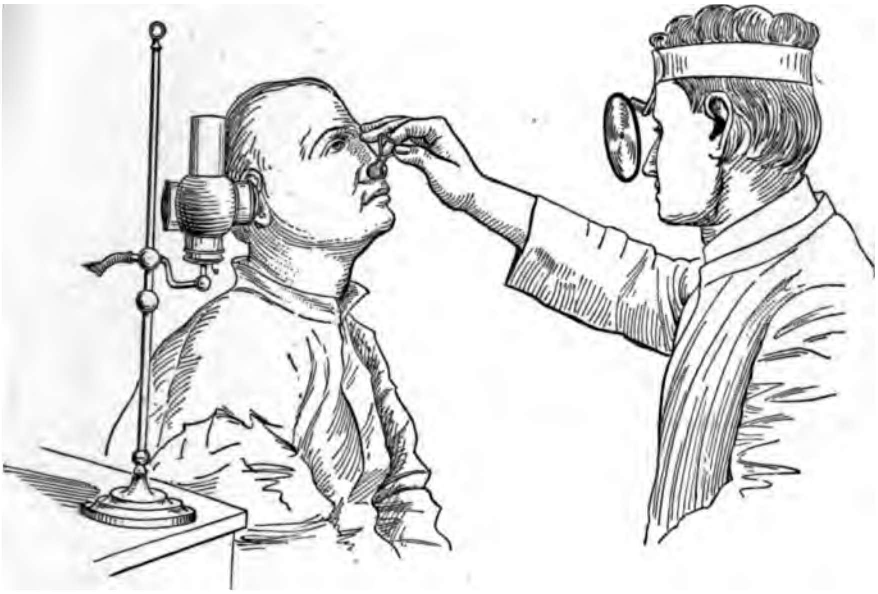


FIG. 343.—Showing the method of performing anterior rhinoscopy.

frequently other aids to diagnosis, as probing, transillumination, or skiagraphy, must be employed.

The attention of the examiner is finally directed to the bony and cartilaginous portions of the nose. Deviations, ulcerations, perforations, and spurs of the septum, contracture or hypertrophy of the turbinal bodies, the presence of foreign bodies, the presence of new growths and their point of attachment, etc., etc., are in a general way the conditions to be looked for.

2. *Posterior Rhinoscopy.*—The operator adjusts the head mirror over his left eye so that the light is thrown upon the patient's mouth. The patient is instructed to open the mouth, and a tongue depressor held between the thumb and the index and middle fingers of the left

hand, is inserted and passed over the dorsum of the tongue until the tip of the instrument rests just behind its arch. The tongue is then drawn downward and forward into the floor of the mouth (Fig. 344). If care be taken not to insert the depressor too far and to avoid pushing back on the tongue, gagging will be prevented. A mirror of suitable size is then warmed and, with the light reflected upon the posterior pharyngeal wall, the mirror is gently introduced into the mouth, lightly held between the thumb and forefinger of the right hand with its metal surface directed toward the tongue. The mirror

Fig. 344.— First step in posterior rhinoscopy, inserting the tongue depressor.

should then be carefully carried back into the nasopharynx, avoiding the back of the tongue, the palate, and uvula. After the instrument has entered the nasopharyngeal space, a clear view of the posterior ends of the turbinates and the other postnasal structures will be obtained by depressing the handle of the instrument slightly so that the upper border of the mirror lies behind the soft palate. At the same time, the handle of the mirror should be so held toward the left angle of the patient's mouth that illumination is not interfered with (Fig. 345).

It should be remembered that it is not possible to obtain a view of the whole postnasal space at one time, but, on turning the mirror in various directions by rotating its handle, different portions may be brought into view and the entire space may thus be examined in detail. By first holding the handle of the instrument well up, the vault of the pharynx will be brought into view, and the presence or absence of adenoids or other tumors may be ascertained. The pharyngeal vault is usually smooth and dome-shaped, but it may be almost completely filled up and show depressions and elevations depending on the size and condition of the pharyngeal tonsil. On depressing the handle slowly, the posterior nares may be examined in detail from above downward. In the median line is seen the sep-

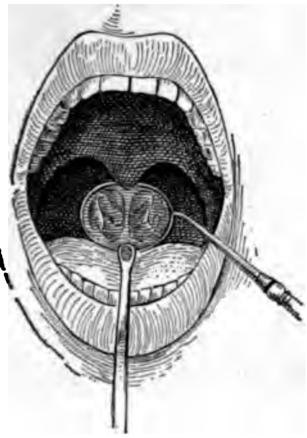


FIG. 345.

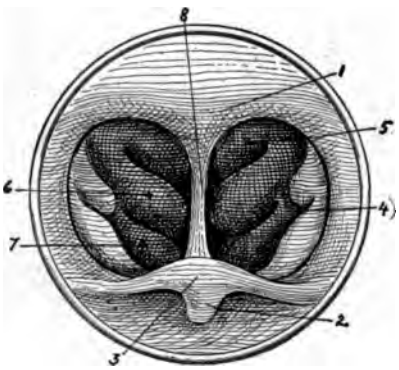


FIG. 346.

FIG. 345.—Showing the rhinoscopic mirror in place.

FIG. 346.—Posterior rhinoscopic image. 1, Roof of pharynx; 2, uvula; 3, soft palate; 4, opening of Eustachian tube; 5, superior turbinate; 6, middle turbinate; 7, inferior turbinate.

tum; on either outer wall from above downward will be seen the ridge of the superior turbinate, with the superior meatus lying just below as a darkened depression. Below this will be observed the middle turbinate as a pinkish-white fusiform body, and, underlying this, the middle meatus. The inferior turbinate appears just below this as a grayish-white body. Finally, by turning the mirror to either side, the orifices of the Eustachian tubes and the Eustachian cushions are brought to view. Care should be taken not to keep the mirror in the throat too long or the patient will be tired out; to make a complete examination, it is better to reinsert it more than once if necessary.

In some cases it may be almost an impossibility to make a satisfactory posterior rhinoscopic examination. This may be from the formation of the parts, as, for example, in the presence of a hard palate which extends so far back that there is no room for the mirror, or a broad soft palate with a long uvula, or it may be due to the presence of a growth in the nasopharynx. The most common obstacle, however, is the involuntary elevation of the soft palate on the introduction of the mirror, so that the view of the parts above is blocked. Instructing the patient to breathe through the nose with the mouth open, or to pronounce "en" with strong nasal sound, often suffices to overcome this impediment. In other cases it will be necessary to use a palate retractor, such as White's. After applying cocain to the palate, the wire palate loop of the instrument is passed behind the soft palate

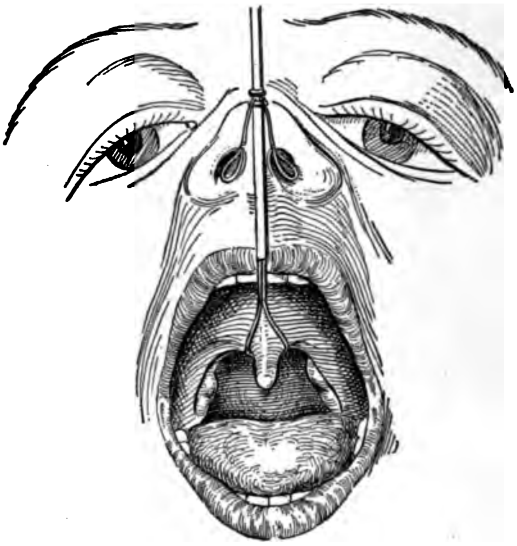


FIG. 347.—White's palate retractor in place.

and the stem of the instrument so adjusted as to draw the palate well forward into the desired position. The instrument is maintained in position by means of the wire loops which rest within the nose (Fig. 347).

INSPECTION OF THE NASOPHARYNX BY MEANS OF THE HAYS PHARYNGOSCOPE

To overcome the difficulties encountered in examining the nasopharynx with a rhinoscopic mirror, Hays has devised an instrument made on the plan of an indirect view cystoscope, which he calls the pharyngoscope.[1] With this instrument, the use of which requires none of the skill necessary for the ordinary posterior rhinoscopic examination, it is possible to obtain a clear picture of the nasopharynx, posterior nares, Eustachian tubes, as well as the larynx without the slightest discomfort to the patient. Furthermore, as the various structures are brought to view they may be inspected in a very systematic and thorough manner and with the avoidance of any haste, as the instrument, once inserted, may be left in place anywhere from five to twenty minutes, during which time its position need not be changed.

Instruments.—All that is required is the pharyngoscope and a six-dry-cell battery. The instrument is made in the form of a tongue

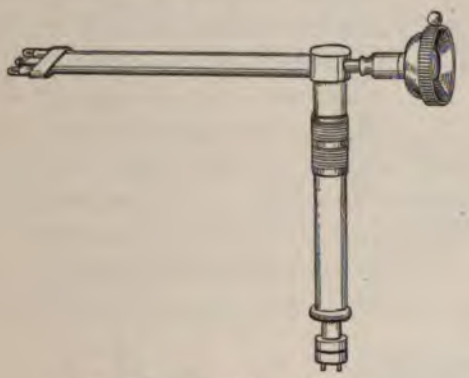


FIG. 348.—Hays' pharyngoscope.

depressor, the horizontal portion of which is flattened in its inner two-thirds, and in its widest part measures less than 5/8 inch (1.6 cm.). It contains a central tube into which a movable telescope fits and also two wire carriers. At the distal end of the instrument are placed two lamps, one on each side of the telescope. On the circumference of the eye-piece of the telescope is a small metal guide, to indicate the direction in which the lens is turned. The length of the horizontal portion including the telescope is about 8 inches (20 cm.). The vertical portion or handle of the instrument contains the wires which carry the current to the lamps. Near its upper end is placed a switch for turning on or off the current (Fig. 348).

Asepsis.—The instrument must be thoroughly sterilized before use. This is accomplished by means of formalin vapor or by immer-

[1] Harold Hays, in the *New York Medical Journal*, April 19, 1909, and the *Laryngoscope* July, 1909.

sion in a 1 to 20 carbolic acid solution followed by rinsing in alc or sterile water. It will not stand boiling

FIG. 349.—Showing the method of inserting the Hays pharyngoscope (after Hays *Am. Jour. Surg.*, May, 1909).

Anesthesia.—As a rule, anesthesia is necessary. Should, however, gaging be duced by the instrument, the post pharyngeal wall may be cocainized.

Technic.—The patient is instructed open his mouth widely and breathe qui The instrument is then inserted in the s manner as a tongue depressor, until its d end lies about 1/16 inch (1.5 mm.) from pharyngeal wall (Fig. 349). The instrur is kept steadily in place upon the ton and the patient is told to close the m and breathe through his nose. This prod relaxation and consequent widening of pharynx and nasopharynx. The light is turned on, and the examiner inspects structures as they are separately brougl view by rotation of the telescope. Thus the lens pointing upward, as shown by knob on the eye-piece, the pharyngeal vault is brought to v

FIG. 350.—Showing the pharyngoscope in place with the examiner inspecti postnasal space.

and, by tilting the distal end of the instrument slightly up the posterior nares are viewed.

To inspect the region of the Eustachian tubes, the lens is rotated about 30 degrees to one side, when the orifices of the tubes, Rosenmüller's fossa, etc., will be clearly shown. By rotating the lens so that it points downward the epiglottis, larynx, and base of the tongue are similarly inspected.

PALPATION BY THE PROBE

The use of the probe is essential to a complete examination of the nose. By its aid the consistency and character of structures normally present, as well as the presence of abnormal growths, adhesions, foreign bodies, and the patency or obstruction of the openings leading to the accessory sinuses, may be determined.

Instruments.—The instruments comprise those necessary for a rhinoscopic examination; a nasal applicator; a nasal probe; and a sinus probe (Fig. 351).

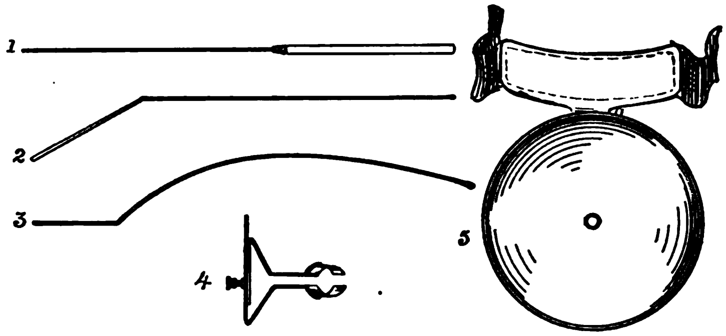


FIG. 351.—Instruments for palpating the interior of the nose. 1, Nasal applicator; 2, nasal probe; 3, sinus probe; 4, Myles' nasal speculum; 5, head mirror.

The nasal probe should be of silver, fairly stiff, but at the same time capable of being bent. It should be about 8 inches (20 cm.) long, and set into its handle at an angle of 135 degrees.

The instrument employed for examination of the sinuses must be of pure soft silver and fine in size so that it may be readily bent to any curve or be adjusted to the shape of the region through which it has to pass.

Asepsis.—The speculum, applicator, and probes are sterilized by boiling.

Anesthesia.—The nasal mucous membrane is very sensitive and manipulations are apt to produce sneezing, so that the parts should be cocainized before the probe is employed. This may be done by applying a 4 per cent. solution on a small pledget of cotton, allowing sufficient time to elapse for the cocain to take effect before proceeding with the examination.

Position of Patient.—The positions of the patient and operator are the same as for a rhinoscopic examination (see page 366).

Technic.—By means of a speculum and reflected light the interior of the nasal cavity is brought into view and is then systematically explored by the probe. Any growths are palpated to determine their consistency, and masses that may be hidden beneath the turbinates and otherwise escape attention may be rolled into view by means of the probe. The condition of the mucous membrane, the presence and depth of ulcerations, etc., are ascertained. All recesses should be thoroughly examined, and especially the walls of the sinuses should be gently palpated for the presence of dead bone.

In the presence of symptoms or signs pointing to involvement of the sinuses, the sinus probe should be employed to determine their

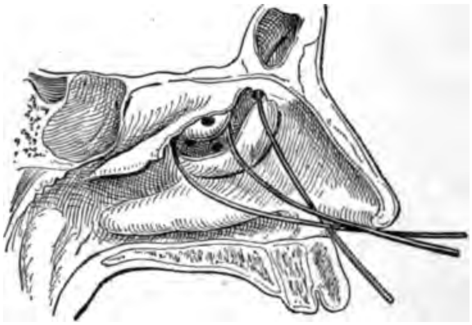


FIG. 352.—Showing the steps in the passage of a probe into the frontal sinus.

condition and the patency of their ostia as a preliminary to irrigation. On account of the anatomical arrangement of the parts, probing is practically limited to the sphenoidal and frontal sinuses unless the middle turbinate is first removed. Before making any exploration of these cavities, any visible pus or discharge is wiped away and the nasal cavity cleansed by syringing.

To enter the frontal sinus, the distal end of the probe, bent to an angle of 135 degrees, is inserted within the middle meatus at the junction of the anterior third and posterior two-thirds of the middle turbinate. Its tip is made to hug the outer wall of the middle turbinate, and is passed upward and forward through the hiatus and into the infundibulum. By depressing the handle of the instrument, its tip will traverse the infundibulum and pass through the ostium frontale unless some obstruction exists. Gentleness should be employed in this maneuver, and no attempt should be made to force the instrument if any obstruction to its passage exists.

To enter the sphenoidal sinus, the end of the probe is bent to a slight curve and is passed into the nose with its convexity upward. The tip of the instrument is made to traverse the roof of the nasal fossa until it meets the resistance of the anterior sphenoidal wall. The probe is then moved gently about in various directions until its point enters the cavity of the sinus, which is then carefully explored.

In either case, when the probing is employed as a preliminary to irrigation, and the particular sinus has been successfully entered by the probe, if the shape of the irrigator be made to correspond to that of the probe it will be of great help in the introduction of the former.

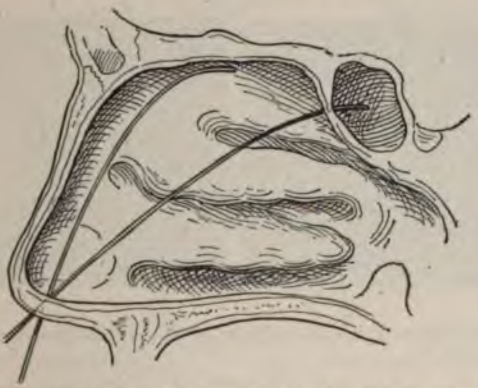


FIG. 353.—Showing the steps in the passage of a probe into the sphenoidal sinus.

DIGITAL PALPATION

Palpation of the posterior nares by means of the finger is employed to confirm the diagnosis made by posterior rhinoscopy, or to obtain information as to the condition of these parts when the latter is not possible. No instruments are needed, except in the case of unruly children, when a mouth gag may be required. While digital palpation is a rather unpleasant procedure for the patient, if performed rapidly and skilfully many of the disagreeable features may be eliminated.

Preparations.—The operator's hands should always be well scrubbed before making such an examination.

Technic.—It is well to first explain to the patient what is intended to be done. The patient is then directed to open the mouth widely. The left hand of the operator supports the patient's head, and at the same time with the thumb or index finger of the same hand he forces the cheek in between the open jaws to prevent the examining finger from being bitten (Fig. 354). The index finger of the right hand is then gently but quickly introduced into the mouth and is hooked around the posterior border of the soft palate into the nasopharynx,

FIG. 354.—Showing the method of palpating the postnasal space with the finger.

and the parts are palpated. In this way the presence of adenoids, hypertrophies of the posterior ends of the turbinates, or other growths are readily recognized.

TRANSILLUMINATION

Transillumination is a valuable aid for determining the condition of the frontal or maxillary sinuses. Its use in connection with other

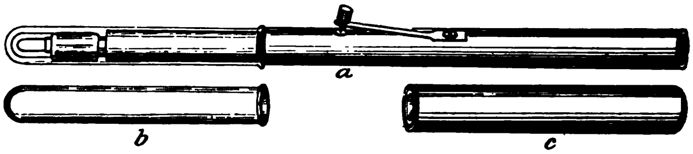


FIG. 355.—Coakley's transilluminator. *a*, Apparatus assembled for transillumination of the antrum; *b*, glass hood for use in transillumination of the antrum; *c*, hood for use in transillumination of the frontal sinus.

sinuses is futile. This method of diagnosis becomes possible from the fact that the air spaces, when in a healthy state, transmit light through their thin walls, which power is diminished when pus is present or the mucous membrane lining the cavity is much thickened.

Transillumination is not an infallible method, the chief causes of error being imperfect symmetry of the two sides, due to a difference in the size of the two sinuses or to a variation in the thickness of the bony walls. Another source of error occurs when involvement of both sides of a pair of sinuses exists, and there is therefore nothing upon which to base a comparison. The method is of greatest service in the diagnosis of empyema of the antrum and of the frontal sinus. In the latter it is not so valuable or nearly so reliable an aid as in the former, for the size of the two frontal sinuses and the thickness in the individual bones are apt to vary.

Fig. 356.—Transillumination effect in a normal right frontal sinus.

Fig. 357.—Transillumination effect in a diseased left frontal sinus.

Apparatus.—There are many lamps adapted to the purpose of transillumination, Coakley's being an excellent model. This consists of a handle of nonconducting material containing a lamp and glass hood for transillumination of the maxillary sinus, and a second hood to fit over the lamp in place of the glass one, for use about the frontal sinus (Fig. 355). The lamps are of about four or five candlepower, the electricity being supplied by a small battery or the street current. In employing the latter, a current controller, by which the amount of current may be regulated, will be necessary.

Technic. 1. *Transillumination of the Frontal Sinus.*—The patient is seated in a dark room. The black hood is drawn over the transilluminator and the instrument is placed beneath the orbital portion of the brow at the nasal side. The light is turned on and the sinus is clearly illuminated, the operator noting the effect. The opposite side is treated in the same manner, and the two are compared as to the intensity with which the light is transmitted.

Through a large sinus in a normal condition the light is transmitted with greater intensity than through a small cavity, or through one with thickening of the bony walls or the lining membrane, or one complicated by the presence of pus or a tumor.

2. *Transillumination of the Antrum.*—The patient is seated in a darkened room, any dental plates or obturators that might obstruct the light having been previously removed. The electric lamp, covered with the glass hood, is then introduced into the mouth, and the patient is instructed to close his lips firmly. Under normal conditions when the lamp is lighted, the cheeks, up to the infraorbital margins, and both pupils are clearly illuminated. If one antrum contains pus or a solid tumor, the malar region of that side will appear

FIG. 358.—Transillumination effect in the normal case. (After Harmon Smith, in Keen's Surgery.)

FIG. 359.—Transillumination effect in sinusitis of the right antrum. (After Harmon Smith, in Keen's Surgery.)

darker and an absence of illumination of the pupil will be noted. The transmission of light will also be interfered with in the presence of thickened walls or lining mucous membrane.

SKIAGRAPHY

The X-ray gives important information in regard to the frontal, ethmoid, and maxillary sinuses, and, when possible, it should be regularly employed as one of the aids in diagnosis. To be of any value, however, it must be applied by a competent radiographer. It is especially valuable in diseases of the frontal sinuses. In a healthy condition, the outlines of the sinuses are clear and distinct; while in diseased conditions the outlines are not so clearly indicated and the whole area of the sinus appears cloudy. In addition the X-ray will show the size and shape of the frontal sinus and the position of the septum, all of which are important points in making a decision as to the method of operating, should it be necessary. To determine the size of a sinus it is necessary to take two plates, one in profile and the other full face.

Therapeutic Measures

NASAL DOUCHING

Nasal douching is employed for the purpose of cleansing the nasal cavity prior to operative procedures or for the purpose of removing secretions or crusts preparatory to the application of other remedies.

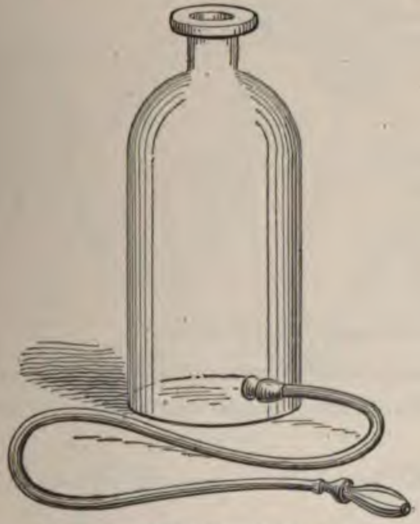


FIG. 360.—Nasal douche apparatus.

It must always be used with due precautions, for there is considerable risk where fluid is forced into the nose in bulk that some of it will enter the Eustachian tubes and cause an otitis media. For this reason only small quantities of solution are employed at a time, and the injection should be made without any force. If one side of the nose is obstructed, the solution should enter by that nostril and escape from the more open one. As a further precaution, any excess of fluid remaining after the irrigation should be allowed to flow from the nose or be drawn into the mouth and expectorated, but not blown from the nose for fear of forcing some into the Eustachian tubes. For the patient's own use nasal spraying is a safer method to employ, and, if it becomes necessary to prescribe a nasal douche, the surgeon should carefully instruct the patient in the proper method of its use.

Apparatus.—An ordinary douche bag with a capacity of about a pint (500 c.c.), fitted with a nasal nozzle, forms a simple and effective douche. There are a number of douches especially made for the nose, a convenient type for use with large quantities of solution being shown in Fig. 360. It consists of a pint bottle to the bottom of which is attached a rubber tube fitted with a nasal nozzle. The small glass douche (Fig. 361), known as the "Bermingham douche," is useful where the cleansing is to be carried out by the patient.

Solutions.—For ordinary cleansing purposes the solution should be alkaline and as unirritating as possible.

One of the following formulæ may be employed.

℞. Sodii bicarbonatis,			
Sodii biboratis,		āā. dr. i (4 gm.)	
Acidi carbolici,		♏xv (1 c.c.)	
Glycerini,		oz. i (30 c.c.)	
Aquæ,	q. s. ad.	Oi (500 c.c.)	M.

℞. Sodii bicarbonatis,		dr. i (4 gm.)	
Acidi salicylici,		gr. x. (0.65 gm.)	
Aquæ,	q. s. ad.	Oi (500 c.c.)	M.

℞. Sodii bicarbonatis,		
Sodii biboratis,		
Sodii chloridi,	āā. oz. i (30 c.c.)	M.

Sig. A teaspoonful to a pint of warm water.

Some of the proprietary preparations, such as listerin, borolyptol, glycothymolin, alkalol, etc., will be found of value where an antiseptic

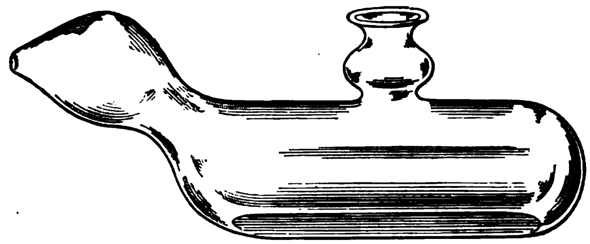


FIG. 361.—The Bermingham nasal douche.

action is also desired. They may be used in the proportion of dr. ss to dr. i (2 to 4 c.c.) to the ounce (30 c.c.) of water. When there is an offensive discharge, the following may be employed.

℞. Potassii permanganatis,	gr. i–ii (0.06–0.1 gm.)	
Aquæ,	ad. oz. i (30 c.c.)	M.

Temperature.—All solutions should be used warm, at a temperature of about 100° F. (38° C.).

Quantity.—For ordinary cleansing purposes or for the removal of free secretion from the nose, a few ounces of solution are sufficient. When hard crusts are abundant, however, it sometimes requires a pint (500 c.c.) of solution, or more, to loosen them and effect their removal.

Rapidity of Flow.—The solution should be injected with only sufficient force to permit its return from the opposite nostril in a slow,

Fig. 362.—Showing the method of using the nasal douche.

gentle stream—never under high pressure. Accordingly, the reservoir should be raised only 2 or 3 inches (5 to 7.5 cm.) above the level of the nose.

Technic.—The patient sits with his head bent slighly forward over a basin or sink, with a towel or napkin placed about his neck for protection of the clothes. The douche nozzle, held in the right hand, is then inserted into one nostril with sufficient firmness to prevent the solution from escaping, while with the left hand the reservoir is raised a few inches so that the solution enters the nose in a weak stream. The patient is directed to breathe through his mouth and to avoid swallowing during the lavage. In this way, when the patient's head is bent forward, the fluid does not escape into the pharynx, but passes through one nostril back into the nasopharynx and out through the other nostril (Fig. 362). When no obstruction exists in either side, half the solution may be injected through one nostril and the remainder in the reverse direction through the other.

With the small glass douche cup the technic is very simple. The patient inserts the nozzle of the partially filled instrument into one nostril, holding the finger over the side opening. He then throws his head well back and removes his finger from the opening, which allows the solution to flow through the nose into the mouth, whence it is expectorated. Each nostril in turn may be thus irrigated.

THE NASAL SYRINGE

The nasal syringe is employed mainly for cleansing the nose. The solution may be injected either from the front, returning through the opposite nostril, after the manner of the nasal douche, or the nose may be washed out from behind forward. By the latter method the postnasal space may be more effectually cleansed of sticky secretions and mucus than by injecting the solution from the front. The same precautions should be observed in using the syringe as have been mentioned for the use of the douche.

Instruments.—A syringe with a capacity of 1 to 2 ounces (30 to 60 c.c.), made of metal or hard rubber, will be required. It should

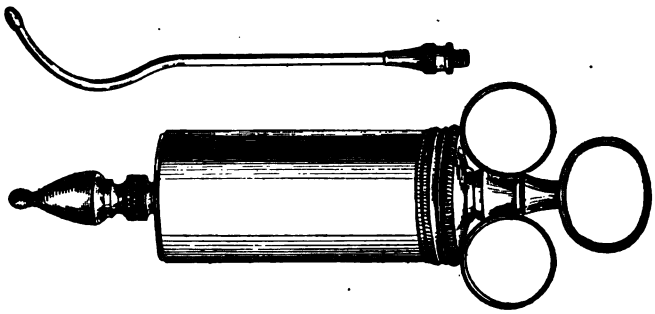


FIG. 363.—Nasal syringe with anterior and posterior nasal tips.

be supplied with a straight nozzle for injection through the anterior nares, and with one bent up almost at right angles for cleansing the postnasal space (Fig. 363).

Solutions.—Any of the cleansing solutions mentioned on page 380 may be employed. They should always be used warm.

Technic.—In employing the nasal syringe much the same technic is followed as with the douche, observing due care against injecting the solution with too much force, etc. The nozzle of the syringe is inserted into one nostril and the patient is directed to keep his head bent well forward over a receptacle and to breathe through the mouth. The solution is then slowly injected and returns through the opposite nostril. The irrigation should be so regulated that the fluid returns as quickly as it enters, thus avoiding any undue accumulation in the postnasal space and lessening the dangers of infecting the Eustachian tubes.

To syringe from the posterior nares, a tongue depressor is introduced into the mouth to keep the tongue out of the way, while the distal end of the postnasal tip is introduced behind the soft palate.

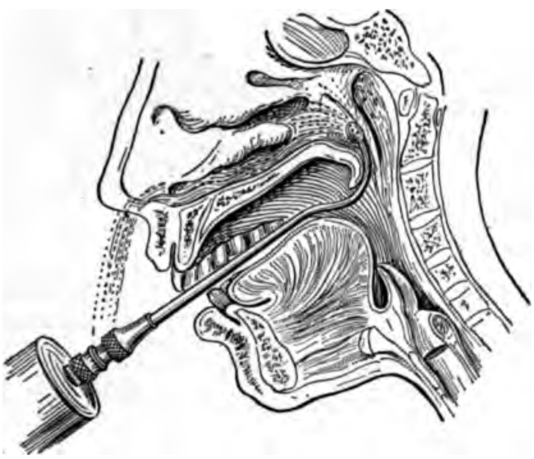


FIG. 364.—Showing the method of syringing the nose from behind.

The patient is then directed to hold his head well forward, the fluid is slowly injected and escapes from the anterior nares, flushing out the postnasal space and nose from behind forward (Fig. 364). On account of the sensitive condition of the parts in some cases it may be necessary to cocainize the pharynx and soft palate before the syringing can be properly performed.

THE NASAL SPRAY

Sprays or atomizers are utilized either for cleansing purposes or for the application of remedies to the nasal mucous membrane when it is not necessary to confine the solution to one particular spot.

Apparatus.—The simplest form of atomizer usually proves most satisfactory, and is less liable to get out of order. The Whitall

Tatum (Fig. 365), the Davidson, or the De Vilbiss (Fig. 366) are all good atomizers. The latter is especially serviceable, and the spray part, being of metal, may be readily sterilized. The instrument should be provided with a straight nasal tip as well as with a postnasal tip. The air current may be supplied by a rubber compression bulb or from a compressed air tank (Fig. 367). The latter will be found more convenient for office work.

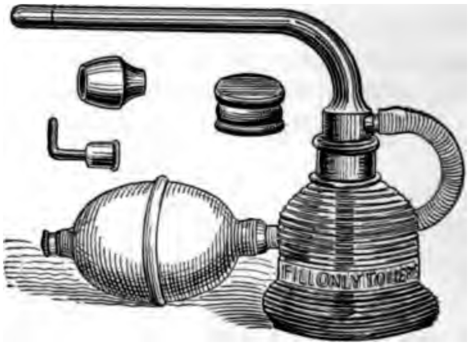


FIG. 365.—Whitall Tatum atomizer.

For cleansing purposes, the spray should be rather coarser than that employed for medication. Oily preparations may be sprayed with an ordinary atomizer provided with an oil tip, or a special nebulizer may be employed.

Solutions.—Any of the cleansing solutions mentioned on page may be employed in a spray.

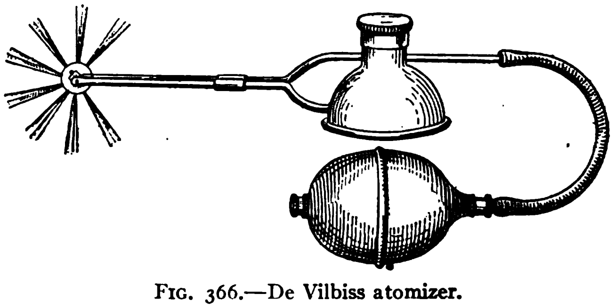


FIG. 366.—De Vilbiss atomizer.

When a mild antiseptic action is desired, the solutions given on page 380 or the following may be used:

℞. Acidi carbolici	gr. v (0.3 gm.)
Glycerini,	dr. i (4 c.c.)
Aquæ	q. s. ad. oz. i (30 c.c.) M.

℞. Resorcini,	gr. iii (0.2 c.c.)
Glycerini,	dr. i (4 c.c.)
Aquæ,	q. s. ad. oz. i (30 c.c.). M.

Astringent solutions, for purposes of lessening secretions, include such drugs as zinc sulphocarbolate, zinc sulphate, copper sulphate, alum, tannic acid, silver nitrate, etc., used in the strength of 5 gr. (0.3 gm.) to the ounce (30 c.c.) of water.

Oily preparations, with albolene or benzoinol as a base, are frequently used after the application of aqueous solutions for the purpose of protecting the parts, the oil being deposited upon the mucous membrane in a thin coat. Usually eucalyptol, camphor, menthol, or thymol are combined with the oil in the proportion of 2 to 5 gr. (0.1

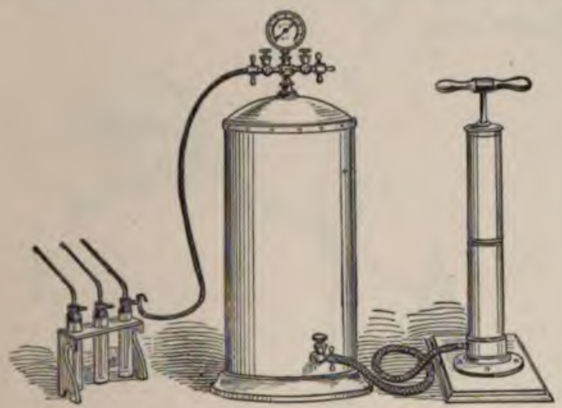


FIG. 367.—Compressed-air atomizing apparatus.

to 0.3 gm.) or more to the ounce (30 c.c.) for the sedative effect, as in the following:

℞. Eucalyptol,	♏x (0.6 c.c.)
Menthol,	gr. v (0.3 gm.)
Benzoinol,	oz. i (30 c.c.) M.
℞. Thymol,	
Menthol,	āā gr. ii (0.1 gm.)
Albolene,	oz. i (30 c.c.) M.
℞. Camphoræ.	
Menthol,	āā gr. v (0.3 gm.)
Albolene,	oz. i (30 c.c.) M.

When a stimulating action is indicated, the proportion of the above drugs may be increased.

Technic.—The tip of the nose is gently raised and the nozzle of the spray is inserted into the vestibule. To avoid injuring the mucous membrane of the septum or turbinates, care should be taken to keep the long axis of the spray and that of the nose in the same line. By alternately compressing and relaxing the rubber bulb, the solution is forced into the nose in a spray. The direction of the spray should be altered from time to time by raising or lowering the proximal end of the atomizer.

For spraying from the posterior nares, the same technic is employed as with the postnasal syringe (see page 383).

THE DIRECT APPLICATION OF REMEDIES

This method is employed for the application of strong solutions or solid caustics, or when it is desired to confine the action of the remedy to any particular area.

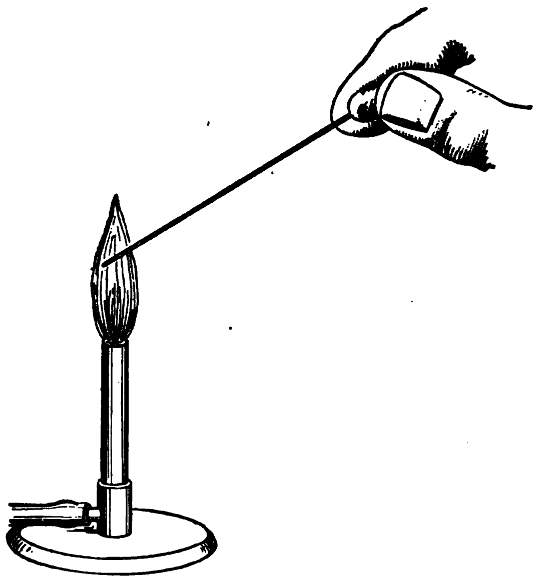


FIG. 368.—Fusing chromic acid on a probe. First step, heating the probe. (Gleason.)

Instruments.—For the application of solutions, a nasal applicator, the tip of which is wound with a thin layer of cotton, is employed. Solid caustics, as chromic acid, silver nitrate, etc., are best applied fused upon a probe or applicator.

Chromic acid may be prepared for application as follows: The probe tip is brought to a red heat over an alcohol flame (Fig. 368) and is then dipped into crystals of the acid (Fig. 369). Upon withdrawing the probe a few crystals will be found adhering to its point. This mass is then heated in the flame until the crystals begin to melt

(Fig. 370), and, upon cooling, they recrystallize in the form of a bead on the end of the instrument (Fig. 371). If it is desired to employ silver nitrate in this way, a few of the crystals should be melted in a crucible. The tip of a probe or applicator is then dipped into this liquid mass until sufficient of the caustic adheres, and, as soon as it solidifies, it is ready for use. In applying chromic acid a second cotton-wrapped applicator, saturated with a solution of bicarbonate of soda—30 gr. (2 gm.) to the ounce (30 c.c.)—should be at hand to neutralize any excess of acid.

FIG. 369.

FIG. 370.

FIG. 371.

FIG. 369.—Fusing chromic acid on a probe. Second step, dipping the hot probe in the crystals. (Gleason.)

FIG. 370.—Fusing chromic acid on a probe. Third step, heating the crystals into a bead. (Gleason.)

FIG. 371.—Fusing chromic acid on a probe. Showing the finished probe. (Gleason.)

Anesthesia.—The parts should be cocainized by the application of a 4 per cent. solution of cocain.

Technic.—The mucous membrane is well cleansed, and, when using caustics, the area to be treated is rendered as dry as possible to prevent the caustic spreading over too large a surface. The application is then made to the diseased spot under guidance of the nasal speculum, being careful not to allow the applicator to touch any other points. If acid is employed, any excess is immediately neutralized with the strong solution of bicarbonate of soda by means of an applicator previously prepared and in readiness.

INSUFFLATIONS

Various powders with sedative or antiseptic properties are applied to the nasal mucous membrane by means of a special powder blower. Finely powdered starch, stearate of zinc, or powered acacia is usually employed as a base, in the proportion of two parts to one of the active principle. Nosophen, aristol, europhen, iodoform, iodal, etc.,

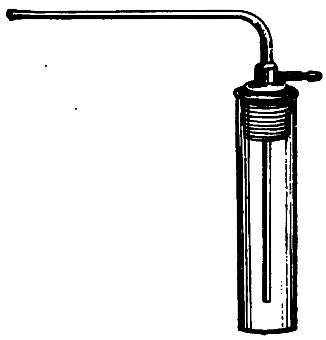


FIG. 372.—Powder blower.

are remedies frequently applied in this manner. Morphin and cocain in small doses may be combined with these powders when indicated.

Instruments.—The insufflator shown in Fig. 372 or that shown in Fig. 373 may be used. The former is made on the same principle as a hand spray, but with larger tubes. It, however, requires the

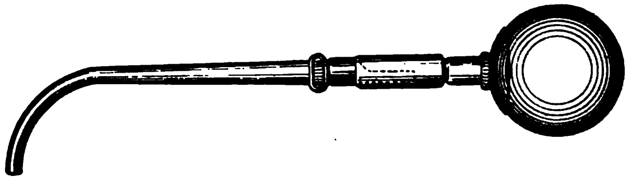


FIG. 373.—Scoop powder blower.

use of both hands in its manipulation. The latter instrument consists of a rubber compression bulb to which is fitted a vulcanized rubber tube. Into this latter fits the nasal tip, the proximal end of which is made in the form of a scoop for taking up the powder. When the instrument is filled, a sudden compression of the bulb forces air through the apparatus, blowing the powder out in front of it. This instrument may be manipulated with one hand, and the quantity of powder used can be accurately measured. Insufflators are supplied with straight tips for the anterior nares, and with curved tips for making applications to the posterior nares.

For the patient's use, an insufflator such as Sajous' (Fig. 345) will be found convenient. It consists of a small glass receptacle with an opening for pouring in the powder, to one end of which a rubber mouthpiece is attached, the other end being rounded off to fit into the nostril.

Technic.—With a suitable powder blower, the application of powders is very simple. The instrument being properly filled, the tip is inserted into the nostril or up behind the soft palate, according to whether the anterior or the posterior portions of the nose are to be medicated, and, with two or three rapid compressions of the bulb,

FIG. 374.—Sajous' powder blower.

the powder is forced out of the instrument and is deposited upon the mucous membrane.

When the insufflation is performed by the mouth, as with the Sajous insufflator, the tip is inserted into the nostril, the instrument being held with one finger over the opening in the bottom of the receptacle to make it air-tight. The mouthpiece is held between the lips and, by one or more gentle puffs, the powder is blown out upon the parts to be medicated.

LAVAGE OF THE ACCESSORY SINUSES

This procedure is employed as a means of diagnosis, for the purpose of removing purulent secretions, and for cleansing the mucous lining in the treatment of suppuration involving the accessory sinuses. It is performed by means of a suitable cannula introduced into the sinus through the natural or an artificial opening. Treatment by irrigation is most successful in the early cases of empyema; in those complication by granulation tissue or dead bone, it is not so satisfactory. It should, however, be given a trial in any case before the more radical surgical measures are considered.

Solutions Used.—Normal saline solution (salt ʒi (4 gm.) to the pint (500 c.c.) of boiled water), a saturated solution of boric acid, or any of the solutions mentioned on page 380 may be used.

Temperature.—All solutions employed in irrigating should be warm—at about 100° F. (38° C.).

Lavage of the Maxillary Sinus.—It is rarely possible to insert a probe or cannula into the maxillary sinus through its normal opening, on account of its hidden position and the fact that the opening is directed somewhat downward and forward from the infundibulum. If an accessory opening be present, however, it may be possible to irrigate through it, but in most cases an artificial opening will have to be made through the inferior turbinate, or through the alveolus after removal of the second bicuspid, or the first or second molar tooth. The former approach should be chosen when the teeth are sound and

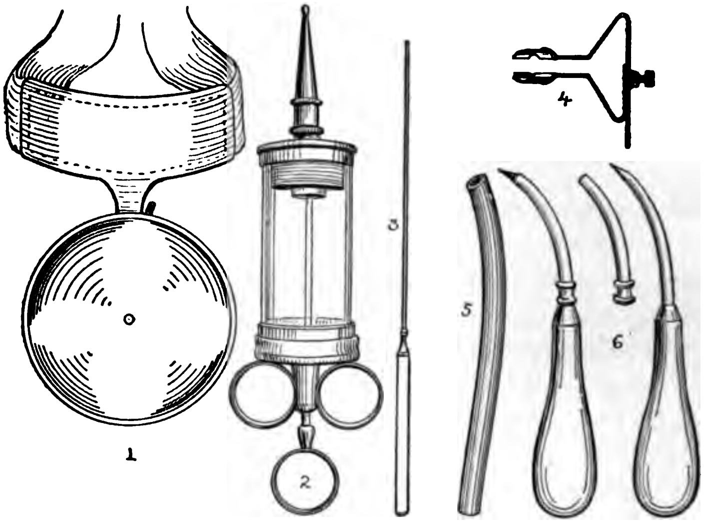


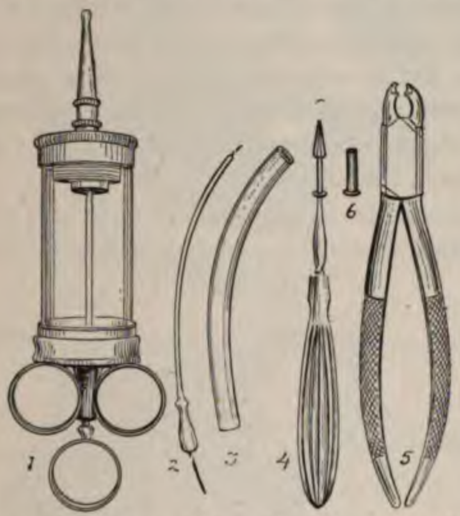
FIG. 375.—Instruments for lavage of the maxillary sinus through a puncture in the inferior meatus. 1, Head mirror; 2, syringe; 3, applicator; 4, Myles' nasal speculum; 5, tubing to connect the syringe and cannula; 6, Myles' trocar and cannula.

the origin of infection is apparently from the nose. When a decayed tooth is the source of trouble and the tooth is beyond saving, puncture through the alveolus is justifiable.

Instruments.—For irrigating through the inferior meatus, an antrum trocar and cannula and small syringe will be required. For opening through the alveolus, there should be provided suitable tooth-pulling forceps, an alveolar drill, a syringe, and a silver or aluminum tube of the same caliber as the drill, ½ to ¾ inch (1 to 2 cm.) long and provided with a flange to prevent its slipping into the antrum.

sis.—The instruments are sterilized by boiling, and the s nose is cleansed by gentle syringing.

thesia.—For puncture of the antrum through the inferior local anesthesia by the application of a 4 per cent. solution of n a pledget of cotton twenty minutes before will be sufficient.



76.—Instruments for lavage of the antrum through the alveolus. 1, Syringe; ; 3, tubing to connect the syringe to the cannula; 4, alveolar drill; 5, drainage-oth-extracting forceps.

ous oxid anesthesia should be employed for the extraction th and drilling through the alveolus.

nic. 1. *Through the Inferior Meatus.*—Having obtained a ew of the interior of the nose by the aid of a speculum and

—Showing the method of puncturing the antrum through the inferior meatus.

l light, a point is selected just beneath the inferior turbinate ut ½ inch (1 cm.) behind its anterior extremity, and the introduced, pushing it in an outward, backward, and slightly upward direction, through the thin bony wall into the antrum (Fig. 377). The relation of the sinus to the orbit should be borne in mind when making this puncture and care taken not to enter the latter; this may happen if the puncture be made through the middle meatus (Fig. 378). As soon as the antrum has been entered, the trocar is withdrawn. The syringe is then attached to the cannula by a piece of rubber tubing, and the cavity thoroughly irrigated. Any secretion is thus forced out through the normal opening of the sinus and appears in the middle meatus. During the irrigation, the head should be held downward over a receptacle, so that the solution will readily escape from the nose.

The sinus should be irrigated daily until the discharge ceases, employing stronger or more stimulating solutions if they seem indi-

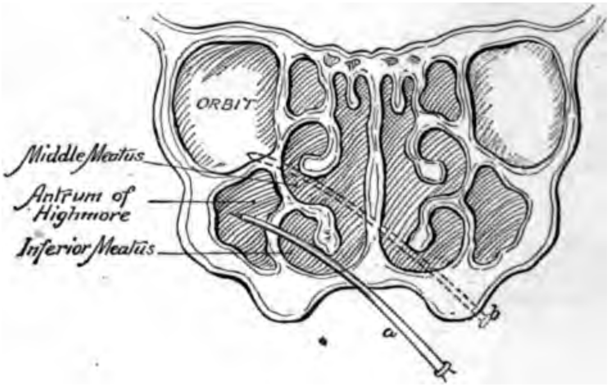
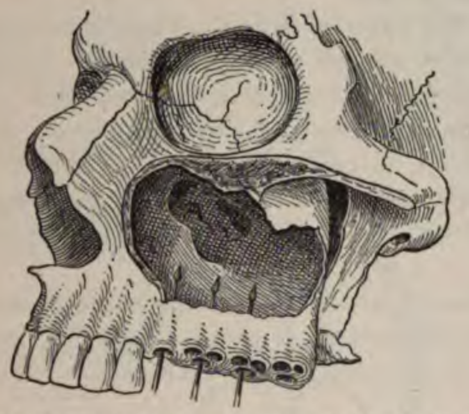


FIG. 378.—Transverse section through the nose, showing cannula. *a*, Entering antrum through inferior meatus; and *b*, cannula entering the orbit through the middle meatus. (After Coffin.)

cated. Usually there is no great difficulty in reinserting the cannula through the opening each day, if it is provided with a blunt obturator. The parts should be cocainized, however, before each irrigation.

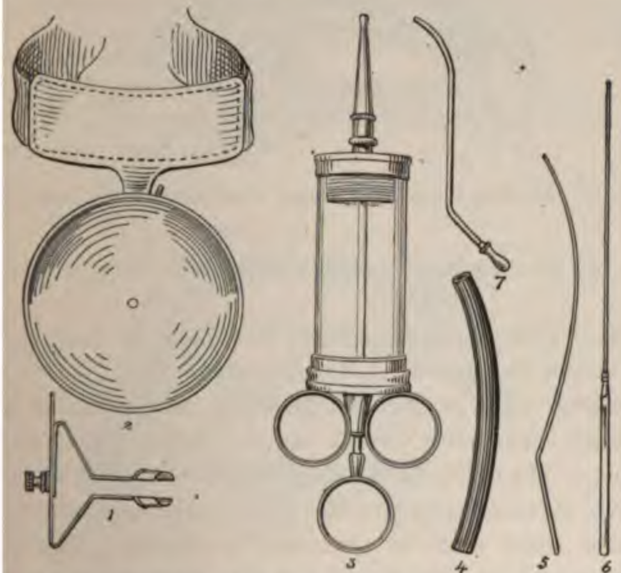
2. *Through the Alveolus.*—The puncture is made through the socket of the second bicuspid or the inner root socket of the first or second molar tooth (Fig. 379). The affected tooth is first removed, and the drill inserted by a boring motion, as follows: For the first molar, in an upward and slightly inward direction; for the second molar, in an upward, slightly inward and forward direction; and for the second bicuspid, upward, slightly inward, and backward. Unless the approximate position of the antrum is kept in mind and the drill inserted accordingly, the cavity may be missed. As soon as the antrum has been entered the cavity is irrigated by means of a syringe,

ion escaping into the nose through the natural opening. ts escape, the patient's head should be inclined forward.



Showing drills entering the antrum through the alveolus. (After Schultze and Stewart.)

ı metal drainage-tube of the proper size is inserted, through bsequent irrigations may be made.



o.—Instruments for lavage of the frontal sinus. 1, Myles' nasal speculum; tor; 3, syringe; 4, tubing to connect the syringe to cannula; 5, sinus probe; plicator; 7, sinus cannula.

rrigations may be performed once or twice a day, and later be carried out by the patient himself. When the discharge ceases, the irrigations are discontinued for a day or two, and, if there is no recurrence of the trouble, the tube is then removed and the opening allowed to close.

Lavage of the Frontal Sinus.—The frontal sinus may be irrigated by means of a small cannula introduced through the fronto-nasal duct. In some cases, where the opening is occluded by the middle turbinate or an enlarged bulla ethmoidalis, the middle turbinate will have to be removed before the attempt is successful. Another difficulty presents itself in the close proximity of the anterior ethmoidal cells, and the cannula may enter this group instead of the frontal sinus.

Instruments.—A head mirror, a speculum, a nasal applicator, a sinus probe, a pure soft-silver cannula that may be easily bent to accommodate itself to any curve—such as Hartmann's—and a syringe that can be attached by means of rubber tubing will be required (Fig. 380).

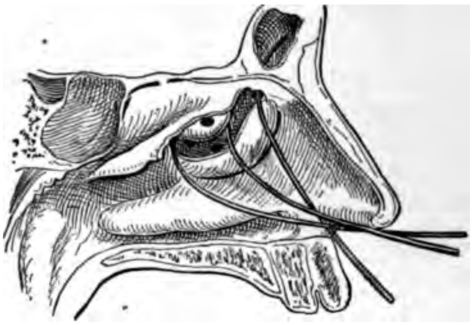


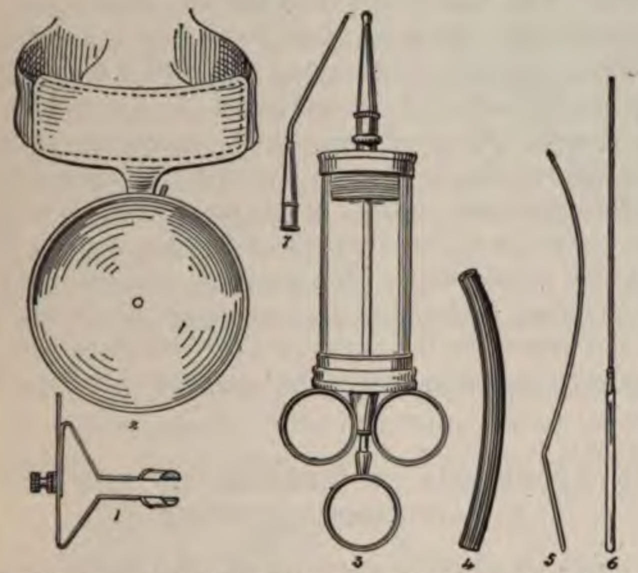
FIG. 381.—Showing the steps of passing a cannula into the frontal sinus.

Asepsis.—The instruments are sterilized by boiling, and the patient's nose is cleansed by gentle syringing.

Anesthesia.—A 4 per cent. solution of cocain should be applied to the middle meatus for twenty minutes before the operation.

Technic.—The cannula, bent at its distal end to an angle of about 135 degrees, is introduced into the middle meatus at the junction of the anterior third with the posterior two-thirds. The tip of the cannula is passed into the hiatus and then forward and upward into the infundibulum, and thence still upward and slightly forward into the sinus, through the fronto-nasal duct (Fig. 381). The syringe is then attached to the cannula and the sinus is gently irrigated with one of the warm cleansing solutions previously mentioned.

vage of the Sphenoidal Sinus. **Instruments.**—A head mirror, al speculum, a nasal applicator, a sinus probe, a sphenoidal



. 382.—Instruments for lavage of the sphenoidal sinus. 1, Myles' nasal specu- head mirror; 3, syringe; 4, tubing to connect the syringe to cannula; 5, sinus 6, nasal applicator; 7, sinus cannula.

d cannula, and a syringe with rubber-tubing attachment will uired (Fig. 382).

G. 383.—Showing the steps of passing a cannula into the sphenoidal sinus.

epsis.—The instruments are boiled, and the patient's nose is ed by gentle syringing.

Anesthesia.—The region is anesthetized with a 4 per cent. solution of cocain.

Technic.—The cannula is passed into the nasal cavity with the convexity upward. The point of the instrument is inserted between the middle turbinate and the septum, and should follow the roof of the nose until it meets the resistance of the anterior wall of the sphenoidal sinus. By gently moving the instrument up and down and from side to side, its tip will eventually be made to enter the sphenoidal opening (Fig. 383). The depth of the sinus is only about ⅝ inch (1.5 cm.), and care should be taken not to force the instrument through its thin walls. The syringe is attached to the cannula by rubber tubing, and the cavity thoroughly but gently irrigated. During this procedure the patient's head should be bent forward and the mouth opened to prevent the backward flow of the returning solution.

PASSIVE HYPEREMIA IN DISEASES OF THE NOSE AND ACCESSORY SINUSES

The beneficial effects of passive hyperemia in the treatment of inflammations have already been discussed in Chapter X, to which section the reader is referred for a full consideration of the subject and the technic of its application. According to Ballenger,[1] the indications for passive hyperemia in rhinology are: (1) in the first five days of acute rhinitis; (2) in the first five days of acute sinusitis; (3) in the first five days of acute inflammation of the pharyngeal tonsil; (4) in acute tubal catarrh; (5) in chronic purulent inflammation of the sinuses.

The hyperemia may be effected by means of a neck band (as described on page 256) or by a special form of suction apparatus. The latter is more efficacious in the presence of a purulent discharge, the vacuum serving to remove secretions as well as to induce a beneficial hyperemia; but it must be used with great care not to induce a harmful degree of hyperemia. The apparatus shown in Fig. 221 or one provided with glass tips which fit into the nostrils may be used. With the apparatus applied to the nose, the air is slowly rarefied while the patient swallows. This causes the soft palate to rise up in apposition with the posterior wall of the pharynx and to close the naso-pharynx and nose from the pharynx, and a hyperemia of the mucous membrane of naso-pharynx, nose, accessory sinuses, and Eustachian tubes is thus induced.

[1] Ballenger: "Diseases of the Nose, Throat, and Ear."

TAMPONING THE NOSE FOR THE CONTROL OF HEMORRHAGE

Nasal hemorrhage may be the result of trauma, ulcerations, new growths, cardiac disease, certain constitutional diseases and infections, diseases of the blood, etc. Usually the bleeding ceases spontaneously or under simple treatment which aims at lessening the congestion of the nasal mucous membrane and favoring the formation of a clot, such as the application of cold over the nose and at the base of the neck, removing tight collars, etc., from the neck, or having the patient remain quietly in an upright position with the head erect, at the same time forbidding any attempts at blowing the nose.

If these simple measures are insufficient, a speculum should be introduced and the interior of the nose inspected for the source of the hemorrhage. If the bleeding point is within reach, it should

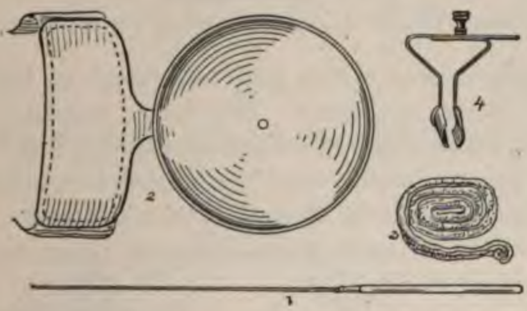


FIG. 384.—Instruments for tamponing the anterior nares. 1, Nasal applicator; 2, head mirror; 3, narrow strip of gauze; 4, Myles' nasal speculum.

be cauterized by touching with the electro-cautery or with silver nitrate; or else some styptic solution, as peroxid of hydrogen, a watery solution of tannic acid, or a 1 to 1000 solution of adrenalin chlorid should be applied to the part upon a pledget of cotton. It may be impossible to locate the bleeding point, or the hemorrhage may continue in spite of such treatment, so that in the presence of a profuse hemorrhage it becomes necessary to pack the nose. In the majority of cases tamponade through the anterior nares will be sufficient; in others, the bleeding may occur posteriorly and the posterior nares as well will have to be packed.

Instruments, etc.—To pack the nose from the front, a head mirror, a nasal speculum, a nasal applicator, and a single narrow strip of gauze should be provided (Fig. 384).

For packing the posterior nares a tampon about 1 inch (2.5 cm.) long and ½ inch (1 cm.) thick, should be prepared by rolling a strip of gauze to the required size, to the center of which a heavy piece of silk thread is tied, the two ends, which should each be about 18 inches (45 cm.) long, being left free. For the purpose of adjusting the tampon in place, a rubber urethral catheter of a size that will readily pass through the nose into the mouth (Fig. 385), or an instrument especially made for this purpose, known as Bellocq's sound (Fig. 386), will be necessary. This latter consists of a curved metal cannula containing a concealed steel spring, which is protruded into the pharynx and mouth when the cannula is in place in the nose, and to the end of which the tampon is then attached.

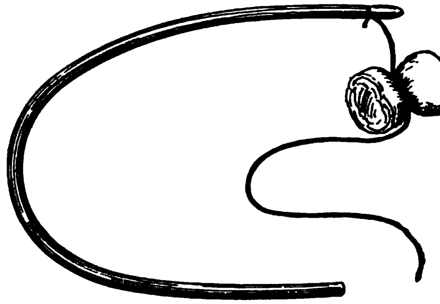


FIG. 385.—Catheter for drawing plug into the posterior nares.

Asepsis.—The instruments are boiled, and the gauze used for the tampon should be sterile.

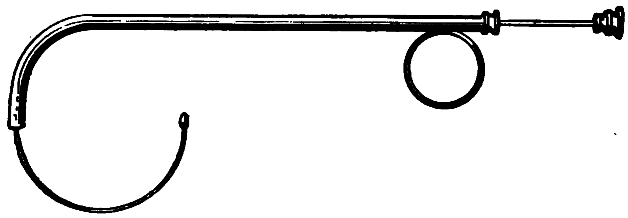
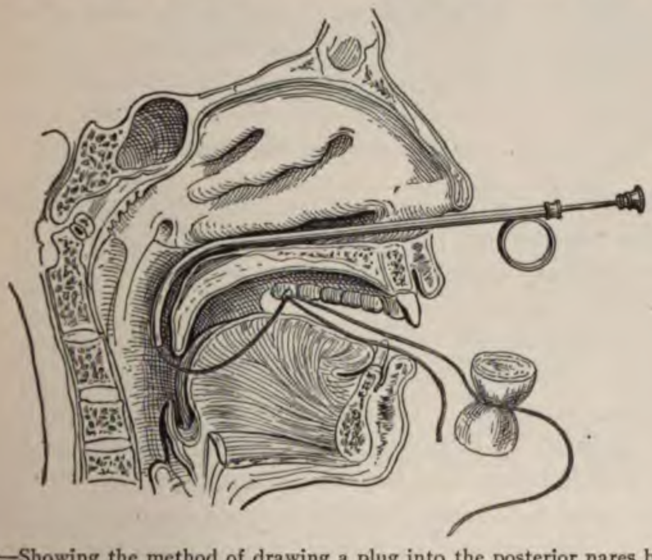


FIG. 386.—Bellocq's cannula.

Technic (1) (*Anterior Nares*).—In tamponing the anterior nares speculum is inserted in the nose and a good view of the interior obtained. A narrow strip of gauze, saturated with peroxid of hydrogen, is then gently carried well back into the nose by means of an applicator, and by forcing in more gauze the whole nose is tamponed and the hemorrhage controlled (Fig. 387). This packing should always be removed within forty-eight hours. Only a single strip of ıze should be used, as it will be less difficult to remove and there is danger of leaving any behind in the nose. As a further aid in ıoval, the end of the gauze should be left within easy reach.

FIG. 387.—Showing the method of tamponing the anterior nares.



388.—Showing the method of drawing a plug into the posterior nares by the aid of Bellocq's cannula.

(2) (*Posterior Nares*).—The tampon, as already described, should vell lubricated with sterile vaselin and placed near at hand. The

Bellocq cannula is passed along the floor of the nose on the bleeding side until its tip appears back of the soft palate. The steel spring is pushed home and is protruded into the mouth. The tampon is then tied to the end of the carrier by one of the strings (Fig. 388), the spring is returned within the cannula, and the latter is removed from the nose and with it the end of the tampon spring. By pulling upon the string, assisted by a finger placed in the naso-pharynx, the tampon is drawn lightly into the posterior nares (Fig. 389). In addition, it is well to pack the anterior nares with gauze or a plug of cotton, over which is tied the string protruding from the nose. The other end of

FIG. 389.—The posterior nasal plug in place.

the string, which is left in place for the purpose of removing the pack, is brought out through the mouth and loosely fastened to the ear. When an ordinary catheter is employed in place of a special sound, precisely the same technic is followed.

The packing should be removed in twenty-four hours, since, if left in longer, it is apt to set up an irritation and may lead to infection of the Eustachian tube. To remove the pack, the string tied to the anterior tampon is first cut free. The naso-pharynx should be cleaned of blood-clots, and the whole region sprayed with adrenalin chlorid to cause the tissues to shrink as much as possible. The posterior plug is then removed by gentle traction upon the string.

CHAPTER XV

THE EAR

Anatomic Considerations

The ear is divided into three portions: the external ear, the middle ear, and the internal ear. For the purposes of this work, a consideration of the anatomy of the external ear and the middle ear will suffice.

The external ear comprises the auricle or pinna and the external auditory canal.

The auricle is the irregular shaped mass composed of fibrocartilage, covered by perichondrium, connective tissue, and skin, which projects from the side of the head. It has the function of collecting sounds and reflecting them to the external auditory meatus. The central depressed portion, resembling a shell in form, is called the concha. It is bounded by a rim, the antihelix, which runs at first backward and then upward and forward, finally dividing into two arms. The space between these two arms is known as the fossa of the antihelix. From the front portion of the concha extends a ridge, known as the helix, at first in a forward and upward direction and then around the circumference of the auricle toward the lowest portion. The space between the antihelix and the helix is designated the fossa of the helix. The small backward projection lying in front of the concha is called the tragus, and the small tubercle at the lowest portion of the antihelix, the antitragus. The lobule of the ear is the lowest soft pendulous portion of the auricle.

FIG. 390.—The left auricle. 1, Concha; 2, antihelix; 3, fossa of antihelix; 4, helix; 5, fossa of the helix; 6, tragus; 7, antitragus; 8, lobule.

The external auditory canal extends from the concha to the drum membrane. It serves the purpose of conveying sounds collected by the auricle to the drum membrane. The canal measures about 1½ inches (4 cm.) in length, the floor being slightly longer than the roof on account of the oblique position of the drum membrane. Its outer third is composed of cartilage, a continuation of that forming the auricle, while the inner two-thirds has a bony framework. The interior is lined with thin skin, which contains hair follicles and cerumenous glands, the latter being most abundant at the junction of the cartilaginous and bony portions. The widest portion of the canal is near the external orifice, the narrowest portion near the center, and, beyond this, as it nears the drum membrane, the canal expands again. The direction of the canal traced from without inward is at first upward and forward, then backward, and finally forward and downward. By traction, however, in an upward, back-

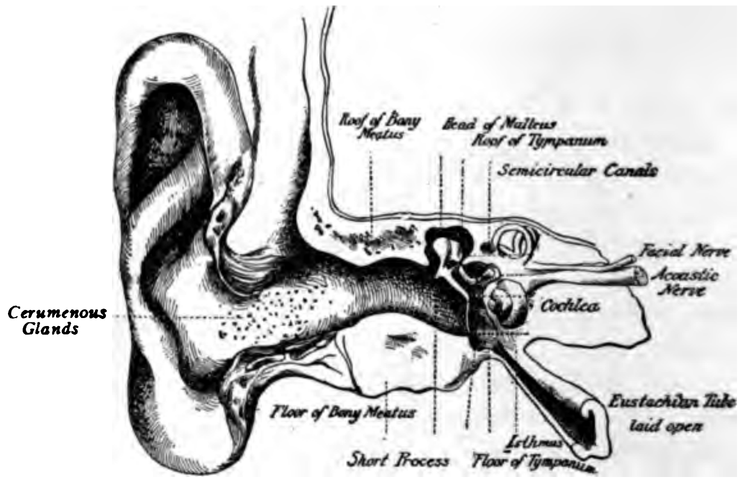


FIG. 391.—Front view of the organ of hearing. (Randall.)

ward, and outward direction upon the auricle the canal may be straightened out and its interior viewed.

The middle ear, or tympanum, is an irregularly shaped cavity situated in the petrous portion of the temporal bone, between the external and the internal ear. The interior of the cavity is lined with a delicate mucous membrane. Within it lie the chain of ossicles, the tympanic muscles, and the chorda tympani nerve.

The tympanic cavity is bounded above by the roof, consisting of a thin plate of bone, the tegmen tympani et antri, which separates it from the dura; below by the floor which corresponds to the jugular fossa; by an outer wall composed of the drum membrane and the ring of bone into which it is inserted; by an inner wall which is contiguous to the labyrinth, and presents an oval window closed by the stapes and a round window closed by membrane; by an anterior wall which separates the tympanic cavity from the carotid canal, and in the upper part of which is the tympanic orifice of the Eustachian tube and above this the canal for the tensor tympani muscle; and by a posterior wall, in the upper part of which lies the narrow opening leading into the mastoid antrum, the *aditus ad antrum*. The cavity is practically divided by the chain of ossicles into two portions, an upper epitympanic space or attic, and a lower cavity or atrium.

The ossicles are three small bones, the malleus or hammer, the incus or anvil, and the stapes or stirrup, joined together by movable articulations, and forming an osseous chain between the drum membrane and the labyrinth. They are held in place by the attachment of the malleus to the membrana tympani and of the stapes to the

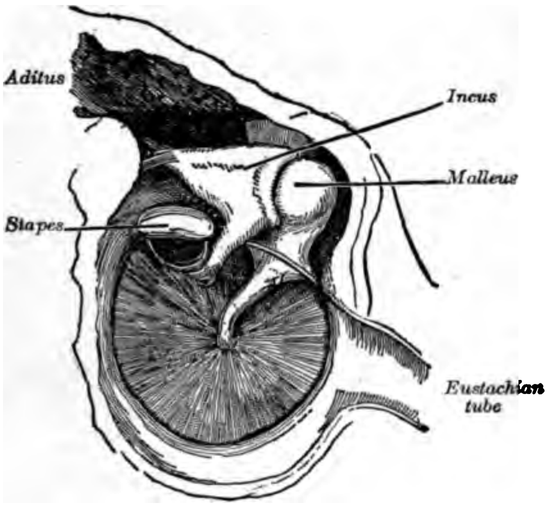


FIG. 392.—Anatomy of the ossicles. (Pyle.)

oval window, and in addition by various ligaments extending between them and the bony walls. Their function is to convey sound waves from the drum to the labyrinth.

The malleus consists of an oval head which extends upward and articulates with the incus, a neck, a manubrium or handle which extends downward and is embedded in the membrana tympani, a short process, which extends outward from the neck to the membrana tympani and pushes the latter outward before it, and a long process which passes anteriorly into the Glaserian fissure.

The incus is the middle ossicle. It consists of a body which articulates with the malleus, a short horizontal process which extends to the posterior wall where it is attached by ligaments, and a long process which extends downward and outward and then near its tip sharply inward to articulate by its orbicular process with the head of the stapes.

The stapes consists of a broad base or foot-piece which fits into the oval window, to the membrane of which it is attached, two crura or legs, and a head which articulates with the orbicular process of the incus.

The membrana tympani, or ear-drum, is a thin elastic membrane stretched obliquely downward and inward across the inner end of the external auditory canal forming the outer wall of the tympanic cavity. The drum membrane is made up of three layers, an outer one of skin, a middle of fibrous tissue, and an inner formed by the reflection of the mucous membrane of the middle ear. It serves the purpose of receiving and transmitting sound waves to the chain of ossicles.

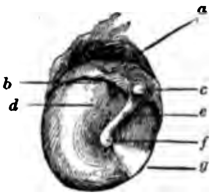


FIG. 393.—Outer surface of the right membrana tympani. (Gleason.) *a*, Membrana flaccida; *b*, posterior fold; *c*, short process; *d*, incudostapedial articulation; *e*, malleus handle; *f*, umbo; *g*, cone of light.

It may be described as elliptical in outline, and of a pearly gray color, but at the same time translucent. Its outer surface is concave and normally smooth. By the aid of a speculum and suitable illumination there will be noted a whitish ridge formed by the handle of the malleus, running from a tubercle near the upper and anterior periphery downward and backward toward the center of the membrane. This tubercle represents the short process of the malleus. Where the handle of the malleus ends near the center of the membrane is a depression, the umbo. Under illumination in the anterior and lower quadrant of the drum will also be noted a triangular area of light (the reflection of light) with its apex at the tip of the handle and its base at the periphery of the drum. Extending anteriorly and posteriorly from the short process of the malleus are two delicate folds of membrane which divide the drum into two portions. That portion above these folds is known as Shrapnell's membrane, or the membrana flaccida, and that below as the membrana tensor.

The Eustachian tube is a canal about $1\frac{1}{2}$ inches (4 cm.) long, connecting the pharynx with the tympanic cavity. It has a general direction from the tympanum forward, downward, and inward, opening upon the lateral wall of the pharynx near the inferior meatus of the nose in front of Rosenmüller's fossa as a crater-like eminence.

The tube is made up of a framework which in the outer third is bony and in the inner two-thirds cartilaginous and membranous, and is lined with ciliated epithelium which waves in a direction toward the pharynx. The two ends are enlarged, but approaching the juncture of the osseous and cartilaginous portions the tube narrows considerably. Normally the walls are in apposition, but when the palatal muscles contract, as, for example, in the act of swallowing or yawning, the walls are separated. The function of the Eustachian tube is to equalize the atmospheric pressure on the outer and inner sides of the drum, and to provide drainage for the tympanic cavity and mastoid cells.

Diagnostic Methods

A complete examination of the ear should comprise a clinical history, an examination of the nasopharynx, and then an investigation of the ear itself.

A history is quite essential, but it need not necessarily be an exhaustive one. It should first be ascertained what symptoms or symptom the patient complains of, and whether only one ear or both are affected. The duration of the trouble is also of importance, as it has considerable bearing upon the prognosis in any given case. The probable cause of the condition should also be determined as far as is possible by careful questioning. Among the many etiological factors of ear diseases are severe colds, grippe, some injury, foreign bodies, acute infectious diseases, syphilis, tuberculosis, etc. The symptoms or symptom complained of should then be investigated more in detail.

Deafness and tinnitus are the common complaints for which relief is sought, and are frequently associated. In the presence of the former it should be learned whether the deafness developed slowly or suddenly, whether one or both ears are involved, and, if the latter be the case, which ear is more affected. The duration of the condition must also be ascertained. Not infrequently in the presence of chronic catarrh of the middle ear, the patient, while not actually deaf, will complain of certain disturbances of hearing, as, for example, the ability to hear better in the presence of noise, as on a railroad train or street car (paracusis Willisii), or hearing sounds as if repeated twice (paracusis duplicata), or, again, in the presence of marked unilateral deafness the inability to locate the source of sounds (paracusis localis).

Tinnitus, or subjective noises, are present in middle-ear diseases as well as affections of the internal ear, in neurasthenic conditions, arteriosclerosis, and may follow the taking of certain drugs, as, for example, quinin or the salicylates. They may be described by the patient as singing, whistling, buzzing, loud and roaring or musical in character, or they may resemble voices. When present, it should be learned whether they are located in the ear or in the head, whether unilateral or bilateral, and whether they are modified by mental or physical exertion or by the time of day. As a rule they are worse at night, and in some cases they may be entirely absent during the day.

In the presence of pain or earache, its character, the duration, and whether constant or intermittent should be noted. Pain may be the result of morbid conditions in the ear or it may be reflex, as, for example, from a decayed tooth, or from an inflammation of the pharynx, tonsils, etc. When it suddenly develops in an ear previously healthy it generally points to an acute inflammation of the middle ear, while, if, on the other hand, it occurs during the course of some chronic affection of the ear, a collection of fluid in the middle ear or destruction of bone may be suspected. Pressure tenderness is also of diagnostic importance in determining the origin of the trouble. Thus, pain caused by traction upon the auricle or by pressure on the tragus points to an inflammation involving the external auditory canal, tenderness elicited by pressure in the depression below the lobule of the ear to middle-ear inflammation, and pressure tenderness over the mastoid to involvement of that bone.

The presence or absence of a discharge is next determined. With a history of a discharging ear, the length of time the discharge has lasted, the character of the discharge, whether serous, bloody, or purulent, whether scanty or in large amounts and whether continuous or intermittent should be noted. It is also important to ascertain if the discharge is accompanied by pain, and the relation the pain and discharge bear to one another.

In addition to the above points, the occupation and habits of the patient should be investigated as having an etiological bearing upon the case, and in certain cases a general physical examination should be made. One should never fail to investigate the condition of the nose and throat, especially the nasopharynx, noting the presence or absence of congestion, swelling of the mucous membrane, adenoid growths, ulcers, etc., and the condition of the pharyngeal ends of the Eustachian tubes. The technic of such examination has already been described in Chapter XIV. The parts in the vicinity of the ear should likewise be inspected as well as palpated for signs of inflamma-

tion, swellings, new growths, enlarged glands, or signs of tenderness. Having completed these preliminaries, the actual examination of the ear should be instituted.

The examination of the ear comprises (1) direct inspection of the external ear, (2) inspection of the external auditory canal and tympanic membrane by the aid of specula, (3) determination of the mobility of the drum membrane, (4) various tests of the power of hearing, and (5) determination of the patency of the Eustachian tubes. In all cases the examiner should not fail to investigate the condition of *both ears*.

DIRECT INSPECTION

A thorough inspection of the auricle and external auditory canal should always precede the use of a speculum. In this way the examiner may be enabled to recognize pathological conditions at the entrance of the auditory canal that might otherwise escape attention or be hidden from view by the speculum.

Instruments.—All that is required is suitable illumination. This may be furnished by means of an electric head light (see Fig. 340), or by means of light reflected upon the part by a head mirror.

Position of Patient.—The patient is seated upon a stool with the ear to be examined turned toward the surgeon, who is also seated upon a stool of such height that his eyes are on a level with the ear of the patient. If reflected light is employed, the source of illumination should be a little above the level of the patient's ear and upon the examiner's left side.

Technic.—Under full illumination the auricle is first carefully inspected, noting the presence or absence of excoriations from discharges, eczema, swellings, deformities, new growths, etc. Then by means of traction upon the auricle in an upward and backward direction, the external auditory canal is straightened out and a view of a considerable portion of its interior becomes possible. The examiner should note especially the color of the canal for signs of inflammation, the presence or absence of swellings, fissures, foreign bodies, new growths, etc.

OTOSCOPY

Otoscopy is the inspection of the external auditory canal and tympanic membrane by the aid of a speculum and suitable illumination. By this means parts of the auditory canal and the drum membrane invisible to direct inspection may be viewed in detail, and the presence or absence of pathological conditions recognized.

Instruments.—There will be required a strong light, such as is obtained from a Welsbach burner covered by a Mackenzie condenser, mounted upon an adjustable bracket so that it may be raised to any

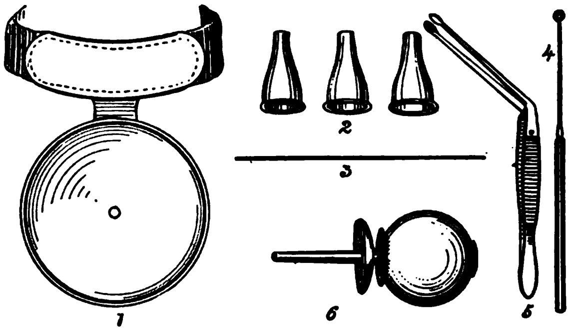


FIG. 394.—Instruments for otoscopy. 1, Head mirror; 2, aural specula; 3, ear probe; 4, ear curet; 5, angular ear forceps; 6, ear syringe.

desired height, a concave head mirror 3½ to 4 inches (9 cm. to 10 cm.) in diameter with a central perforation for the eye, three sizes of metal aural specula, a fine ear curet, a probe, a pair of Politzer angular ear forceps, and an ear syringe (Fig. 394). If desired, in place of reflected light, illumination from an electric head light may be substituted.

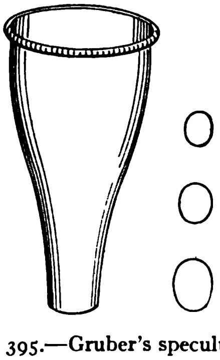


FIG. 395.—Gruber's speculum.

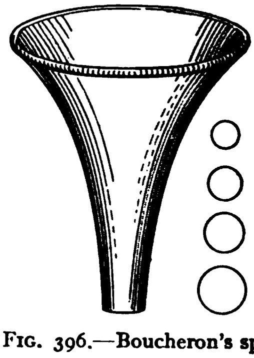


FIG. 396.—Boucheron's speculum.

For purposes of examination Gruber's specula (Fig. 395) are most satisfactory, as they are elliptical in shape upon transverse section, thus corresponding to a transverse section of the external auditory canal. Where, however, operative procedures are indicated a speculum with a wide proximal end that will permit the manipulation of instruments, such as Boucheron's (Fig. 396) or Toynbee's is prefelectric-lighted specula (Fig. 397) are now used to a large nd simplify the operation considerably.

is.—To avoid carrying infection from one patient to another ıments employed in otoscopy should be boiled or immersed 20 carbolic acid solution and then rinsed in sterile water l before use.

on of Patient.—The patient and examiner should be seated, ɪr with the ear turned toward the examiner. The examiner's ıld be on a level with the patient's ear and in a horizontal th the external auditory canal. If reflected light is em- he source of illumination should be a little above the level of nt's ear and upon the examiner's left.

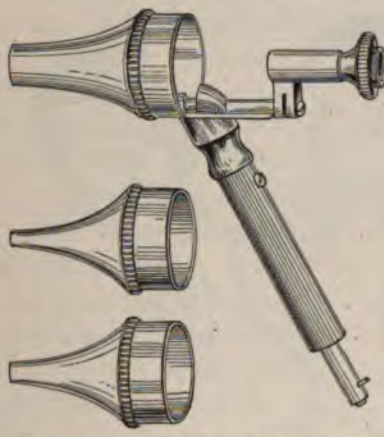


FIG. 397.—Electric-lighted speculum.

ıic.—The examiner directs the light full upon the external meatus and, grasping the auricle between the thumb and ger of the left hand (if the right ear is being examined and), makes traction in an upward, backward, and slightly direction, to straighten out the auditory canal. In infants, plish this, it is necessary to pull the auricle outward and a lit- ward, as the wall of the canal has no bony support at this lies collapsed against the side of the head. The speculum is med and, grasped by its rim between the thumb and index the right hand, it is gently introduced by a slight rotary ntil it has passed the junction of the cartilaginous and bony of the canal. In inserting the instrument, care must be follow the long axis of the auditory canal by watching the minated at the distal end of the speculum until the drum membrane is brought to view. With the speculum properly in place, the left hand is shifted from the auricle to hold the speculum, the right hand being thus left free to manipulate any instruments (Fig. (398).

Before examining the drum menbrane, the external auditory canal should be inspected, noting its color, size and shape, and the presence or absence of foreign bodies, polypi, discharges, secretions, or cerumenous plugs. Signs of inflammation and furuncles should also be looked for. Sometimes secretions and collections of wax require removal before inspection is possible. This may be accomplished, as a rule, by gently syringing the canal with warm saline solution or a saturated solution of boric acid (see page 423). Small

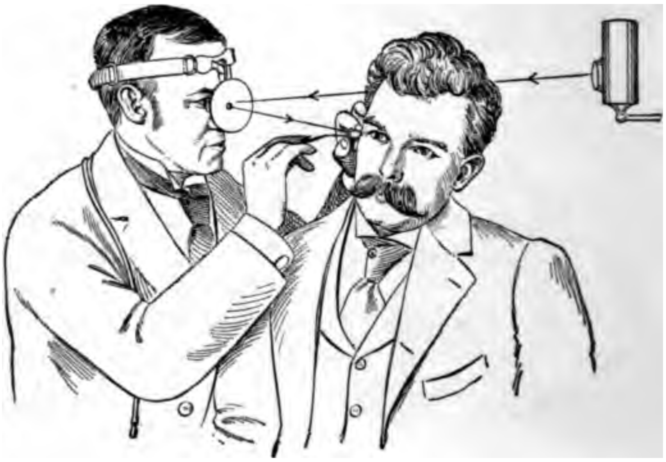


FIG. 398.—Otoscopy with the reflector and ear speculum. The arrows represent course of light. (Gleason.)

masses of wax and flakes may require removal by means of the curet, followed by gentle syringing. The ear is then thoroughly dried by means of small mops of sterile cotton held in angular forceps or wrapped about the tip of a probe.

The examiner next inspects the drum membrane. It is placed at the distal end of the canal, inclining downward and inward at an angle of about 45 degrees. The normal drum appears translucent and of a pearly gray color, with its circumference appearing as a white line. Extending from above downward and backward in the upper half of the drum is seen the handle of the malleus. In the upper and anterior portion, about 1/25 inch (1 mm.) from the superior wall, is the short process of the malleus, and running forward and backward above the short process are two folds of membrane above which lies Sharpnell's membrane. Extending from the tip of the malleus toward the periphery, in the lower and anterior quadrant, will be noted the bright cone of reflected light. In addition to these landmarks normally to be observed, if the membrane is very thin and retracted, there may be seen the long process of the incus as a whitish line running down behind and parallel to the handle of the malleus.

On inspection of the drum membrane, one should note first its color, whether congested and red and if uniformly so, also whether translucent, as it normally should be, or thickened and exhibiting localized opacities. The presence or absence of granulations or perforations should also be determined, the latter being evidenced by the greater depth of the drum at the point of perforation. Note also if the membrane is retracted or bulging with fluid. If retracted, the short process of the malleus appears more plainly, the handle is shortened, and the conical folds are deepened. At the same time the cone of reflected light will appear altered in shape and displaced. If bulging is present, its location should be noted. As a rule, bulging occurs in the posterior portion of the membrane, or the entire drum may be distended. If it occurs in the upper portion only, involvement of the attic is present. By changing the position of the speculum slightly all portions of the drum may be viewed in detail. By means of a cotton-tipped probe, inspection may be supplemented by careful palpation, if further information as to the conditions found is desired. In all manipulations of the speculum or instruments great gentleness should be observed.

FIG. 399.—The appearance of the drum membrane as seen through the speculum.

DETERMINATION OF THE MOBILITY OF THE DRUM MEMBRANE

By the aid of a pneumatic otoscope with which the air in the external auditory canal may be alternately condensed or rarefied, it is possible to determine the degree of mobility possessed by the membrana tympani, and thus recognize undue rigidity or laxness of the drum or the existence of intratympanic adhesions binding the drum or ossicles to the walls of the tympanum.

Apparatus.—Siegle's pneumatic otoscope (Fig. 400) consists of an air-tight chamber, the proximal end of which is closed by a plain glass window or convex lens placed at an angle of 45 degrees to the long axis of the instrument, while to the distal end may be screwed different sized specula. Upon the side of the air-tight chamber is placed a small perforated knob to which is attached a piece of rubber tubing and a hand bulb. The instrument may be obtained with an electric light in its interior or illumination may be supplied by an electric head light or reflected from a head mirror.

Position of Patient.—The patient and the operator occupy the same relative positions as employed for an ordinary otoscopic examination (see page 409).

Asepsis.—The speculum portion of the instrument should be sterilized by boiling.

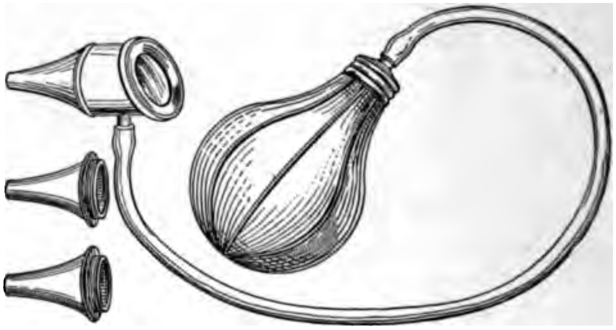


FIG. 400.—Siegle's pneumatic otoscope.

Technic.—Some of the air is expelled from the bag which is held in the examiner's right hand, and the instrument is fitted snugly into the auditory canal in the same manner as an ordinary speculum. A small piece of rubber tubing may be slipped over the end of the speculum, if necessary, to insure its fitting the auditory canal more accurately. The examiner then observes under good illumination the movement of the drum membrane through the window in the otoscope, as he relaxes or compresses the bulb. As the air is rarefied, the drum is sucked outward and becomes convex in shape. As the air is condensed by compression of the bulb, the drum membrane moves inward and becomes more concave. The presence of adhesions will be evidenced by absence of any mobility at that particular point, while other parts of the drum will move freely. Too energetic use of the instrument must be avoided for fear of rupturing a weakened drum.

HEARING TESTS

Hearing tests are very important in the diagnosis of ear diseases, since they not only furnish information as to the extent the hearing is impaired, but also serve to localize the seat of a lesion, that is, whether in the conducting apparatus or in the nervous mechanism. While there have been a number of hearing tests devised, the following are sufficient for all practical purposes: (1) testing the acuteness of hearing by means of the watch and voice, (2) testing the perception of high and low notes, (3) Weber's, and (4) Rinné's test.

Apparatus.—While it is of advantage to have a complete set of tuning-forks, the ordinary tests may be carried out with a low tone fork (C–2,) having thirty-two vibrations per second, a Galton's whistle for high tones, and a C 2 fork having 512 vibrations per second for Weber's and Rinné's tests. Galton's whistle gives tones ranging from about 7000 vibrations per second to the highest perceptible tone limit. The instrument is provided with a scale and screw whereby the number of vibrations may be regulated so as to give any tone within the limits stated above.

Tests of Acuteness of Hearing.—1. *The Watch Test.* —The test is made in a room free from noise and with a watch that ticks rather loudly. Since the ticking of different watches varies considerably, the distance at which the particular watch is heard by a normal ear must be determined by experience. Each ear is tested separately in the following manner: The patient is seated in a chair with his eyes closed, and with his forefinger closing the ear not under examination. The examiner first holds the ticking watch close to the ear being tested so that the patient can hear it distinctly and then slowly brings it from a distance beyond the range of hearing power toward the ear in a line perpendicular to the auricle until the patient again recognizes the ticking. The distance from the ear at which the ticking is heard is then accurately measured, and the result is expressed in a fraction of inches, the denominator of which represents the number of inches at which the particular watch is normally heard and the numerator the number of inches it is heard by the ear under examination. For example, if the watch is heard at forty inches (100 cm.) by the normal ear and the patient hears it at ten inches (25 cm.), the result is expressed as 10/40.

2. *The Voice Test.*—The patient is seated in a large room with the eyes closed and the ear not under examination plugged with the forefinger. The examiner then repeats words of one syllable or numerals

in an ordinary voice and also in a whisper at the end of expiration with the residual air from various distances, and measures the distance at which the patient can hear and repeat them correctly. The result is expressed in a fraction of feet, the denominator of which rep

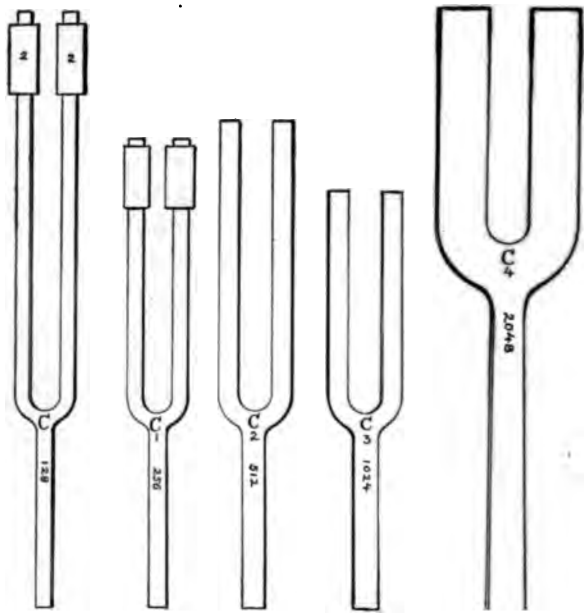


FIG. 401.—Hartmann's set of tuning-forks varying from 128 vs. to 2048 vs.

resents the distance in feet at which the normal ear can hear t voice and the numerator the actual distance at which it is heard the ear under examination. In employing this test it is importa that the patient does not see the lips of the examiner and that t

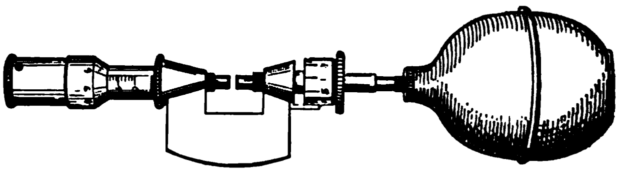


FIG. 402.—Edelmann's modification of Galton's whistle.

sounds are transmitted to the ear under examination at right angl to the auricle.

Testing the Perception of Different Notes.—The norm range of hearing in adults for musical notes lies between 16 and 48,o vibrations per second. The majority of individuals, however, poss a more limited range than this, varying from about 24 to 16,000 vibrations per second. In this test the hearing is tested for low tones with a low-toned fork and for high tones with the Galton whistle. The test is of diagnostic value in differentiating between disturbance of hearing due to affections of the conducting and those of the perceptive apparatus. Where the conduction apparatus is at fault high tones are heard better than low, while in diseases of the perceptive apparatus, the low tones are heard well, but high-tone hearing is lost or diminished. It should be remembered, however, that in advancing age the upper tone limit is lowered.

Weber's Test.—It is employed for the purpose of locating the seat of unilateral deafness. In this test a C 2 (512 vs.) fork is set vibrating and the handle is placed on the incisor teeth or upon the cranium in the mid-line. If the sound is heard best in the affected ear, it is indicative of some affection of the conduction apparatus, as middle-ear disease, impacted cerumen, or occlusion of the Eustachian tube, while if the perceptive apparatus is at fault, it will be heard better in the normal ear.

Rinné's Test.—This test depends upon the fact that aerial conduction is better than bony conduction. In a normal ear, if a C 2 (512 vs.) fork be placed upon the mastoid until the patient no longer hears any sound, and, if the fork is then brought close to the external ear, the sound will again be heard. This is known as a *positive Rinné.* If, however, the sound is not heard again when the fork is thus transposed, it is known as a *negative Rinné.* Therefore, in a deaf ear, if we obtain a positive Rinné, it is indicative of a lesion in the perceptive apparatus, while if, under the same conditions, the test is negative, it shows that bony conduction is increased; *i.e.*, there is some obstruction or disease of the conduction apparatus.

INFLATION OF THE MIDDLE EAR

Inflation of the middle ear has both diagnostic and therapeutic value. As a diagnostic measure it is employed to determine the patency of the Eustachian tubes, that is, whether or not an unobstructed communication exists between the middle ear and the pharynx; for the purpose of detecting the presence or absence of an exudate in the middle ear, and, if so, the character of the exudate; to detect the presence of a perforation of the membrana tympani; and to determine the mobility of the membrana tympani. The therapeutic uses of inflation will be considered later (see page 428).

An auscultatory tube is employed in conjunction with inflation for the purpose of determining whether air enters the middle ear and to distinguish the character of the sound produced which is of diagnostic importance. Thus, in a normal condition of the Eustachian tubes and tympanic cavity, air will be heard to enter the middle ear with a soft blowing sound; if the tube be obstructed, the sound will have a more or less whistling character, while, if the obstruction is not overcome, air will not be heard to enter the middle ear at all and the sound will be distant. When the middle ear contains an exudate, the sound will vary according to the character of the fluid; if it is thin and watery, a fine bubbling sound will be heard; if it is thick and viscid, the sound will be a coarse bubbling one. In the presence of a perforation of the membrana tympani, inflation causes a characteristic hissing or whistling sound and often secretion will be forced out through the perforation into the external auditory canal. By the aid of a speculum, the drum may be inspected and the effect of the inflation upon it noted and the mobility determined.

There are three methods by which the middle ear may be inflated: (1) Valsalva's method, (2) Politzer's method, and (3) catheterization. Before practising inflation it is a wise precaution to inspect the ear-drum to see if it is sufficiently strong to stand the strain, as cases have been reported where a diseased drum has been ruptured by the Politzer bag.

Position of Patient.—The patient should be seated upon a chair. The examiner is also seated, facing the patient.

Preparations of Patient.—In all cases the nose and pharynx should be thoroughly cleansed before inflation is performed by means of gargling and the use of a nasal spray (page 383).

Valsalva's Method.—This method of inflation is the simplest of the three and at the same time is the least reliable. It is fairly successful, however, if only a slight obstruction exists. On account of the ease with which it can be performed by the patient, it is apt to be repeated frequently, with the risk of producing a flaccid condition of the drum unless the patient is cautioned against its overuse.

Apparatus.—There will be required a head mirror and some source of illumination, or an electric head light, aural specula, and an aural stethoscope. The latter instrument (Fig. 403) consists of a piece of rubber tubing, about 3 feet (90 cm.) long into the two ends of which are fitted hard-rubber ear-pieces—a white one for the examiner's ear and a black one to fit into the patient's ear.

Asepsis.—The specula and ear pieces of the aural stethoscope should be sterile.

Technic.—The patient's mouth should be shut and the nostrils held closed by the fingers. Then the patient is instructed to give a forced expiration and at the same time swallow. The act of swallowing causes the tubes to relax, and the air, under pressure, is thus

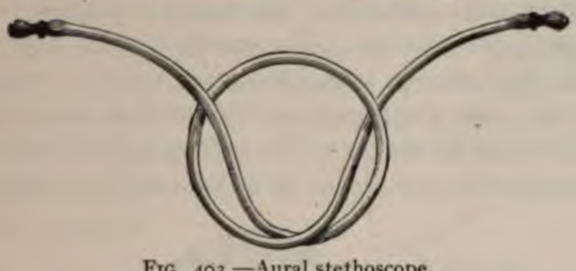


FIG. 403.—Aural stethoscope.

forced through the tubes into the middle ear. As this occurs the patient will have a feeling of distention in both ears, and the examiner by means of the aural stethoscope will hear the sound of air entering the middle ear. If the drum membrane is inspected as the inflation is performed, it will be noticed that the membrane moves outward and becomes somewhat congested.

FIG. 404.—Instruments for Politzer's method of inflation. 1, Head mirror; 2, aural specula; 3, aural stethoscope; 4, Politzer inflation bag.

Politzer's Method.—This is probably the most frequently employed method of inflation.

Apparatus.—There will be required a head mirror and suitable illumination or an electric head light, aural specula, an aural stethoscope, and a Politzer air-bag (Fig. 404). The Politzer air-bag consists of a soft pear-shaped bag of such size and shape that it can be readily compressed in the operator's hand, supplied with a piece of rubber tubing about 8 inches (20 cm.) long, to the end of which is attached an olive-shaped glass nose-piece.

Asepsis.—The glass nose-piece and the specula should be sterilized by boiling before use. The ear pieces of the aural stethoscope should also be sterile.

Technic.—The patient is first given a small amount of water—about a teaspoonful is sufficient—which he is instructed to hold in his mouth until told to swallow. The examiner then inserts the nose-piece of the Politzer bag into one nostril for a distance of about ½ inch (1 cm.), and compresses both nostrils about it by means of the left thumb and forefinger. The patient is then told to swallow, and, as the larynx is seen to rise up at the commencement of the act

FIG. 405.—Inflation by Politzer's method.

of swallowing, the examiner compresses the air-bag with his right hand (Fig. 405). The act of swallowing causes the soft palate to rise upward and shut off the naso-pharynx, and, at the same time, the Eustachian tubes tend to open so that the air is readily forced through the tubes into the middle ear. In children, crying has the same effect as swallowing.

With the auscultatory tube the character of the sound produced is recognized. When it is desired to inflate only one ear, the patient's head should be turned to one side, so that the affected ear lies uppermost, while at the same time the opposite ear is closed by the fingers pressed against the external auditory meatus. In using Politzer's bag care should be taken not to use a great amount of force and thereby avoid causing the patient pain.

Catheterization.—Inflation through an Eustachian catheter is only indicated when inflation by the methods previously mentioned is impossible. The passage of a catheter into the Eustachian tube is a delicate operation requiring skill as well as gentleness of touch for its safe and successful performance. If carelessly performed, there is danger of injuring the mucous lining of the tube or of making a false passage and injecting air into the submucous tissues of the tube. In certain cases it may be impossible to perform catheterization, as, for example, in the presence of marked deviations of the septum, considerable narrowing of the nasal fossæ, tumors, or adenoids, and in nervous or hysterical individuals or in those upon whom attempts to pass the catheter excite coughing, retching, or spasm of the pharyngeal muscles.

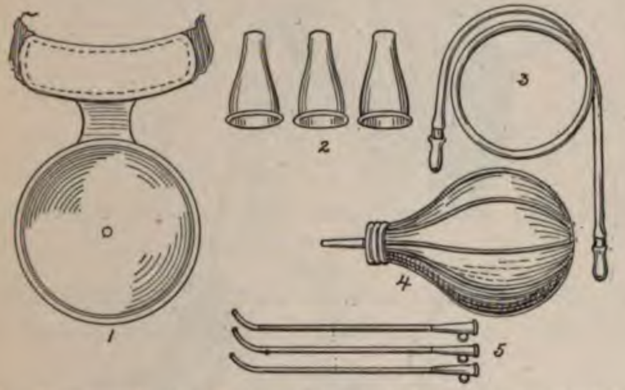


FIG. 406.—Instruments for inflation through an Eustachian catheter. 1, Head mirror; 2, aural specula; 3, aural stethoscope; 4, Politzer's inflation bag; 5, Eustachian catheters.

Apparatus.—There will be required a head mirror and suitable illumination or an electrical head light, aural specula, an aural stethoscope, a Politzer air-bag with an Eustachian catheter tip, and several sizes of Eustachian catheters (Fig. 406). The catheter is a metal tube 6½ inches (16 cm.) long, curved at its distal end, the extreme tip of which is slightly bulbous, and with an expanded proximal end into which the tip of a Politzer bag may be fitted. It should be of pure silver so that its curve may be changed to fit the individual case. A ring is placed upon the side of the instrument near its proximal end to indicate the direction of the beak. Three sizes should be provided $\frac{1}{25}$, $\frac{1}{12}$, $\frac{1}{8}$ inch (1, 2, and 3 mm.) in diameter, respectively.

Asepsis.—The catheter and the specula should be sterilized by boiling; the ends of the aural stethoscope should be likewise sterile, and the hands of the operator should be cleansed as for any operative procedure.

Anesthesia.—In sensitive individuals the nose may be anesthetized by means of a small amount of a 4 per cent. solution of cocain applied by means of a cotton-tipped probe to the inferior meatus.

Technic.—The operator first inspects the nose by the aid of illumination for the presence of deviations of the septum or other pathological conditions which might interfere with the passage of the catheter. The catheter may then be inserted by one of two methods:

1. *Löwenberg Method.*—The proximal end of the lubricated catheter is grasped lightly between the thumb and forefinger of the right hand, while by means of the thumb of the left hand, the tip of the

FIG. 407.—Catheterizing the Eustachian tube. First step, showing the position of the catheter for its introduction.

patient's nose is elevated so as to straighten out the canal. The beak of the instrument is then introduced within the anterior nares, the shaft of the instrument being in an almost vertical position (Fig. 407). The catheter is then elevated to a horizontal position, and, with the tip *kept constantly in contact with the floor of the nose*, it is gently pushed inward until the beak comes in contact with the posterior wall of the pharynx (Fig. 408). The beak is then rotated through an angle of 90 degrees toward the median line, until the guide ring lies horizontal, and the catheter is drawn forward until its beak is found to impinge upon the nasal septum (Fig. 409). The beak is then rotated downward and outward through an angle of a little more than 180 degrees until the guide ring points toward the outer canthus of the eye; at the same time the proximal end of the catheter is moved toward the nasal septum, and its tip thus enters the Eu-

FIG. 408.—Catheterizing the Eustachian tube. Second step, catheter being passed along the floor of the nose.

stachian tube (Fig. 410). In all these manipulations care should be taken to employ the greatest gentleness. The entrance of the

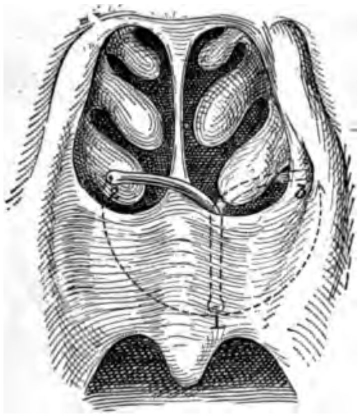


FIG. 409.—Showing the different positions of the beak of the catheter in its insertion into the orifice of the Eustachian tube. (After Barnhill and Wales.)

catheter into the tube will be recognized by the fact that the tip is firmly fixed and cannot be rotated. The catheter is now held in place by the thumb and forefinger of the left hand, the other fingers resting upon the bridge of the nose, and, with the nozzle o air-bag fitted into the proximal end of the catheter, inflation is formed by compressing the bag in the fingers of the right hand

FIG. 410.—Catheterizing the Eustachian tube. Third step, showing the p of the guide when the catheter tip is entering the orifice of the tube.

411). While this is done the examiner notes the sound produce means of the auscultation tube.

FIG. 411.—Inflation through an Eustachian catheter. (Gleason.)

In removing the catheter it is first rotated until its beak p downward and is then gently withdrawn by a reversal of the r ments employed in its insertion.

2. *Binnafont or Kramer Method.*—The instrument is introduced in the same manner as described under the Löwenberg method until the beak is in contact with the posterior pharyngeal wall. The beak is then rotated outward through more than an angle of 90 degrees which causes its tip to rest in Rosenmüller's fossa. The catheter is then withdrawn until its tip is felt to slip over the bulging posterior lip of the Eustachian mouth when its tip will be at the pharyngeal orifice of the tube. The distance it is necessary to withdraw the catheter to accomplish this varies usually from 1/4 to 3/8 inch (6 to 9 mm.). The catheter is then rotated until the guide ring points to the outer canthus of the eye and the tip slips into the tube. With the catheter in position inflation is performed as described above.

Therapeutic Measures

THE EAR SYRINGE

Syringing of the ear is employed for the purpose of removing foreign bodies or cerumenous masses from the external auditory canal and to keep the ear free from purulent material which collects after perforation or incision of the drum membrane. In using an ear syringe one must always employ extreme gentleness and solutions of the proper temperature, otherwise the procedure is not only rendered painful, but is capable of causing harm. Especially is it necessary to avoid forcible injections in cases where the tympanum is exposed through destruction of a considerable portion of the drum membrane.

FIG. 412.—Allport's ear syringe.

The Syringe.—The syringe should be simple in construction and of such material that it may be easily sterilized, and should have a capacity of 1 or 2 ounces (30 to 60 c.c.). It should be provided with a blunt conical nozzle—the ordinary olive-shaped tip is not to be commended, as it interferes with a free return flow. A syringe with a long-pointed nozzle, such as is shown in Fig. 413, will often be found more efficacious in removing foreign bodies than the ordinary syringe.

For irrigating the internal ear through a perforation in the attic, a smaller syringe, such as Blake's (Fig. 414), with a capacity of 1/2 dram (2 c.c.), provided with specially bent tips, is used. There will then grasps the auricle between the left thumb and forefinger and draws it upward and backward, so as to straighten out the external auditory canal. With the right hand he then introduces the nozzle of the syringe into the external canal in such a way that the tip of the syringe rests against the superior wall of the canal, so that the solution, as it is injected, will pass along the upper wall and wash out purulent matter or foreign material below (Fig. 415). The solution is then injected with only a small amount of force in sufficient quantities for the purpose of the operation. Should dizziness or syncope supervene, the operation should be immediately stopped.

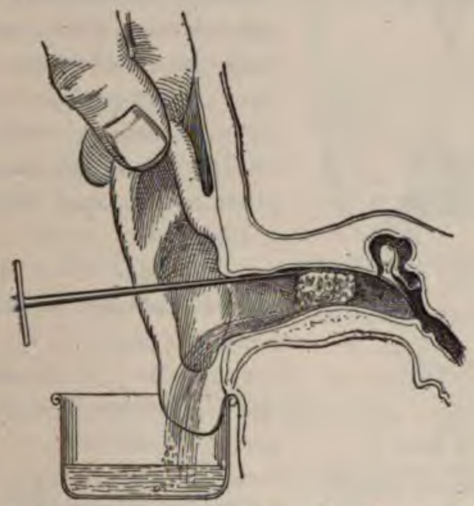


FIG. 415.—Washing impacted cerumen from canal. Showing how to hold auricle to straighten the canal and where to direct the stream of water. (Gleason.)

At the completion of the syringing all moisture is removed by means of a cotton-tipped probe and, in the presence of a discharge, a strip of sterile gauze is lightly placed in the external canal.

In cases where it is necessary to cleanse out the attic through a perforation, the drum is exposed by the aid of a speculum and good illumination, and Blake's angular cannula is inserted through the perforation under direct vision. The cavity is then carefully cleansed by gentle syringing.

INSTILLATIONS

In some cases of otorrhea where the discharge has become scanty, the long continued use of douches often seems to keep up an irritation and a persistence of the discharge. In these cases the insti astringent solutions for the purpose of promoting healthy tions may be substituted. The solutions may be thus appli external auditory canal the lining of the canal or m tympani or to the tympan through a perforation w latter contains unhealthy tion tissue.

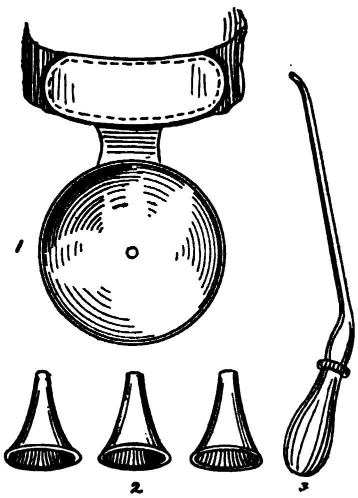


FIG. 416.—Instruments for tympanic instillation. 1, Head mirror; 2, aural specula; 3, glass instillator.

Instruments.—To insti tion into the external auditc an ordinary glass medicine may be employed. For t instillations a pipette glass with a small curved tip, mirror and illumination, aural speculum will be (Fig. 416).

Asepsis.—The instr should always be sterilize use.

Solutions.—Solutions of silver nitrate 5 to 20 per cent sulphate 5 per cent., zinc sulphate 5 per cent., and alcohol per cent. may be used.

Temperature.—The solutions should be warm—at about 100° F. (38° C.).

Position of Patient.—The patient should be seated with the head bent sideways so that the affected ear lies uppermost.


FIG. 417.—Showing 1 pipette inserted for a ty stillation.

Technic.—The ear is first cleansed and all secretion or fluid removed by means of a cotton-tipped probe. The operator then straightens out the external auditory canal by grasping the auricle between the thumb and forefinger of the left hand and exerting traction in an upward and backward direction. With the right hand he then instils drops (0.3 to 0.6 c.c.) of the desired solution into the audito

This is retained for from five to ten minutes, or for a shorter time if it causes burning or pain, and is then permitted to escape by having the patient incline the ear downward.

In making intratympanic instillations the auditory canal is first cleansed and the drum is exposed by means of a speculum. The point of the pipette is then carefully inserted through the perforation and a few drops of weak solution are injected (Fig. 417).

APPLICATION OF CAUSTICS

The application of chemical caustics to the ear may be required for the purpose of destroying granulations or small polypi. The most frequently employed agents for this purpose are chromic acid or silver nitrate. They are applied fused upon the tip of a delicate ear probe. In making such applications with strong chemicals great care must be taken that the caustic only comes in contact with the area to be treated. They should, therefore, only be applied by the aid of a speculum and good illumination.

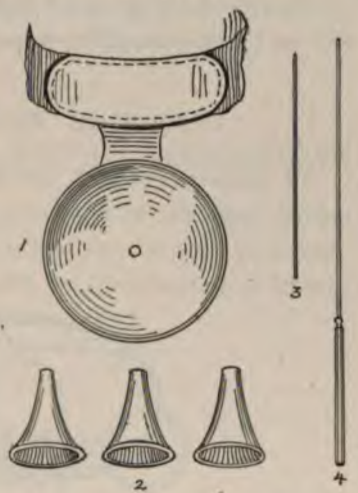


FIG. 418.—Instruments for applying caustics to the ear. 1, Head mirror; 2, aural specula; 3, aural probe; 4, applicator.

Instruments.—There will be required a head mirror and a strong light, aural specula, a delicate aural probe, and an aural applicator (Fig. 418).

The method by which the acid or silver nitrate is fused upon the probe has been previously described (see page 386).

Asepsis.—The instruments should be boiled before use.

Position of the Patient.—The patient and the operator are seated in the same relative positions as for an ordinary otoscopic examination.

Technic.—With the speculum inserted in the ear and the parts well illuminated, the site of the intended application is cleansed and then thoroughly dried by means of cotton wrapped upon the end of an aural applicator. This is very important, for if any fluid be in the ear the caustic will spread to other parts as soon as it is applied. The caustic is then carefully applied to the area it is desired to destroy.

INFLATION OF THE MIDDLE EAR

The value of inflation in diagnosis has been previously considered (see page 415). As a therapeutic measure it is employed in tubal and middle-ear disease with occlusion of the tube for the purpose of restoring the normal tension between the drum membrane, ossicles, and the internal ear. The circulation is thus improved and hyperemia and infiltration of the tubal and tympanic mucous membrane is diminished. At the same time morbid secretions are removed from the Eustachian tube and tympanic cavity, and newly formed adhesions are broken down.

The methods by which inflation may be performed and the technic will be found described on page 416.

INFLATION WITH MEDICATED VAPORS

In certain cases of subacute or chronic nonsuppurative otitis media, inflation with medicated vapors is often employed to better

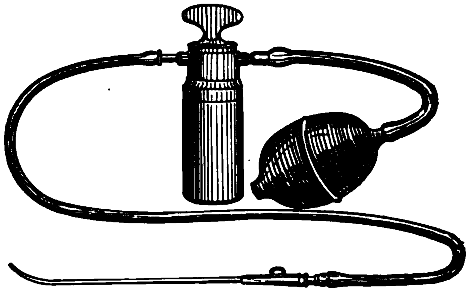


FIG. 419.—Dench's vaporizer and Eustachian catheter.

advantage than plain air. The vapor of drugs having either a sedative or stimulating action may be used. In this way all the benefits of inflation plus the sedative or stimulating effect of the vapor upon the mucous membrane are obtained.

Apparatus.—A vaporizer, in which the air current passes over the volatile drug it is desired to employ, attached to an Eustachian catheter, forms the necessary apparatus. There are a number of convenient vaporizers, such as Hartmann's, Pynchon's, or Dench's (Fig. 419). The latter apparatus is especially useful, as plain air or medicated vapor may be obtained by simply turning a key on the top of the bottle.

Asepsis.—The catheter should be sterilized by boiling before use.

Formulary.—Vapors of menthol, camphor, eucalyptol, iodin, turpentine, chloroform, and ether alone or in combination are most frequently employed.

Preparation of Patient.—Same as for catheterization (see page 416).

Position of Patient.—Same as for catheterization (see page 416).

Technic.—The Eustachian catheter is passed by one of the methods described on pages 420 and 423 and with all the precautions detailed therein. Inflation with air is then performed in order to first force out from the tube any collection of mucous or secretion and thus permit the medicated vapor to come in contact with the mucous membrane. The medicated vapor is then blown into the tympanic cavity in the same manner, after attaching the vaporizer to the catheter.

THE INJECTION OF SOLUTIONS INTO THE EUSTACHIAN TUBES

Direct medication of the Eustachian tubes may be used to advantage in the treatment of middle-ear catarrh for the purpose of lessen-

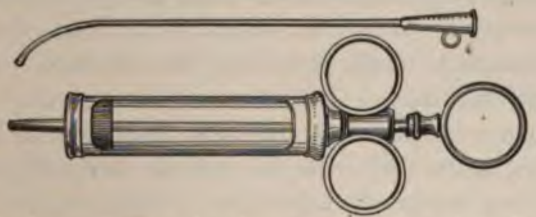


FIG. 420.—Eustachian catheter and syringe for medication of the Eustachian tubes.

ing the swelling of the mucous membrane, and to diminish secretions, thereby rendering the tubes more permeable. Weak astringent solutions are generally employed for this purpose, injected through an Eustachian catheter.

Apparatus.—There will be required an Eustachian catheter, a small syringe, graduated in drops, and provided with a tip that will fit into the proximal end of the catheter (Fig. 420), and a Politzer air-bag.

Asepsis.—The catheter and syringe should be boiled, and the solution employed should be a sterile one.

Solutions Used.—Iodid of potassium 5 gr. (0.32 gm.) to the ounce (30 c.c.), silve nitrate 2 to 5 gr. (0.13 to 0.32 gm.) to the ounce

(30 c.c.), sulphate of zinc 1 gr. (0.065 gm.) to the ounce (30 c.c.), protargol 10 to 50 per cent., bicarbonate of soda 2 to 5 gr. (0.13 to 0.32 gm.) to the ounce (30 c.c.), etc., may be employed.

Quantity.—About five to ten drops (0.3 to 0.6 c.c.) of the selected drug are injected at a time. If perforation of the drum exists more solution may be safely used, but in its absence small amounts only are applicable.

Preparation of the Patient.—Same as for catheterization (see page 416).

Position of Patient.—Same as for catheterization (see page 416).

Technic.—The catheter is introduced into the tube by one of the methods described on pages 420 and 423 and the ear is inflated by the Politzer bag to empty it of secretion. The small syringe is then charged with the warmed solution, and the desired amount is slowly injected through the catheter. The air-bag is then substituted for the syringe and the solution is blown into the tube.

THE EUSTACHIAN BOUGIE

Eustachian bougies are employed in overcoming tubal obstructions which will not yield to inflation and for the purpose of dilating tubal strictures. In the latter condition, however, the use of the Eustachian bougie is rarely curative if the stricture is composed of dense connective tissue.

The bougie is passed into the tube through a catheter, and it should always be inserted with the greatest care and gentleness, as it is a very easy matter to injure the mucous membrane with the result that, if inflation be immediately performed, air may be forced under the mucous membrane through the tear and cause emphysema. It is, therefore, advisable to wait a day or two after passing the bougie before inflation is attempted. Care must also be observed not to pass the bougie a greater distance than the length of the tube; that is, not more than 1¼ inches (3 cm.) beyond the tip of the catheter.

Instruments.—There will be required an Eustachian catheter, Eustachian bougies, and a Politzer air-bag (Fig. 421). The bougies, are made of silkworm gut or whalebone, with tips conical or bulbous in shape, and varying in diameter from 1/64 to 1/25 inch (0.4 mm. to 1 mm.). The catheter used to guide the bougie into the tube should be somewhat shorter than ordinary with a longer curved beak.

Asepsis.—The catheters are sterilized by boiling and the bougies by immersion in a saturated solution of boric acid.

Frequency.—Bougies should not be inserted more frequently than two or three times a week in order to permit the reaction from one insertion to subside before another is attempted.

Preparations of Patient.—Same as for catheterization (see page 416).

Position of Patient—Same as for catheterization (see page 416).

Technic.—The bougie is lubricated and is introduced within the catheter until the tip is level with the distal end of the catheter (Fig. 422). The catheter, with the bougie in place, is then introduced

FIG. 421.—Instruments for dilatation of the Eustachian tubes. 1, Eustachian catheters; 2, Eustachian bougies; 3, Politzer's inflation bag.

into the tube in the manner described on page 420. The bougie is then carefully passed into the tube for not more than 1 ¼ inches (3 cm.) which can be accomplished in a normal tube without difficulty. As the bougie passes into the Eustachian tube, the patient will complain of some pain in the ear, neck, or occiput, whereas, if it doubles back into the pharynx, discomfort will be felt in that region. When resistance is encountered, the bougie should be pushed forward slowly and with great caution, occasionally rotating the bougie;

FIG. 422.—Showing the bougie inserted in the catheter ready to be passed into the Eustachian tube.

forcible manipulations must always be avoided for fear of injuring the mucous membrane. Having successfully overcome the obstruction, the bougie is left *in situ* for five to ten minutes. At the next sitting a larger-sized bougie is employed.

The Medicated Bougie.—A medicated bougie, obtained by dipping a silkworm-gut bougie in some astringent solution, such as silver nitrate, before its passage, often has more pronounced and more prolonged effect than the plain bougie in overcoming a stenosis due to congestion or inflammation of the mucous membrane. The medicated bougie is introduced in the same manner as an ordinary bougie, and should be allowed to remain in place about fifteen to twenty minutes to obtain a prolonged action of the astringent.

MASSAGE OF THE MEMBRANA TYMPANI

Massage of the ear-drum is performed by alternately rarefying and condensing the air in the external auditory meatus. This pro duces an increased mobility in the membrana tympani and ossicle with the result that adhesive processes between the drum membra and inner wall of the tympanum are avoided or broken up wh formed and likewise ankylosis of the ossicular chain is prevente The method, therefore, has greatest value in adhesive forms middle-ear disease; in acute conditions its use is contraindicate In all cases an accurate diagnosis is the first essential, otherwi massage may result in harm. It should be avoided in all cases relaxed drum or where portions of the membrane are atrophic. the latter condition the atrophied weakened portion will move und the influence of suction while the rest of the drum will be unaffecte

Apparatus.—The massage is performed with the Siegle type instrument (see Fig. 400), by means of which the drum membra may be observed and the effect of the massage noted.

Asepsis.—The speculum portion of the instrument should sterile.

Duration.—The massage may be applied for one to two minut at a sitting.

Frequency.—Treatments should be given two to three times week, but only so long as improvement in distance hearing tak place.

Technic.—The otoscope is introduced into the ear in the mann described on page 412, and the air is alternately rarefied and co densed by relaxation or compression of the bulb. The amount pressure used should be regulated by noting the effect upon the me brane and ossicles. If the procedure causes pain, the press should be promptly reduced.

INCISION OF THE MEMBRANA TYMPANI

Incision of the drum membrane should always be promptly p formed in otitis media when the drum is bulging, for the purpose establishing drainage for the exudate and thereby preventing necrosis of the membrana tympani and tympanic contents. It is also indicated in acute cases in which, while the membrane is not actually bulging, it shows marked hyperemia and infiltration and the patient suffers from severe pain and exhibits constitutional symptoms of a severe infection. Especially in infants is early incision required under such conditions. If incision is delayed until bulging is present, extensive destructive changes may have occurred and the process may rapidly extend to the mastoid antrum or to the cranial cavity.

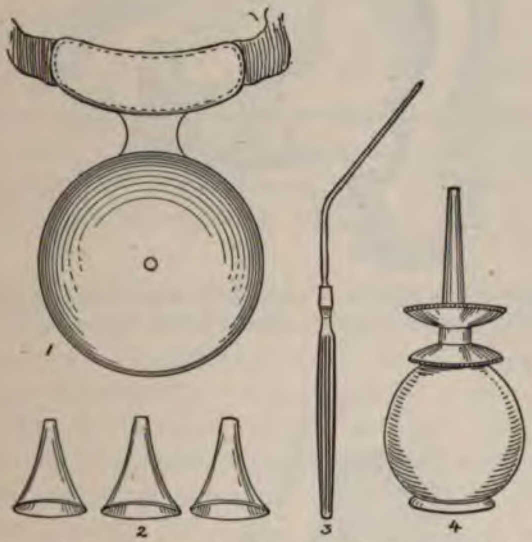


FIG. 423.—Instruments for incising the drum membrane. 1, Head mirror; 2, aural specula; 3, angular paracentesis knife; 4, Allport's ear syringe.

Finally, early incision is always indicated if in the course of middle-ear disease there are signs of mastoid involvement or of meningitis.

The extent of incision is of importance. As a rule simple puncture, or paracentesis, is not enough; instead, the incision should be of sufficient size to afford free drainage for the products of suppuration, varying, according to the age of the individual, from ¼ to ⅜ inch (6 to 9 mm.) in length.

Instruments.—There will be required a head mirror and source of illumination or an electric head light, aural specula, a sharp paracentesis knife (straight or angular), and an ear syringe (Fig. 423).

Asepsis.—The instruments should be sterilized by boiling, and the operator's hands cleansed as thoroughly as for any operation.

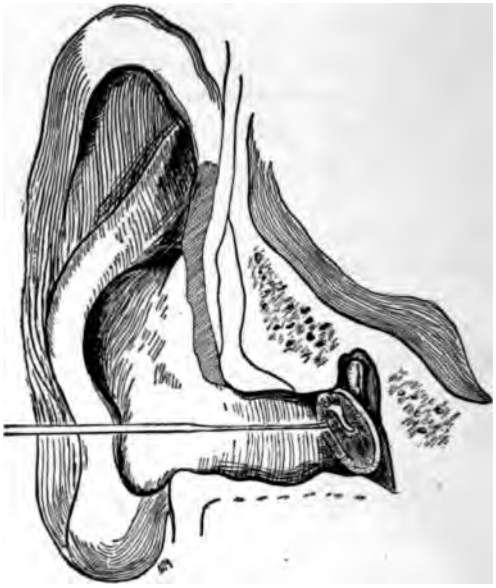


FIG. 424.—Incision of the membrana tympani in acute otitis media involving lower portion of the tympanic cavity. (Dench.)

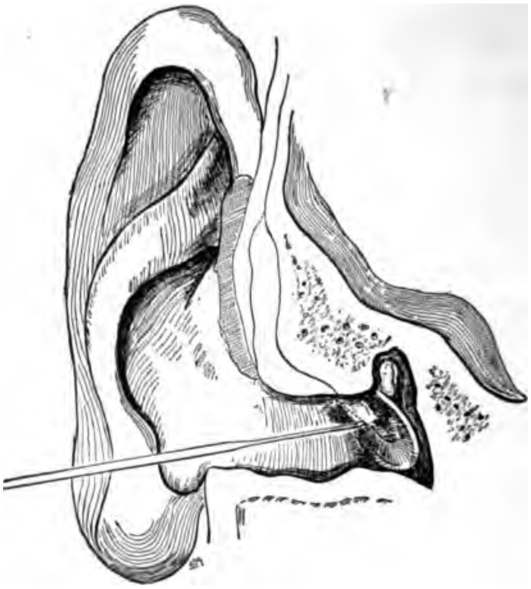


FIG. 425.—Incision of the membrana tympani in acute otitis media, involving upper portion of the tympanic cavity. (Dench.)

ions of Patient.—The external auditory canal should be cleansed by syringing with warm saturated boracic acid with a 1 to 5000 bichlorid of mercury solution.

sia.—The operation is quite painful. In children general y chloroform is indicated, while in adults nitrous oxid form of local anesthesia may be used. Local anesthesia, f a solution of cocain applied to the unbroken mem- t satisfactory, as the cocain is not absorbed. Instead, g mixture may be employed:

in hydrochlorate,	gr. vi (0.4 gm.)
n oil,	
hol,	āā ʒi (4 c.c.)

unt of this solution is instilled into the external auditory allowed to remain for fifteen minutes. It must be used a perforation be present, as it will thus enter the tym- y where absorption is rapid and toxic symptoms may

—The drum is exposed by means of a speculum under ation, and the external canal is thoroughly dried. The inserted through the membrane in the postero-inferior nd the posterior quadrant of the drum is incised in a d to the tympanic vault (Fig. 424). In doing this, the only be inserted through the drum membrane, so as to ng the inner tympanic wall which lies distant 1/12 to to 4 mm.). Of course, if there is any localized bulg- sion should be so placed as to relieve it. When the tym- alone is involved, the knife is entered in the posterior posite the short process of the malleus and the incision ward through Shrapnell's membrane. The knife is then ward, and, as it is withdrawn, the tissues of the posterior uditory canal are incised down to the bone for a distance inch (3 mm.) from the drum (Fig. 425). In this way e tympanic vault and mastoid is relieved.

is then carefully cleansed by syringing and, after being s loosely packed with gauze.

atment.—The ear should be syringed with a warm satur- n of boric acid or a 1 to 5000 bichlorid of mercury often as secretion collects. At first, this will necessitate ery two or three hours. As the discharge decreases, vals may elapse.

CHAPTER XVI

THE LARYNX AND TRACHEA

Anatomic Considerations

The larynx is that portion of the upper air passages extending between the base of the tongue and the trachea. It lies in the median line of the neck, opposite the fourth, fifth, and sixth cervical vertebræ. Anteriorly, it is practically subcutaneous; posteriorly, it forms part of the anterior boundary of the pharynx; while on either side of it lie the great vessels of the neck. Above, it is broad and triangular in shape, while below it is narrow and cylindrical.

The framework, consisting of a number of cartilages held together by ligaments, is lined with mucous membrane, and is capable of being moved by muscles which change the relative positions of the cartilages and thus modify the approximation of the vocal cords during respiration and phonation. The most important of these cartilages are the thyroid, the epiglottis, the cricoid, and the two arytenoids.

The thyroid cartilage is the largest of all, and consists of two broad lateral alæ joined in front at an acute angle. Above, it is joined to the hyoid bone by the thyrohyoid membrane, and, below, to the cricoid cartilage by the cricothyroid membrane. The space between the thyroid and cricoid cartilages in an adult measures about half an inch (1 cm.) in height; an opening made through this space gives easy access to the larynx below the vocal cords.

The epiglottis is a leaf-shaped piece of elastic cartilage 1⅜ inches (3.5 cm.) long, guarding the superior entrance of the larynx. It is attached by its stalk to the upper and posterior aspect of the angle between the thyroid alæ and to the hyoid bone by ligaments. It lies directly behind the tongue, and in swallowing it is pushed backward by the bolus of food, closing more or less completely the laryngeal opening and thereby preventing the entrance of food into the larynx.

The cricoid cartilage is a small, nearly semicircular cartilage forming the lower part of the cavity of the larynx. It is narrow in front, but becomes broadened and high posteriorly. Upon its superior border on either side it supports the arytenoid cartilages.

The arytenoid cartilages, two in number, are irregularly pyramidal in shape and rest by their bases on the superior border of the cricoid cartilage. They rotate upon a vertical axis and also move laterally. Through these movements the vocal cords are approximated or drawn apart.

The Interior of the Larynx.—The superior opening is wide and semicircular in front where it is bounded by the epiglottis. The sides are formed by the arytenoepiglottic folds of mucous membrane which run from the sides of the epiglottis to the tops of the arytenoid cartilages and gradually approach posteriorly, so that the opening is

FIG. 426.

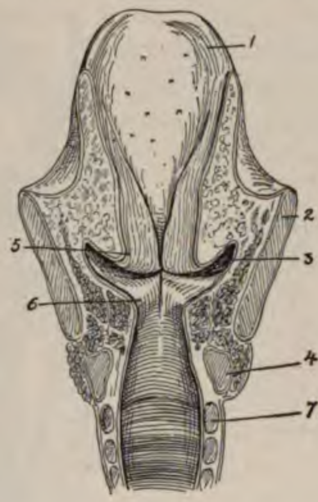


FIG. 427.

FIG. 426.—Anterior view of the larynx. (After Deaver.) 1, Epiglottis; 2, lesser cornu of hyoid bone; 3, greater cornu of hyoid bone; 4, thyrohoid membrane; 5, thyroid cartilage; 6, cricothyroid membrane; 7, cricoid cartilage; 8, trachea.

FIG. 427.—The interior of the larynx. 1, Epiglottis; 2, thyroid cartilage; 3, ventricle of larynx; 4, cricoid cartilage; 5, false vocal cords; 6, vocal cords; 7, first ring of trachea.

narrowed behind. More or less distinct nodular prominences formed by the cuneiform and corniculate cartilages are recognized on these folds.

The cavity of the larynx extends from the superior aperture to the lower border of the cricoid cartilage. It is divided into two portions by the vocal cords—above, into the supraglottic region, and, below, into the subglottic region. The vocal cords consist of two delicate bands of elastic tissue enclosed in thin layers of mucous membrane having a whitish appearance. They are attached anteriorly to the thyroid cartilage and posteriorly to the arytenoids. They measure about ¾ inch (2 cm.) in length in the male, and ½ inch (1 cm.) in the female. Between the two cords is a long narrow chink, the glottis. Above and parallel to the vocal cords are two second folds of mucous membrane enclosing ligamentous tissue, attached to the thyroid cartilage in front and to the two arytenoids behind, commonly called the false vocal cords. Lying between the vocal cords and these two bands are two oblong fossæ, the ventricles of the larynx.

The mucous membrane of the larynx is continuous above with that lining the pharynx, and below with that of the trachea and bron-

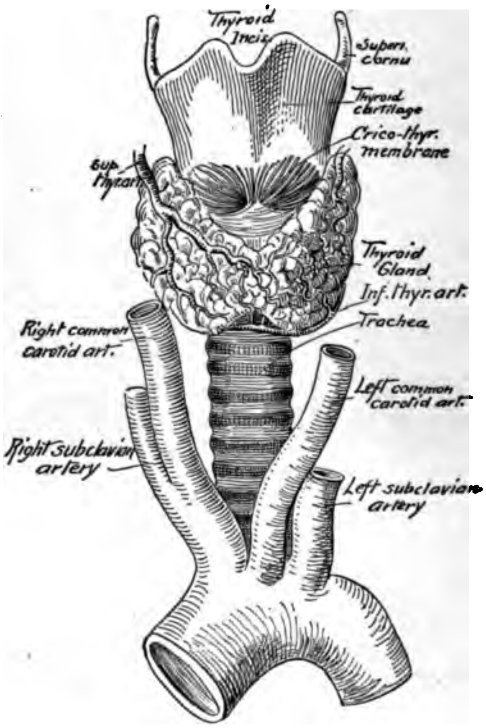


FIG. 428.—Anatomy of the trachea and its relations.

chi. It is of the columnar ciliated variety, excepting where it cover the vocal cords and the space above the vocal cords, in which region it is of the stratified variety. It contains many mucous glands, esp cially numerous upon the epiglottis.

The trachea is a cylindrical tube, composed of cartilages an membrane, extending from the cricoid cartilage, at the level of t sixth cervical vertebra, to a point opposite the fourth dorsal, where divides into a right and left bronchus. It is from 4 to 4 3/4 inch to 12 cm.) long in males, and from 3 2/3 to 4 1/2 inches (9 to 11 .) long in females. Its transverse diameter measures on an aver- 4/5 of an inch (2 cm.) in males, and less in females. In a child rom two to four years, the transverse diameter measures 1/3 of an h (8 mm.); in a child under eighteen months, it measures 1/4 of inch (6 mm.).

The framework of the trachea is composed of from sixteen to eteen rings of hyaline cartilage, incomplete behind, each measur- 1/12 to 1/5 of an inch (2 to 5 mm.) in breadth. The narrow ce between these rings is filled with an elastic fibrous membrane ch splits into two layers to enclose each cartilage, and also es to complete the tube posteriorly. Internally, the trachea is d with a smooth mucous membrane of the ciliated variety, con- ous above with that of the larynx and below with that of the nchi. It contains an abundance of lymphoid tissue and mucous ds.

The trachea lies in a mass of loose fat which permits free motion ard, downward, and horizontally. In its upper part it lies com- tively superficial, but becomes more deeply placed as it ap- ches the thorax. The isthmus of the thyroid gland lies opposite second and third rings; below this the following structures will net from above downward: the inferior thyroid veins, the arteria oidea ima (if present), the sternohyoid and sternothyroid mus- the cervical fascia, an anastomosis of the anterior jugular veins; in the thorax, the remains of the thymus gland, the left innomi- vein, the arch of the aorta, and the innominate and the left mon carotid arteries. Behind lies the esophagus. Laterally, trachea is in relation with the common carotid arteries, the ral lobes of the thyroid, the inferior thyroid arteries, and the re- ent laryngeal nerves. These relations are important to bear in d in performing tracheotomy.

Diagnostic Methods

The diagnostic methods employed in connection with the larynx trachea consist in (1) inspection by means of a laryngeal mirror, direct inspection through endoscopic tubes, (3) palpation by the be or finger, and (4) skiagraphy.

As a preliminary to the local examination, attention should first given to the general condition of the patient, and the history of er affections that may have a bearing upon the conditions should be inquired into. This is important, for, while the symptoms of processes involving this portion of the respiratory tract are characteristic (consisting of cough, dyspnea, aphonia or dysphonia, dysphagia, etc.), and as a rule clearly indicate the seat of the trouble, it should be borne in mind that many of these symtoms are secondary to other conditions, such as gout, diphtheria, rheumatism, diabetes, nephritis, tuberculosis, syphilis, diseases of the nervous system, etc. Thus it becomes of the utmost importance to examine other organs as well and not to limit the investigation to the affected region alone.

Having completed this portion of the examination, external inspection and palpation of the parts should be performed. In this way the presence of inflammation, swellings, new growths, enlarged glands, fractures of the cartilages, etc., may be determined, and the mobility or fixation of the parts during swallowing and respiration may be noted.

LARYNGOSCOPY AND TRACHEOSCOPY

By this method the interor of the larynx and trachea are inspected by means of a laryngoscopic mirror and reflected light. The technic is not difficult, and, if properly carried out, a satisfactory inspection of the tissues may be made as far as the true vocal cords, and under favorable conditions the region beyond the glottis as far as the subdivision of the trachea may also be explored, and foreign bodies or pathological conditions recognized. Such examination is best made before a meal, as, otherwise, retching and vomiting may be induced.

Instruments and Apparatus.—Requisites for an ordinary laryngoscopic examination are: a strong light, such as is obtained from a Welsbach burner covered by a Mackenzie condenser; a concave head mirror, 3 1/2 to 4 inches (9 to 10 cm.) in diameter with a central perforation for the eye; laryngeal mirrors of three sizes, 1/2, 3/4 and 1 inch (1, 2, and 2.5 cm.) in diameter, that they may be adapted to the size of the individual fauces; and an alcohol lamp (Fig. 429). The light should be placed upon a suitable bracket, that it may be raised or lowered to any desired height (see Fig. 339).

Asepsis.—The laryngeal mirrors should be sterilized by immersion in a 1 to 20 solution of carbolic acid, then rinsed off in sterile water and dried before use.

Position of Patient and Examiner.—To obtain the best results, the examination should be performed in a partially darkened room. The patient sits in a straight-backed chair with the head raised and

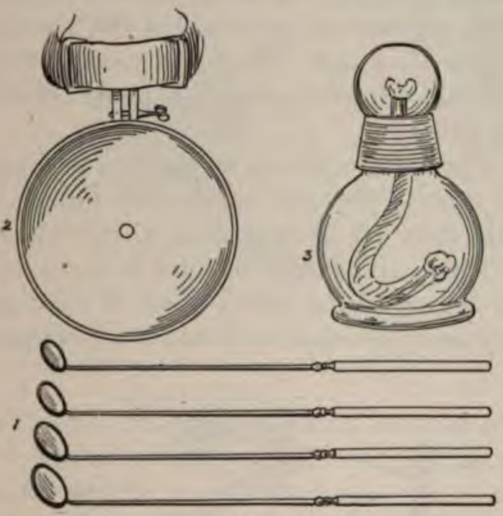


FIG. 429.—Instruments for laryngoscopy. 1, Laryngeal mirrors; 2, head mirror; 3, alcohol lamp.

FIG. 430.—Laryngoscopy. First step, showing the method of grasping the tongue.

inclined slightly backward. The light is located upon the patient's right, a little behind him and about on a level with the ear. The operator sits facing the patient, with his knees to one or the other side of the patient's, and with his eye on a level with the patient's mouth, at a distance of about a foot (30 cm.), or the focal length of the mirror.

Anesthesia.—Ordinarily, cocainization of the parts is unnecessary, but, where the mucous membrane of the pharynx is very sensitive, brushing a 4 per cent. solution of cocain over the posterior pharyngeal wall and soft palate may be required before a satisfactory examination is possible.

Technic.—The operator places himself and patient in the proper positions, and adjusts the head mirror over the left eye in such a manner that the light will be reflected in a circle upon the mouth of the patient. The patient is then directed to protrude the tip of the tongue, which is surrounded with a piece of clean gauze or small napkin and is grasped between the thumb and forefinger of the opera-

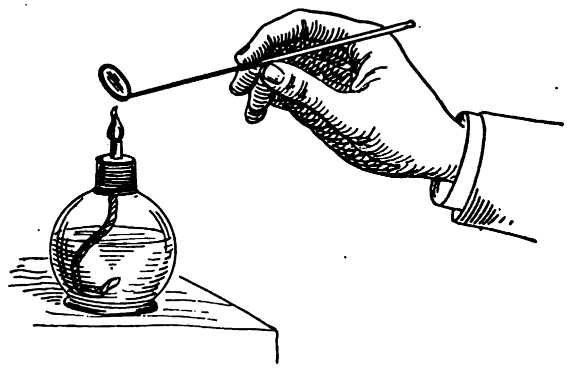


Fig. 431.—Laryngoscopy. Second step, heating the mirror.

tor's left hand (Fig. 430). Light traction is made outward and slightly upward rather than downward, so as to avoid forcing the under surface of the tongue against the lower incisor teeth. The laryngeal mirror is then warmed to avoid condensation of moisture upon its reflecting surface, by holding it at a little distance above a flame for a few seconds (Fig. 431), *the precaution being taken to test the temperature of the mirror before introducing it into the mouth*; this is determined by bringing the back of the mirror in contact with the back of the operator's hand. To introduce the mirror, it should be held lightly between the thumb and forefinger of the right hand with its reflecting surface downward (Fig. 432), and should be made to follow the curve of the hard palate until its back touches the uvula and soft palate. It is then pushed upward and backward, raising the uvula as far out of the way as possible. Care must be n in performing this maneuver to avoid touching the base of the ue, and, when the mirror is in position, to keep it held steadily in e so as not to excite gagging or. retching. Should this accident r, the mirror must be removed and sufficient time must be al-

FIG. 432.—Showing the method of holding the mirror.

d for the patient to recover his breath and the irritability to ide before it is reintroduced. As soon as the instrument is in er position, the handle is moved to one side of the patient's th so as to be well out of the line of vision. The mirror is then ly and gently turned until a view of the base of the tongue is

G. 433.—Laryngoscopy. Third step, showing the mirror being introduced lso the relative position of the patient and examiner and the position of the light.

ined, and any abnormalities of the organ are noted; it is then ted in such a manner that its face looks downward and the nx is brought into view (Fig. 434).

t should be remembered that the laryngeal image will be inverted—that is, the structures of the front part of the larynx appear on the upper part of the mirror, and *vice versa*; the right and left

Fig. 434.—Laryngoscopy. Fourth step, showing the mirror in place. (J. M. Anders

Fig. 435.

Fig. 436.

Fig 435.—The laryngoscopic image. 1, Epiglottis; 2, false vocal cords; 3, voc cords; 4, glossoepiglottic fossa; 5, interarytenoid space; 6, cartilage of Santorini and t location of the arytenoid cartilage; 7, cartilage of Wrisberg.

Fig. 436.—The larynx during gentle respiration.

sides of the laryngeal image, of course, correspond to the same sid of the patient. In a normal case, the following are noted: at th upper part of the picture, the saddle-shaped epiglottis of a yellowis ıversed by its pink blood-vessels; extending backward across ror back of the epiglottis are a pair of pearly-white bands, al cords; parallel to the vocal cords, but lying anteriorly and are a second pair of bands with a reddish hue, the ventricıds, or false vocal cords; between the vocal cords and the ılar bands may be observed the ventricles of the larynx, into better view if the head is tilted to the side; where the ords terminate at the lower part of the image are to be seen :enoid cartilages, and between them the interarytenoid space; ıg from either side of this notch to join the epiglottis are the ottic folds, with the two prominences marking the site of the es of Wrisberg and Santorini, the latter lying on top of the id cartilages; on either side of the image will be noted the ›iglottic fossæ.

nake a complete examination, the larynx should be inspected quiet respiration, deep respiration, and phonation. During

437.—The larynx in phonation.

FIG. 438.—The larynx during deep respiration.

ion the vocal cords are seen to move with each expiration the median line, and away from the median line with inspirag. 436). By requesting the patient to say "ee" or "he," a ›btained of the larynx with the cords almost in apposition and rarytenoid space obliterated (Fig. 437). During deep respihe cords are widely separated, and a view is obtained of the wall of the region below the vocal cords (Fig. 438). There seen the broad yellow cricoid cartilage and the yellowish carus rings of the anterior wall of the trachea with the intervenmembranous portion. By tilting and carefully adjusting the the bifurcation of the trachea and the openings of the two in favorable cases may be brought into view. To obtain st favorable position for inspection of the trachea, the paıeck should be held straight and the chin extended somewhat . The mirror will also require a different adjustment, being held more horizontally than for laryngoscopy, and the surgeon should be seated lower.

The examiner should first note the color of the various parts brought to view for signs of congestion or inflammation, bearing in mind that if cocain has been employed the parts will appear anemic, and that gagging or retching may be responsible for congestion He should look for the presence of exudations, foreign bodies, and any structural changes, such as ulcerations, swellings, abscesses, edema, new growths, malformations, and dislocations of the arytenoid cartilages, etc. Finally, the condition and mobility of the vocal cords during respiration and phonation are observed. They should approximate symmetrically in the mid-line during phonation, and separate equally with inspiration. The whole examination should be made as rapidly as possible, not more than half a minute or so being consumed, to avoid tiring the patient and inducing an irritable state of the parts. Since often only a glimpse of the various structures may be thus obtained, it may be necessary to make more than one inspection before the whole examination is completed in a satisfactory manner.

Difficulties in Laryngoscopy.—It is sometimes a difficult matter for a beginner to inspect the parts, owing to faulty technic or to structural peculiarities. A view of the larynx may be missed entirely through an improper adjustment of the light, faulty position of the patient's head, or holding the mirror at a wrong angle. Clumsy and hasty introduction of the mirror, the use of a mirror too hot or too cold, or rough traction on the tongue, all militate against success. In some cases an excessive irritability of the pharynx precludes a successful examiation without preliminary cocainization. In other cases the presence of enlarged tonsils may prevent a good view of the parts. If such a condition is present, a small oval mirror should be substituted. A large pendulous epiglottis is not infrequently a cause of difficulty. By placing the mirror close to the posterior pharyngeal wall and holding it more nearly vertical than usual, with the patient's head thrown back, a better view may often be obtained.

In young children considerable difficulty may be encountered. It is best to wrap the child in a sheet so that the arms are restrained, and to have it held upon the lap of an assistant, who also steadies the child's head. A tongue depressor with a curved tip should be employed to hold the tongue forward, and, if necessary, a mouth-gag may be inserted between the teeth. A small laryngeal mirror is then introduced, and the examination is made in the usual way. If carefully and gently performed, a satisfactory examination may often be made even upon unruly children.

DIRECT LARYNGOSCOPY

The larynx and portions of the air passages beyond may be examined under direct vision either by the aid of illuminated tubes or by means of a suitable tongue depressor and illumination from a head light, the latter a method designated by Kirstein as autoscopy. The parts inspected in this manner appear more nearly normal as to position and color than when a laryngeal mirror is employed. Furthermore, foreign bodies and new growths may be removed, and applications made to diseased areas under direct vision. The method may be employed in young children upon whom ordinary laryngoscopy is

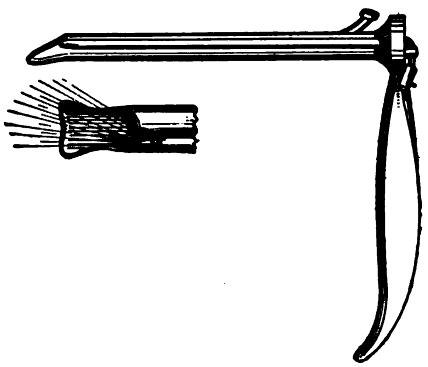


FIG. 439.—Jackson's self-illuminated tube spatula for direct laryngoscopy.

difficult, and it may also be performed upon a patient under general anesthesia. It is, however, more uncomfortable for the conscious patient than ordinary laryngoscopy.

Instruments.—A tubular spatula, self-illuminated, such as Jackson's (Fig. 439), or with the illumination furnished from an electric head light, as Killian's, is generally employed. Kirstein uses a tongue depressor of special shape (Fig. 440) and an electric head light (Fig. 441). In addition a mouth-gag and a Sajous applicator are required (Fig. 442).

Asepsis.—The tubes and tongue depressor may be boiled, while the light-carrying apparatus in the self-illuminated tube is sterilized by immersion in alcohol.

Position of the Patient.—The patient is seated on a low stool with the upper part of the body bent slightly forward and with the head raised and thrown back so that a direct view from above downward is possible. An assistant stands or sits behind, supporting the patient's head, and holding the mouth-gag in proper position. The operator stands in front.

A child should be seated upon the lap of a nurse, who encircles its body with her arms, confining the child's arms closely to its sides

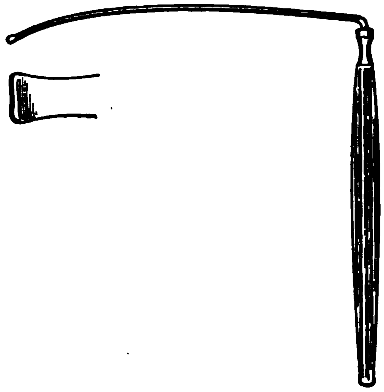


FIG. 440.—Kirstein's tongue depressor.

and clasping its legs between her knees. The child's head rests upon the nurse's shoulder, being held in the proper position from behind by an assistant.

Anesthesia.—Cocainization of the parts is usually necessary to avoid unpleasant gagging and retching. This is accomplished by

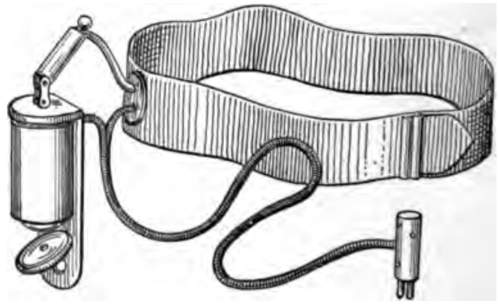


FIG. 441.—Kirstein's head light.

the application to the larynx and neighboring parts of a 4 per cent. solution of cocain by means of a cotton swab held by a Sajous applicator. This should be performed by the aid of a laryngeal mirror. If operative procedures are required, the application of a 20 per cent. solution of cocain should follow the preliminary cocainization. In young children the examination may be carried out under general anesthesia.

Technic.—The operation should, when possible, be performed when the stomach is empty, as, otherwise, retching may result in

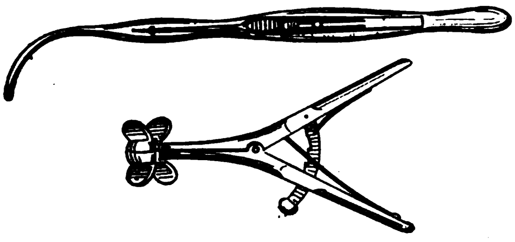


FIG. 442.—Sajous' applicator and mouth-gag.

regurgitation of the stomach contents. The parts having been cocainized, and with the patient seated in the proper position, a mouth-gag is inserted in one side of the mouth and is held in place by the

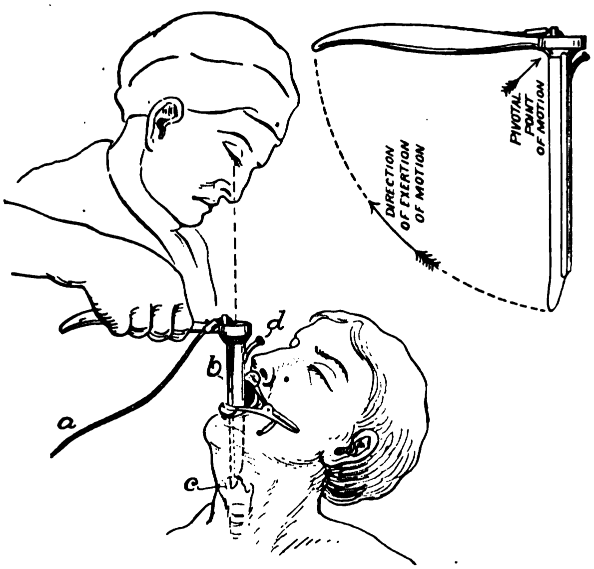


FIG. 443.—Direct laryngoscopy with Jackson's self-illuminated spatula. (Modified from Ballenger,) *a*, Electric cord supplying lamp of speculum; *b*, conduit for light carrying tube; *c*, shows the tube holding the epiglottis forward; *d*, conduit for removing secretions, etc., by aspiration during the examination.

assistant who supports the head. With the lamp at the end of the instrument properly lighted, if a self-illuminated spatula is employed, or with the head lamp lit and adjusted so as to throw the light into the mouth, if a nonilluminated tube is used, the tubular speculum is introduced past the base of the tongue until the epiglottis appears. Its tip is passed to a point about 1/2 inch (1 cm.) below the free edge of the epiglottis, which is then drawn forward, and with it the base of the tongue out of the line of vision by exerting pressure upon the handle of the instrument in an upward and backward direction (Fig. 443).

The operator then inspects the larynx by looking down the tube. The arytenoid cartilages, vocal cords, interior of the larynx, and portions of the trachea may thus be viewed in detail. The points especially to be noted in such examination have already been referred to under laryngoscopy. By the aid of these tubes, applications may also be made, if desired, to diseased areas, and growths may be removed by means of delicate instruments of special design.

Under the method designated by Kirstein as autoscopy, the patient is placed in the same position as above, the mouth is illuminated from the electric head light, and the special tongue depressor is gently introduced behind the tongue until its tip rests between the epiglottis and the base of the tongue. By elevating the handle of the instrument, the base of the tongue is drawn downward and forward, and the epiglottis is raised, so that a groove is formed along the back of the tongue. With the head light properly adjusted the operator looks down this groove and inspects the larynx. The posterior walls of the larynx and trachea are clearly viewed by this method, but the anterior parts are not seen so well as with the laryngoscopic mirror.

SUSPENSION LARYNGOSCOPY

A method of laryngoscopy of great value for certain cases has been devised by Killian under the name of suspension laryngoscopy. It is performed with the patient in the dorsal position, his head suspended by means of a specially made spatula introduced over the tongue. The curved region from the teeth to the larynx is thus converted into a straight line, and it is possible to obtain a direct view of the larynx and surrounding parts not possible under other methods.

Suspension laryngoscopy is not intended to take the place of indirect laryngoscopy for routine office examinations, and, as a diagnostic measure, should be reserved for cases in which difficulty is met in making a satisfactory examination by the usual methods.

ecial value for operative procedures, such as the removal of odies or growths from the larynx, the cauterization or of ulcerations, etc., and as an aid in introducing the bron- r esophagoscope. Its advantages over the other methods scopy for operating is that the operator is brought near f operation and both of the operator's hands are left free. re, on account of the position of the patient's head, blood ions escape toward of the pharynx and scure the operative ter the larynx.

ion laryngoscopy limitations, how- is not suitable for Rigidity of the rtion of the verte- nn, a very thick ry prominent upper any condition that the mouth being the fullest extent -indications. The us has a wider field ss in children than It is claimed that nsion causes only mfort and that the ts are mild.

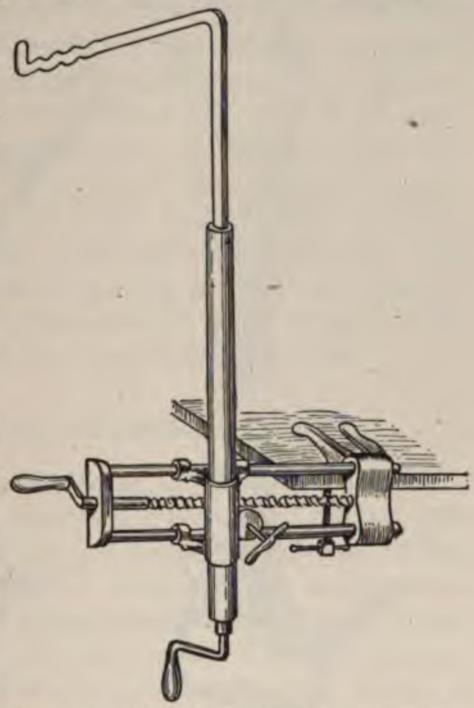


FIG. 444.—Travelling crane for suspension laryngoscopy.

tus.—Killian's strument, as modi- nch, consists essentially of a travelling crane, or "gallows," spatula. The gallows (Fig. 444) can be raised or lowered, in a horizontal direction. The horizontal arm of the gal- ovided with notches to receive the handle of the hook

ok spatula consists of a handle, tongue holder, and mouth handle consists of a vertical arm with a joint in the center, lation of which, the arm may be bent or straightened. One arm terminates in a hook and to the other end a tongue mouth gag is attached. The mouth gag, which may be closed by means of a screw, has a plate which engages the upper teeth and prevents the spatula from slipping out of the mouth (Fig. 445).

Illumination is furnished by a Kirstein head lamp, reflected light from a head mirror, or by a lamp designed to be fastened to one of the bars of the mouth gag.

An operating table that can be raised or lowered to suit the height of the operator is necessary.

Asepsis.—The operation should be performed under the usual

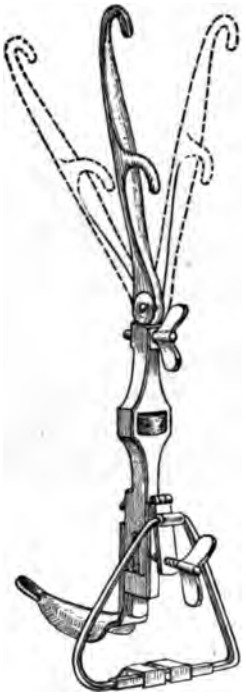


FIG. 445.—Lynch's modification of Killian's hook spatula.

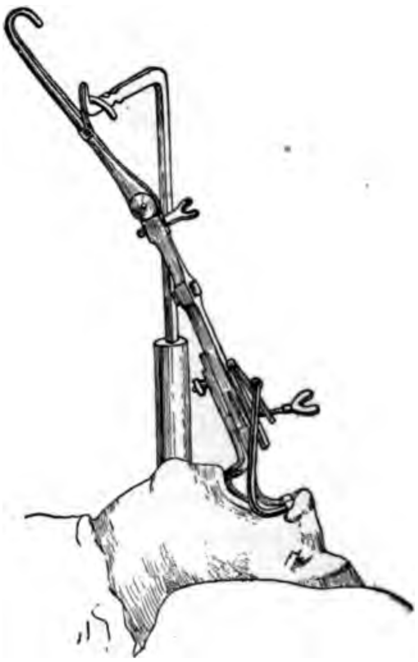


FIG. 446.—Suspension laryngoscopy. (Modified from Lynch.)

aseptic precautions. The hook spatula and mouth gag are boiled and the operator's hands are prepared as for any operation.

Position of the Patient.—The patient should be in the dorsal position on a table, with the shoulders brought to the edge of the table and the head supported by an assistant.

Anesthesia.—In this country general anesthesia is usually employed for adults and always for children. If local anesthesia is used, the patient is given, two hours before the operation, 1/100 of a grain (.00065 gm.) of scopolamin and 1/4 of a grain (0.0162 gm.) of morphin hypodermically. Anesthesia is obtained by applying a 20 per cent. solution of cocain to the base of the tongue, pharynx, epiglottis, and larynx.

Technic.—The patient is placed on the table, with his shoulders at the edge and his head supported by an assistant, and the crane is secured to the table on the right side. Then under illumination from a head light, the tongue spatula, with the mouth gag closed, is carefully passed well over the base of the tongue *in the median line* until its tip engages in front of the epiglottis. Pressure of the tongue against the lower teeth should be prevented by means of a small wad of gauze previously placed between the inner surfaces of the teeth and the tongue. The tooth plates are adjusted and the mouth gag is then opened to its fullest extent and securely locked. The operator brings the vertical arm of the hook toward him, thereby crowding the tongue forward and at the same time elevating the epiglottis. The hook is finally hung on the horizontal arm of the crane, the assistant slowly releasing the head until it hangs by its own weight supported by the hook spatula. Any additional adjustment that may be necessary may be made by moving the crane in a vertical or horizontal direction. The illumination is finally turned on exposing to direct view the larynx and the neighboring parts.

DIRECT TRACHEO-BRONCHOSCOPY

In 1897 Killian devised long endoscopic tubes that could be introduced through the mouth or through a tracheotomy wound, with which the trachea and bronchi may be examined by the aid of illumination from an eletric head light. This operation is designated respectively as "upper direct tracheo-bronchoscopy," and "lower direct tracheo-bronchoscopy." In this country, Chevalier Jackson has perfected similar tubes, in which, however, the illumination is supplied by a small electric light at the distal end of the instrument.

The bronchoscope is employed both for diagnostic and therapeutic purposes, and is of especial value in locating and removing foreign bodies and growths from the air passages, or in making direct applications to ulcers and other lesions in the trachea and bronchi. Marvelous results have been obtained by those expert in the use of these instruments, and foreign bodies have been frequently removed from the bronchi of patients upon whom thoracotomy would otherwise have been required. The use of the bronchoscope, however, requires such skill and practice as to be only of service in the hands of an accomplished specialist; *in unskilled hands it becomes a dangerous instrument.*

Tracheo-bronchoscopy through a tracheotomy wound is the simpler of the two methods, and, as larger tubes may be employed than in the upper operation, it is often of value for the removal of foreign bodies too large to be extracted by upper tracheo-bronchoscopy. Upper tracheo-bronchoscopy, however, should be the operation of choice when possible.

Instruments.—The tubes employed are of rigid metal highly polished internally, somewhat similar to the endoscopic tubes employed in the urethra. They vary in size according to the age of the patient and the part of the air passages to be explored. Only

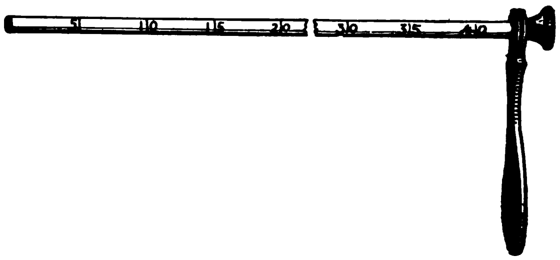


FIG. 447.—Killian's bronchoscope.

the smallest sized tubes should be used for the bronchi. Jackson employs for lower tracheo-bronchoscopy a tube $\frac{1}{3}$ inch (8 mm.) in diameter by 8 inches (20 cm.) long for adults, and one $\frac{1}{5}$ inch (5 mm.) in diameter by $5\frac{1}{2}$ inches (14 cm.) long for children; and for upper tracheo-bronchoscopy a tube $\frac{7}{25}$ inch (7 mm.) in diameter by 18 inches (45 cm.) long for adults, and one $\frac{1}{5}$ inch (5 mm in diameter by 8 inches (20 cm.) long for children.

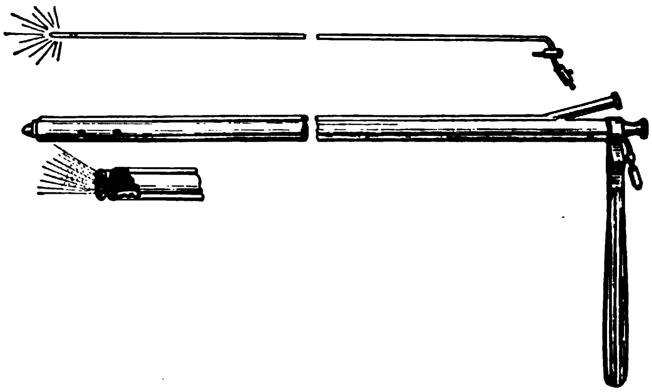


FIG. 448.—Jackson's bronchoscope.

In Killian's instruments (Fig. 447) illumination is supplied from an electric head light. In the Jackson tubes (Fig. 448) the illumination is supplied by a small electric light at the distal end of the instrument. These latter are somewhat easier to use than

Killian's instruments. In addition, the Jackson instruments are provided with a conduit to which is attached a suction apparatus and exhaust pump, for the purpose of removing secretions that may collect and obscure the view (Fig. 449). For inserting these instruments, a special split tube (Fig. 450), resembling that used in direct laryngoscopy, is supplied which is, removed in two halves after the bronchoscope has entered the glottis.

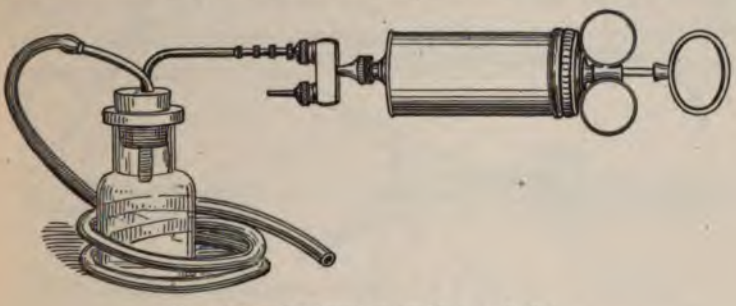


FIG. 449.—Jackson's secretion aspirator.

A portable battery with rubber-covered cords, a mouth-gag, a Sajous applicator, variously shaped forceps, applicators for applying cocain or drugs to the mucous membrane, hooks, etc., for the removal of foreign bodies through the instrument, and a tracheotomy set

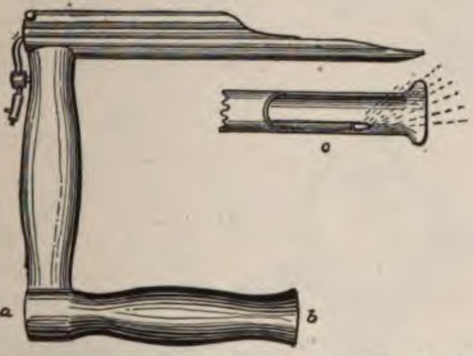


FIG. 450.—Jackson's separable speculum for passing the bronchoscope. The handle, *ab*, for use when the patient is in a sitting posture; *c*, shows the arrangement of the lamp at the distal end.

(see page 479) are required. The operator should also be provided with a number of extra lamps to replace those that may burn out.

Asepsis.—Strict asepsis in all details is necessary. The tubes and accessory instruments are boiled, the lighting apparatus is sterilized by immersion in alcohol or in a 1 to 20 carbolic acid solution followed by rinsing in alcohol, and the rubber-covered battery cords are wiped off with bichlorid solution. The hands of the operator and assistants should be as thoroughly cleansed as for any operation. On account of the danger of sepsis from the mouth, the patient's teeth should

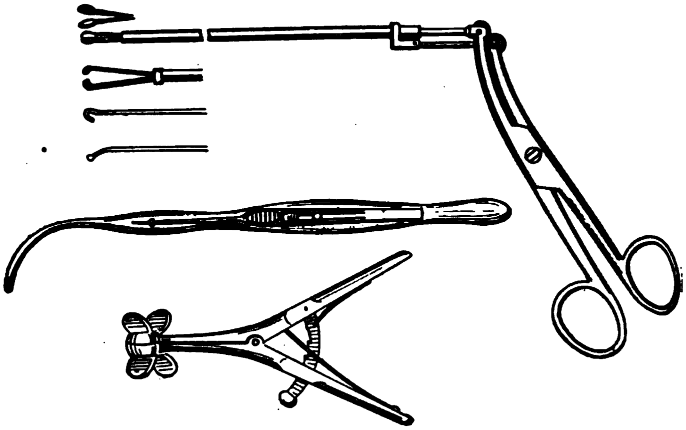


FIG. 451.—Accessory instruments for tracheo-bronchoscopy.

be brushed and the mouth well cleansed with an antiseptic w before passing the instruments. A tube employed in the up

FIG. 452.—The position of the patient and the assistant for upper tracheo-bronchosc (After Jackson.)

operation should not be used for lower bronchoscopy withc resterilization.

Preparation of the Patient.—If general anesthesia is to be employed, the patient should be prepared according to the usual method (page 18). In any case, the operation should be performed on an empty stomach. For lower tracheo-bronchoscopy, the neck, if hairy should be shaved and painted with tincture of iodin.

Position of the Patient.—If done under local anesthesia, upper tracheo-bronchoscopy may be performed with the patient in the upright position. The patient sits on a low stool, with the head extended backward as far as possible and the tongue projected forward. An assistant holds the head from behind and steadies the mouth-

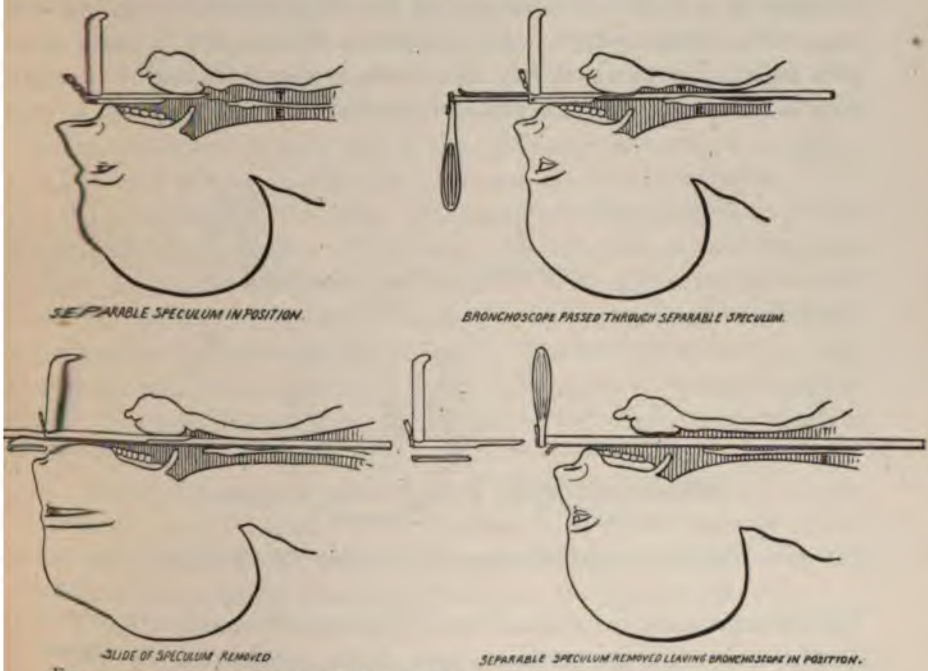


FIG. 453.—Showing the various steps in upper bronchoscopy. (After Jackson.)

gag, while the operator stands in front. When a general anesthetic is employed, and in all cases of lower bronchoscopy, the patient should be in the dorsal position on a table, the front of which is slightly elevated, with the head hanging over the edge of the table, in which position it is supported by an assistant who takes care of the mouth-gag, as shown in Fig. 452.

Anesthesia.—In children, general anesthesia is necessary. In adults, preliminary cocainization of the pharynx and larynx with a 4 per cent. solution of cocain, followed by a 20 per cent. solution of cocain, applied to the larynx and trachea is in most cases sufficient, unless the patient is very excitable, although general anesthesia renders the operation easier in any case. Even when general anesthesia is used, cocain should be applied by means of cotton applicators to the larynx and trachea before the introduction of the tube, to avoid dangerous reflexes from stimulation of the endings of the superior laryngeal nerve.

Technic.—1. *Upper Tracheo-bronchoscopy.*—With the patient in the proper position, and the parts cocainized, the mouth is widely opened and the mouth-gag is inserted and given to the assistant to maintain in position. The larynx and vocal cords are exposed by introducing a split tube spatula, as for direct laryngoscopy (page 449). The bronchoscope, well lubricated with sterile vaselin, and with the illumination properly turned on, is passed through the split tube as far as the epiglottis under the guidance of the operator's eye.

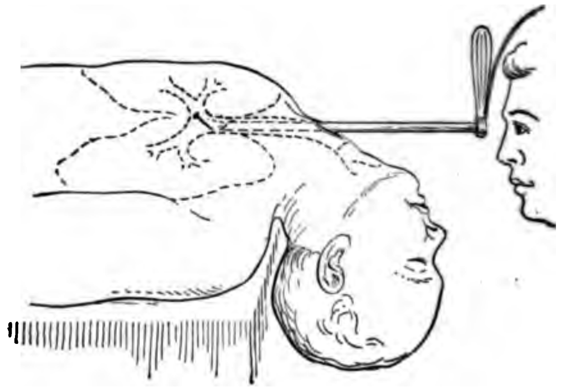


FIG. 454.—Lower bronchoscopy. (Modified from Ballenger.)

The operator notes the vocal cords and instructs the patient to breathe deeply, and, while the cords are open during inspiration, the instrument is gently passed through the glottis until it enters the trachea. The split tube is then separated and removed. As the bronchoscope is advanced, the mucous membrane in front should be anesthetized by means of a 20 per cent. solution of cocain applied with cotton swabs on a long applicator. The instrument is thus slowly passed to the bifurcation of the trachea, and the parts are examined in detail as the tube advances.

To enter the right bronchus, the instrument should be turned toward the left angle of the patient's mouth, and toward the right side if the left bronchus is to be entered. By very careful and gentle manipulations with the tube, and by using the smallest sizes, the y and even the third division of the bronchi may be inspected specially skilled in this work.

ig the examination, secretions or blood may be removed by cotton wrapped on long applicators or by the special aspirat- ratus supplied with the instrument, the manipulation of entrusted to an assistant. In this way the entire mucous ie lining the trachea may be examined, foreign bodies located oved, and lesions treated by direct application.

wer Tracheo-bronchoscopy.—Low tracheotomy is first per- s described on page 486. After all the bleeding has been d, a Trousseau dilator is inserted and the tracheal wound is i. The mucous membrane of the trachea is then cocainized per cent. solution of cocain. A short bronchoscope, with iination turned on, is introduced, and the instrument is l under the guidance of the operator's eye, which is applied id of the instrument. As soon as the bifurcation of the s reached, the tube may be directed into either bronchus manipulation. The patient's head is turned sideways, and, ht bronchus is to be entered, the tube is inserted on the left ie head; if the left bronchus is to be examined, the tube is at the right side of the head. The bronchi should be anes- as before, in advance of the instrument with cocain applied g applicators through the instrument, and the examination d with as above.

fter-treatment of the patient consists in inserting a tracheot- which is worn for several days. After the removal of this wound should be carefully protected by a gauze dressing and daily, being allowed to heal from the bottom up.

PALPATION BY THE PROBE

tion by the probe is of value in determining the consistency nt of new growths, the depth and size of ulcerations, the of necrosed cartilage, and the sensibility of the mucous ie.

iments.—A laryngeal mirror, an alcohol lamp, a head light, yngeal probe are necessary (Fig. 455).

is.—The probe should be boiled and the laryngeal mirror by immersion in a 1 to 20 solution of carbolic acid, then in sterile water and dried before use.

unless the patient is very excitable, although general anesthesia renders the operation easier in any case. Even when general anesthesia is used, cocain should be applied by means of cotton applicators to the larynx and trachea before the introduction of the tube, to avoid dangerous reflexes from stimulation of the endings of the superior laryngeal nerve.

Technic.—1. *Upper Tracheo-bronchoscopy.*—With the patient in the proper position, and the parts cocainized, the mouth is widely opened and the mouth-gag is inserted and given to the assistant to maintain in position. The larynx and vocal cords are exposed by introducing a split tube spatula, as for direct laryngoscopy (page 449). The bronchoscope, well lubricated with sterile vaselin, and with the illumination properly turned on, is passed through the split tube as far as the epiglottis under the guidance of the operator's eye.

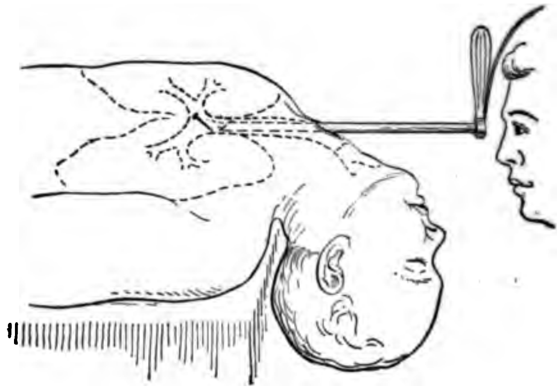


FIG. 454.—Lower bronchoscopy. (Modified from Ballenger.)

The operator notes the vocal cords and instructs the patient to breathe deeply, and, while the cords are open during inspiration, the instrument is gently passed through the glottis until it enters the trachea. The split tube is then separated and removed. As the bronchoscope is advanced, the mucous membrane in front should be anesthetized by means of a 20 per cent. solution of cocain applied with cotton swabs on a long applicator. The instrument is thus slowly passed to the bifurcation of the trachea, and the parts are examined in detail as the tube advances.

To enter the right bronchus, the instrument should be turned toward the left angle of the patient's mouth, and toward the right side if the left bronchus is to be entered. By very careful and gentle manipulations with the tube, and by using the smallest sizes, the condary and even the third division of the bronchi may be inspected one especially skilled in this work.

During the examination, secretions or blood may be removed by eans of cotton wrapped on long applicators or by the special aspirat-g apparatus supplied with the instrument, the manipulation of nich is entrusted to an assistant. In this way the entire mucous embrane lining the trachea may be examined, foreign bodies located id removed, and lesions treated by direct application.

2. *Lower Tracheo-bronchoscopy.*—Low tracheotomy is first per-rmed as described on page 486. After all the bleeding has been ontrolled, a Trousseau dilator is inserted and the tracheal wound is eld open. The mucous membrane of the trachea is then cocainized ith a 20 per cent. solution of cocain. A short bronchoscope, with he illumination turned on, is introduced, and the instrument is dvanced under the guidance of the operator's eye, which is applied t the end of the instrument. As soon as the bifurcation of the achea is reached, the tube may be directed into either bronchus y gentle manipulation. The patient's head is turned sideways, and, the right bronchus is to be entered, the tube is inserted on the left de of the head; if the left bronchus is to be examined, the tube is serted at the right side of the head. The bronchi should be anes-hetized, as before, in advance of the instrument with cocain applied pon long applicators through the instrument, and the examination roceeded with as above.

The after-treatment of the patient consists in inserting a tracheot-ny tube which is worn for several days. After the removal of this be, the wound should be carefully protected by a gauze dressing and eansed daily, being allowed to heal from the bottom up.

PALPATION BY THE PROBE

Palpation by the probe is of value in determining the consistency d extent of new growths, the depth and size of ulcerations, the esence of necrosed cartilage, and the sensibility of the mucous embrane.

Instruments.—A laryngeal mirror, an alcohol lamp, a head light, id a laryngeal probe are necessary (Fig. 455).

Asepsis.—The probe should be boiled and the laryngeal mirror erilized by immersion in a 1 to 20 solution of carbolic acid, then nsed off in sterile water and dried before use.

Position of Patient.—The patient is in the same position as for ordinary laryngoscopy.

Anesthesia.—The larynx should be cocainized by spraying or by the application of a 10 per cent. solution of cocain.

Technic.—The tongue is protruded and held by the patient with a cloth, and the laryngeal mirror is warmed and inserted in such a position that a good view of the larynx is obtained. The probe is held in the operator's right hand and is introduced into the patient's mouth turned on its side, with the laryngeal portion horizontal and the handle in the angle of the mouth until it almost reaches the posterior pharyngeal wall (see Fig. 456). It is then brought into the natural position, with the laryngeal portion vertical and the handle in the mid-line, the point of the instrument lying in the pharynx behind the epiglottis. By raising the handle of the instrument, the point is then brought forward over the arytenoids. By directing the point of the probe, guided by the image in the mirror, the diseased areas are then explored (see Fig. 457). In performing this manipulation, it must be remembered that the image in the mirror is reversed, so that movements of the instrument will likewise appear reversed, and that the distance between the arytenoids and the vocal cords is much greater than appears in the image.

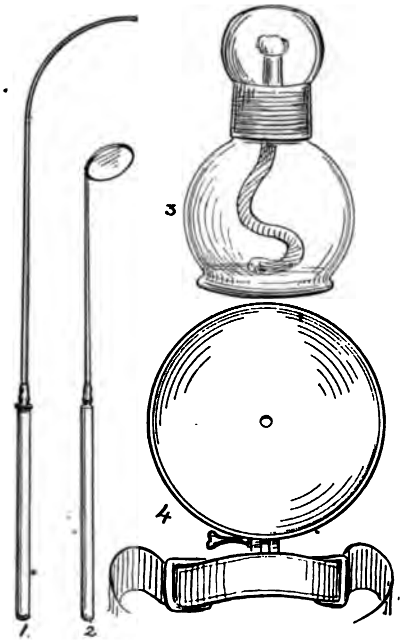


FIG. 455.—Instruments for probing the larynx. 1, Laryngeal probe; 2, laryngeal mirror; 3, alcohol lamp; 4, head mirror.

SKIAGRAPHY

Skiagraphy is employed as an adjunct to other diagnostic measures for locating metal and other foreign bodies which are impenetrable to the rays, and also for localizing certain growths of greater density than the surrounding tissues.

Therapeutic Measures

THE LARYNGEAL SPRAY

laryngeal spray is employed for the purpose of cleansing and ication. Cleansing of the larynx is frequently required for oval of purulent secretions the result of syphilitic or tubercu- erations, and to soften and wash away the crusts which are n accompaniment of fetid laryngitis. Whenever possible, g of the larynx should be done by the surgeon himself, as it s be performed by the aid of direct vision in a thorough man- this is not feasible, the patient must be very carefully in- in the use of the instrument.

ication of the larynx may be required in the treatment of id chronic inflammations, ulcerations, etc., and according to cations of the individual case, remedies with an antiseptic, nt, sedative, stimulating, or caustic action are employed. nay be used in the form of watery or oily solutions. The nsitiveness of the laryngeal mucous membrane should be mind in making any topical application, and the use of very g drugs should be avoided.

uments.—It is important to select a spray that will not expel tion in such a powerful stream as to produce irritation and add to the local inflammation. The Davidson, the Whitall see Fig. 365), and the De Vilbiss atomizers (see Fig. 366) are nd very efficient instruments. They should be provided with eal nozzle, which turns downward. The air current may be by a rubber compression bulb or by means of a compressed- ratus (see Fig. 367).

ad mirror, a laryngeal mirror, and proper illumination will equired when the spraying is to be done by the operator under sion.

ions.—For cleansing purposes, the alkaline solutions recom- on page 380 for use in the nose may be employed. For pplications to the larynx, the formulæ of antiseptic, astrin- lative, and stimulating solutions given on page 385, for use ose, may be employed according to the indications.

perature.—The solutions should always be used warm, at rature of about 100° F. (38° C.).

thesia.—When the parts are very sensitive, preliminary with a 10 per cent. solution of cocain may be required.

Technic.—The patient is directed to open his mouth widely and to protrude his tongue, which he may hold forward with the fingers of his right hand if desired. The operator then warms and introduces a laryngeal mirror, holding it so as to obtain a good view of the parts Then, with his right hand, he introduces the spray nozzle into th mouth, and with the aid of the mirror passes it behind the epiglott and depresses the tip so that it points toward the diseased are When the nozzle is in proper position, the mirror is removed and t bulb of the spray is sharply compressed, the patient being instruct to phonate while this is being done. The spray is then immediate removed, as the patient will cough and want to expectorate. Wh performed for cleansing purposes, the spraying should be repeat several times until the larynx is well washed out. Each time t patient coughs, mucus, purulent secretion, and crusts, which ha been softened and separated by the spray, will be expelled.

When the spraying is carried out by the patient, the mouth widely opened and the tongue protruded as before. The spray no zle, held in the patient's right hand, is then introduced well back the tongue, with the tip directed downward and forward over t larynx, and, while the patient phonates, the bulb is sharply compresse In employing oily preparations, the patient should take an inspir tion at the moment of compressing the bulb, so as to aid in drawi the solution into the larynx. Until the patient becomes skilled in t introduction of the spray, it is well for him to perform the operati standing in front of a mirror.

THE DIRECT APPLICATION OF REMEDIES

This method is indicated when it is desired to apply remedies some particular spot, especially when strong stimulants or causti are used. Liquids may be applied by means of swabs or brush Solid caustics should be fused on a probe. The application shou be made with the aid of a laryngeal mirror, and great care must taken to avoid bruising the tissues or causing trauma.

Instruments.—For the application of liquids, a camel's-ha brush, mounted on a wire which is bent at right angles about 2½ to 3 inches (6 to 7 cm.) from the end and inserted into a handle, Sajous applicator (see Fig. 442), or an ordinary laryngeal applicat wrapped with cotton may be employed. In making use of the latte care should be taken that the cotton is wrapped tightly about the en of the instrument, so that there is no danger of its falling off and sli ping into the larynx.

Solid caustics, as silver nitrate and chromic acid, may be applied fused on the end of a laryngeal probe, as described on page 386.

FIG. 456.—Method of inserting the laryngeal applicator.

FIG. 457.—Shows the method of making direct applications to the larynx by the aid of the laryngeal mirror.

Anesthesia.—The parts should be anesthetized by means of a 10 per cent. solution of cocain applied by means of a spray or on a cotton applicator.

Technic.—The laryngeal mirror is warmed and introduced by the operator's left hand, so as to obtain a clear view of the parts to be medicated. If secretion or mucus be present, the parts should be first cleansed by spraying. The applicator is then dipped in the solution to be applied, and *any excess of fluid is removed* to prevent it from running into the trachea. This precaution is especially necessary when using strong solutions or caustics. The instrument, held in the operator's right hand, is then introduced into the mouth, with the curved surface held first horizontally (Fig. 456), and then, as soon

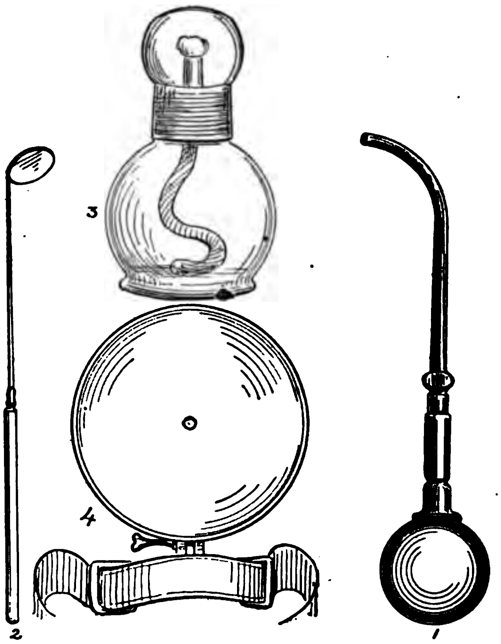


Fig. 458.—Instruments for applying powders to the larynx. 1, Powder blower; laryngeal mirror; 3, alcohol lamp; 4, head mirror.

as the tip of the instrument reaches the pharynx, turned to a vertical position. The applicator is then guided to the desired spot by the aid of the laryngeal mirror (Fig. 457). The application should be made with great gentleness and care and the instrument quickly removed.

The application of acids is carried out in the same manner, any excess of acid being immediately neutralized by the application of a solution of bicarbonate of soda, gr. xxx (2 gm.) to the ounce (30 c.c.). A dusting powder may finally be applied to the cauterized area.

INSUFFLATIONS

ers may be applied to the larynx by means of a special r. They are of use chiefly in cases of ulceration, where a or antiseptic action is desired. A combination of nosophen, urophen, iodoform, etc., with finely powdered starch, stear-c, or powdered acacia as a base, are usually employed in the n of one part of the active principle to two parts of the base. ounts of morphin or cocain may also be combined with the applied, when indicated, for the relief of pain.

ments.—A laryngeal powder blower, a head light, a laryn-or, an alcohol lamp, and suitable illumination are necessary. flator shown in Fig. 458 is very convenient, as with it the f powder may be accurately measured, and the instrument anipulated with one hand.

ic.—The laryngeal mirror is warmed and properly inserted harynx, so that a good view of the parts to be medicated is The insufflator, filled with the desired amount of powder, l in the mouth and carried back to the larynx under the of the image in the mirror. When in proper position, a mpression on the bulb forces out the powder and deposits it eased surface. If it is desired to carry the powder deep into c, the patient should be requested to phonate at the moment ssing the bulb.

STEAM INHALATIONS

eans of steam inhalations the active principle of certain t are readily volatilized by heat may be brought into con-the mucous membrane of the respiratory tract and carried ne larynx to the trachea and bronchi. The effect of the lf is also valuable, for it acts as an anodyne upon inflamed embranes by supplying moisture and so relieving the heat ss of congestion. In the latter stages of an inflammation , furthermore, dilutes and assists in removing secretions. alations are thus of great value in congestion and edema of x, croup, membranous laryngitis, and bronchitis. They lly serviceable in softening the thick tenacious secretion of ryngitis.

haler.—When it is simply intended to convey the vapor to y of the patient, a croup kettle with a long spout, such as shown in Fig. 459, is most convenient. For direct inhalation, more or less elaborate forms of apparatus are manufactured (Fig. 460), but

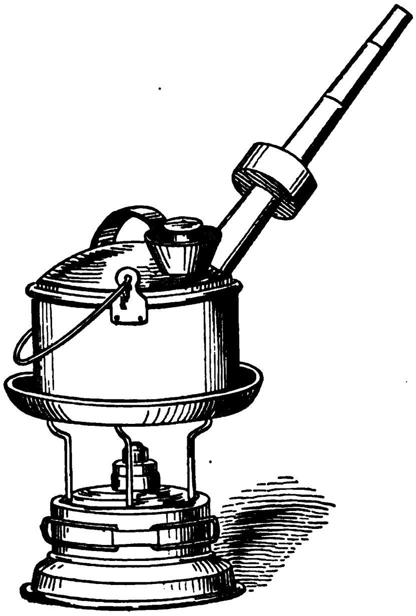


FIG. 459.—Croup kettle.

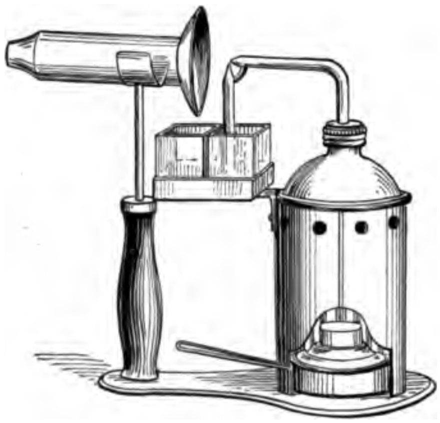


FIG. 460.—Steam atomizer.

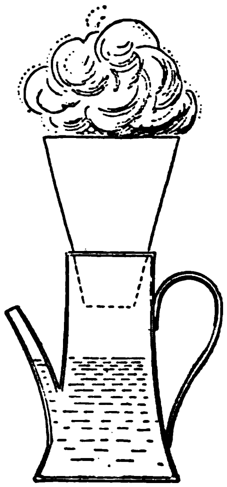


FIG. 461.—Steam inhaler improvised from a coffee-pot.

a coffee-pot with a funnel of heavy paper placed in the top makes simple and efficient inhaler (Fig. 461).

Formulary.—Sedative, stimulating, or antiseptic drugs are the ones usually employed for inhalation. These include tincture of benzoin compound in the strength of 1ʒ (4 c.c.) to the pint (500 c.c.); creosote, 5 to 10 ♏ (0.3 to 0.6 c.c.) to the pint (500 c.c.); ol. cubebæ, 5♏ (0.3 c.c.) to the pint (500 c.c.); spirits camphori, 5♏ (0.3 c.c.) to the pint (500 c.c.); ol. pinus sylvestris, 5♏ (0.3 c.c.) to the pint (500 c.c.), etc.

Temperature.—When directly inhaled, the vapor should not be of a higher temperature than 150° F. (65° C.). If used too hot irritation of the mucous membrane may be produced and there is danger of the steam scalding the face.

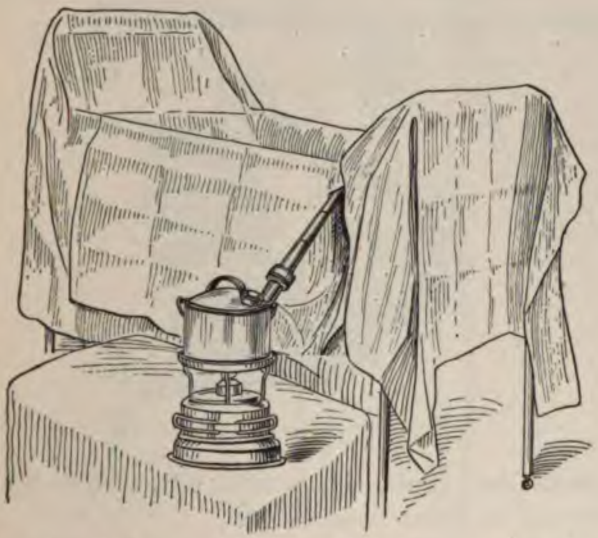


FIG. 462.—Crib arranged for steam inhalations. (After Kerley.)

Technic.—Into an inhaler a pint (500 c.c.) of nearly boiling water is placed and the proper quantity of the drug is added. The patient then places his nose over the cone and inhales the escaping vapor, taking about six to eight breaths a minute. The inhalation should not be continued for more than five or ten minutes at a time. It may be employed three or four times daily. The treatment should be carried out in a warm room, *i.e.*, at a temperature of about 68° F., (20° C.) and care should be taken to protect the patient from draughts. As the steam relaxes the mucous membrane and renders the patient susceptible to cold, he should not be allowed out of doors for several hours afterward.

In using the croup kettle, the steam may be delivered into the room or directly over the patient. When the latter method is used, it is well to cover the bed of the patient with a sheet arranged in the form of a tent and raised sufficiently high to permit a free circulation of air, the nozzle of the croup kettle being inserted under one side of the tent and the water kept boiling (Fig. 462).

DRY INHALATIONS

These are useful in diseases of the upper respiratory tract for those who cannot tolerate the steam inhalations.

The Inhaler.—A special mask made of woven metal, which accurately fits the mouth and which is provided with a sponge upon which the medication is dropped, is employed (Fig. 463).

FIG. 463.—Inhalation mask.

Formulary.—Any of the very volatile oils, such as thymol, menthol, eucalyptol, etc., may be employed.

Technic.—Twenty or thirty drops (1.25 to 2 c.c.) of the oil are placed upon the sponge of the mask and the latter is placed over the patient's face and is secured by strings fastened back of the head and neck. The patient inhales through the mask by means of the mouth, and exhales through the nose. The mask may be worn for about half an hour two or three times a day.

INTUBATION OF THE LARYNX

Intubation of the larynx, an operation devised by O'Dwyer, consists in the introduction of a tube into the larynx for the purpose of securing free respiration in the presence of obstruction in the larynx or upper portion of the trachea. It is an operation which gives prompt relief without the necessity of cutting and without producing any loss of blood or shock. It is less terrifying to the patient than tracheotomy and the after-care is not so troublesome. Anesthesia is not necessary nor is any previous preparation of the patient required. Special instruments, however, are essential, and the feeding of the patient is often troublesome and, while not a difficult operation in itself, it requires special training for its skilful performance which is best learned by practice upon the cadaver.

Indications.—The operation was originally devised for the relief of obstruction to respiration in cases of laryngeal diphtheria and has

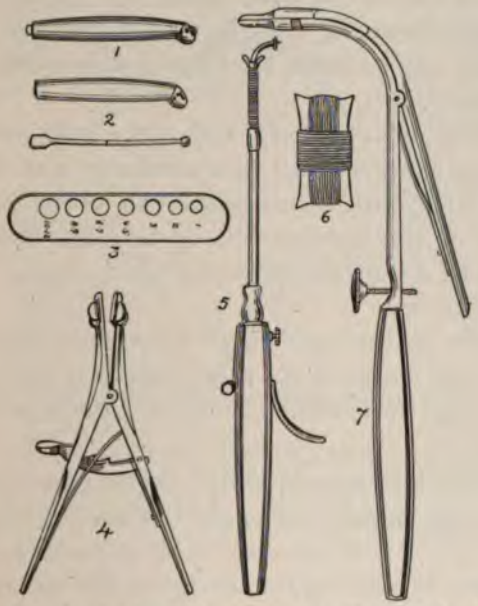


FIG. 464.—O'Dwyer intubation instruments. 1, Tube with obturator in place; 2, tube and obturator separated; 3, gauge; 4, mouth gag; 5, introducer; 6, silk thread; 7, extractor.

now almost entirely supplanted tracheotomy in such cases. The immediate indications are dyspnea accompanied by cyanosis, depression of the suprasternal and supraclavicular spaces on inspiration, and sinking in of the lower portion of the chest. Intubation is also employed in laryngeal stenosis from other causes for the purpose of producing gradual dilatation of the parts, progressively larger tubes being introduced and worn for a few days at a time.

Instruments.—The instruments required are an O'Dwyer intubation set including seven metal or hard-rubber tubes, an introducer, an extractor, a mouth gag, and a gauge indicating the size of the tubes according to the age of the patient (Fig. 464). Although these instruments have been modified and attempts have been made to improve upon them, those originally designed by O'Dwyer give the best results.

The intubation tube has an expanded head prolonged backward in the form of a flange to prevent it from slipping through the vocal cords and a fusiform bulb in the middle to aid in keeping the tube in position. In the anterior portion of the head a perforation is provided for the attachment of a piece of silk thread. The lower end of the tube is rounded off and oval. Each tube is provided with an obturator which can be screwed on to the introducer. The free extremity of the obturator ends in a protuberance which projects beyond the tube and prolongs the latter into a rounded extremity to aid in its introduction.

The introducer, or intubator, consists of a handle in which is set a rod, to the extremity of which the obturator may be screwed. A sliding joined tube fits over this, which can be pushed forward by a small knob set on the handle of the instrument, thereby detaching the intubation tube from the obturator when the former is in proper position in the larynx.

The extractor, or extubator, is an instrument supplied with jaws which fit into the lumen of the tube, and when opened by pressure upon a lever engage the tube with sufficient force to permit its removal from the larynx.

Asepsis.—The instruments should be sterilized before use.

Position of the Patient.—The child, with its arms at its sides, is wrapped from chin to foot in a sheet or blanket and is supported upon the lap of a nurse in a sitting posture facing the operator with its feet held between the nurse's knees and its head resting on her right shoulder. An assistant should stand behind and grasp the child's head firmly, lifting upward as though holding the child by the head, thus extending the head as far as possible (Fig. 465). Some operators, however, prefer to intubate with the patient in a horizontal position and with a small sand-bag placed under the back of the neck.

Technic.—A tube of a size corresponding to the age of the patient is selected and is properly threaded with a piece of silk 2 or 3 feet (60 to 90 cm.) long. Then, with the obturator in place, the tube is screwed on the introducer in such a manner that its projecting flange lies behind and faces away from the operator. The mouth gag is next inserted between the patient's jaws on the left side and is held in place by the assistant who supports the child's head. The operator, with his eyes, nose, and mouth protected against possible infection in diphtheria cases, faces the patient and inserts his left index-

FIG. 465.—Position of child for intubation and method of holding.

finger into the mouth, hooking up the epiglottis (Fig. 466). In doing this care should be taken to keep the finger to the left side and out of the way as much as possible. The operator then takes the introducer

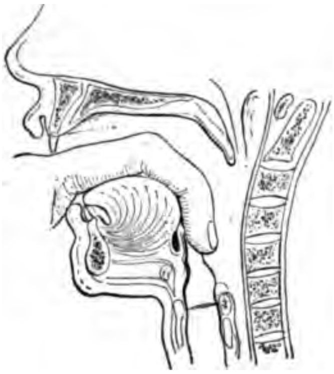


FIG. 466.—Intubation. First step, showing the method of drawing the epiglottis forward.

with the tube attached in his right hand, holding it as follows: The thumb pressed against the button on the upper side of the handle, the index-finger around the hook on the under surface of the instrument, and the loop of silk wound over his little finger, as shown in Fig. 467. He then slowly introduces the tube into the mouth in the me-

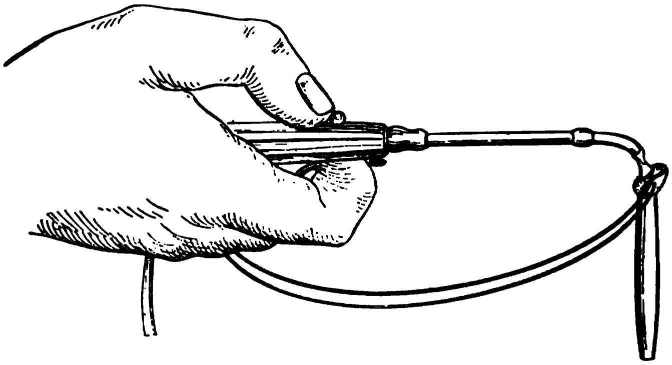


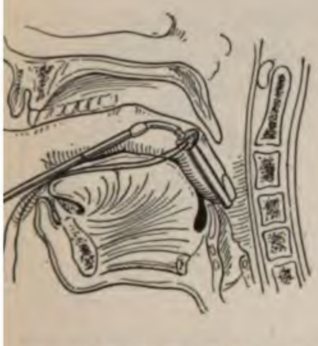
FIG. 467.—Showing the intubation tube on the introducer and the method of holding the latter.

dian line, hugging the center of the tongue and keeping the handle of the instrument at first well down on the chest of the patient (Fig. 468). When the end of the tube reaches the epiglottis (Fig. 469), the

FIG. 468.—Intubation. Second step, introducing the tube into the patient's mo-

handle is sharply elevated, so that the tube is brought into a verti- position (Fig. 470). If the handle of the instrument is not sufficien- elevated, the tube will point toward the entrance of the esophag- which it will be apt to enter during the next maneuver (Fig. 471).

e same time the finger of the operator is moved to the posterior rtion of the larynx, resting on the arytenoid cartilages to prevent e tube from entering the esophagus. The tube is then gently shed through the chink of the glottis and on into the larynx, guided the operator's finger. No force whatever should be used.



469.—Third step in intubation.

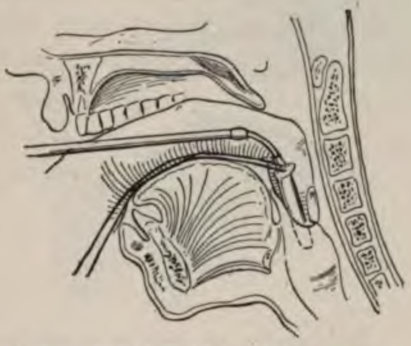


FIG. 470.—Fourth step in intubation.

As soon as the tube is in proper position, the operator's forefinger laced on its head holding it in place while the button on the handle he instrument is pushed forward, thus disengaging the obturator n the tube (Fig. 472). The intubator with the obturator attached hen removed, and the tube is pushed well into the larynx by

G. 471.—Showing a faulty position e tube, due to the handle of the in- cer not being raised sufficiently high.

FIG. 472.—Fifth step in intubation withdrawing the introducer while index-finger holds the tube in place.

finger (Fig. 473). Not more than five to ten seconds should be sumed in introducing the tube, for while this is being done breath- is interfered with; if the tube cannot be promptly inserted, the ration should be suspended and a second attempt made after wing the child time to recover its breath.

solid food. As a rule, by having the patient lie with the head lowered, fluids will pass along the roof of the mouth to the posterior pharyngeal wall, and will enter the esophagus, and, if given slowly, sufficient food may be administered in this way (Fig. 476); or food may be administered by having the patient suck up the food through a tube while lying face downward upon the lap of a nurse. In some cases, where the patient refuses foods, liquids may be administered by means of the stomach-tube passed through the mouth or by means of a soft-rubber catheter passed into the stomach through the nose (page 555). Rectal feeding may be combined with the above if indicated.

When to Remove the Tube.—The tube should always be removed as soon as possible, as its prolonged use may produce ul-

FIG. 477.—Extubation.

ceration of the larynx. In cases of diphtheria, where antitoxin has been administered, the tube may be removed in three to seven days, depending to some extent upon the age of the patient, being left in for longer intervals in very young children. If the tube becomes occluded at any time, it must be removed without delay, cleaned, and then reintroduced. When the tube is to be permanently removed, the physician, after extracting it, should wait sufficiently long to see that respiration does not become impeded and necessitate its reintroduction.

Technic of Extubation.—The patient is placed and held in the same position as for introduction of the tube. The mouth gag is inserted, and the operator passes his left index-finger into the mouth and over the epiglottis until it rests on the head of the tube. The ever, in that it is possible for the child to remove the tube if it gets hold of the string.

Should the tube be placed in the esophagus by mistake, there will be no relief to the dyspnea and the cyanosis, there will be an absence of cough, and the string of silk will be seen to gradually shorten as the tube passes down the esophagus. In such a case, the tube should be removed by pulling on the string, and, after waiting a sufficient time for the patient to recover from the excitement attending the operation, it should be reintroduced.

FIG. 476.—Method of feeding an intubation patient with the head lowered.

In some instances, the tube may become occluded by pushing the false membrane ahead of it. If this occurs, the tube should be removed at once, and, if the obstructing membrane is not expelled from the larynx and cannot be extracted and suffocation seems imminent, tracheotomy should be performed. Care should be taken not to select too small a tube, for it may be expelled by coughing or may escape into the trachea.

Feeding Intubated Patients.—The tube renders swallowing difficult, and the patients are only able to take liquid, or, at most, semisolid food. As a rule, by having the patient lie with the head lowered, fluids will pass along the roof of the mouth to the posterior pharyngeal wall, and will enter the esophagus, and, if given slowly, sufficient food may be administered in this way (Fig. 476); or food may be administered by having the patient suck up the food through a tube while lying face downward upon the lap of a nurse. In some cases, where the patient refuses foods, liquids may be administered by means of the stomach-tube passed through the mouth or by means of a soft-rubber catheter passed into the stomach through the nose (page 555). Rectal feeding may be combined with the above if indicated.

When to Remove the Tube.—The tube should always be removed as soon as possible, as its prolonged use may produce ul-

FIG. 477.—Extubation.

ceration of the larynx. In cases of diphtheria, where antitoxin has been administered, the tube may be removed in three to seven days, depending to some extent upon the age of the patient, being left in for longer intervals in very young children. If the tube becomes occluded at any time, it must be removed without delay, cleaned, and then reintroduced. When the tube is to be permanently removed, the physician, after extracting it, should wait sufficiently long to see that respiration does not become impeded and necessitate its reintroduction.

Technic of Extubation.—The patient is placed and held in the same position as for introduction of the tube. The mouth gag is inserted, and the operator passes his left index-finger into the mouth and over the epiglottis until it rests on the head of the tube. The ubator, held in the operator's right hand, is then introduced with jaws closed, by the same maneuvers employed in introducing the ıbator, until its tip is felt by the finger on the tube. It is then :fully guided into the lumen of the tube. By pressing the lever on of the handle, the jaws of the instrument are separated and obtain :cure hold on the tube, so that it may be easily withdrawn (Fig.). To accomplish this, the tube must be lifted at first vertically 'ard. The handle of the instrument is then depressed, and the e is brought out by a reversal of the movements of intubation.

In an emergency, when the tube becomes obstructed, it may be sible to remove it by enucleation, especially if the tube be short. s consists in placing the thumb of the right hand on the larynx eath the end of the tube while the patient's head is extended, and a quick motion of the head forward, at the same time exerting 'ard pressure on the larynx, the tube is expelled into the mouth.

TRACHEOTOMY

The term tracheotomy is generally used to designate the operation pening into the air-passages at some point between the sternum thyroid cartilage. To be exact, however, the term should be ted to operations below the cricoid cartilage, while above that ıt, that is, in the cricothyroid space, the operation is called laryn-omy. Tracheotomy is subdivided into the high operation when opening is made above the isthmus of the thyroid gland, and into tracheotomy when the operation is performed below this point.

Indications.—Tracheotomy is indicated for the relief of obstru- dyspnea, which may be the result of any one of the following ditions: The formation of pseudomembrane; the presence of ign bodies; the presence of growths within the larynx or trachea :xternal to these structures; edema of the larynx; spasm of the 'nx; rapid swelling of the tonsils and pharynx; injuries to the 'nx and trachea, such as contusions, fractures, burns, cicatri- stenosis, etc. For the relief of obstruction from diphtheritic nbranes, however, intubation should, as a rule, be the operation :hoice, tracheotomy being reserved for those cases where intuba- ı fails, as when the membrane extends down low in the trachea, vhere the necessary instruments for intubation are not available. ıcheotomy may also be required for the removal of foreign bodies m the larynx, trachea, and bronchi, for the administration of cheal anesthesia in operations upon the mouth, pharynx, jaws,

or larynx, and as a preliminary to laryngectomy and lower tub
bronchoscopy.

Choice of Operation.—The choice between laryngotomy, h
tracheotomy, and low tracheotomy depends upon the seat of
obstruction and also upon the age of the patient and the necessity
haste. Of the three, laryngotomy is the most easily and q
performed. It thus becomes the operation of choice in a m
emergency where the obstruction is located in the larynx and t
there is demand for haste in order to avoid imminent suffocati
where the proper instruments and assistants are lacking. It i

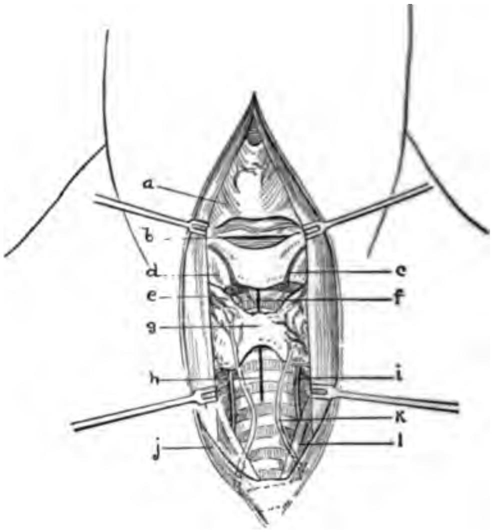


FIG. 478.—The location of the incisions in laryngotomy and tracheot
Bickham.)

a, Thyroid cartilage; *b*, incision for laryngotomy; *c* and *c*, branch
thyroid arteries; *d*, cricoid cartilage; *f*, incision for high tracheotomy; *g*,
h, incision for low tracheotomy; *i*, pneumogastric nerve; *j*, sterno-m
k, inferior thyroid veins; *l*, sterno-thyroid muscle.

however, a suitable operation to be performed upon t
thirteen years of age, on account of the small size of the c
space, nor should it be performed for the relief of co
quiring the wearing of a tube for any length of time, or
the proximity of the vocal cords and their liability to i
tube.

On account of the small number of important vessels e
and the greater ease with which the trachea is reached, hi
omy is preferable to the low operation where the loca

ıble permits. It is the operation of choice for children and in ᵶs of diphtheria where a tube has to be worn for some time.

Low tracheotomy may be required for the removal of foreign bod- from the bronchi, for lower tracheo-bronchoscopy, for the relief hreatened suffocation from occulsion of the trachea by tumors of thyroid, etc. It requires more skill in its performance than does high operation, as in the lower portion of the neck the trachea is ·e deeply placed and important structures at the root of the neck in close proximity.

Instruments.—The instruments that should be provided include: alpel, a narrow bistoury, scissors, two sharp retractors, two ten-

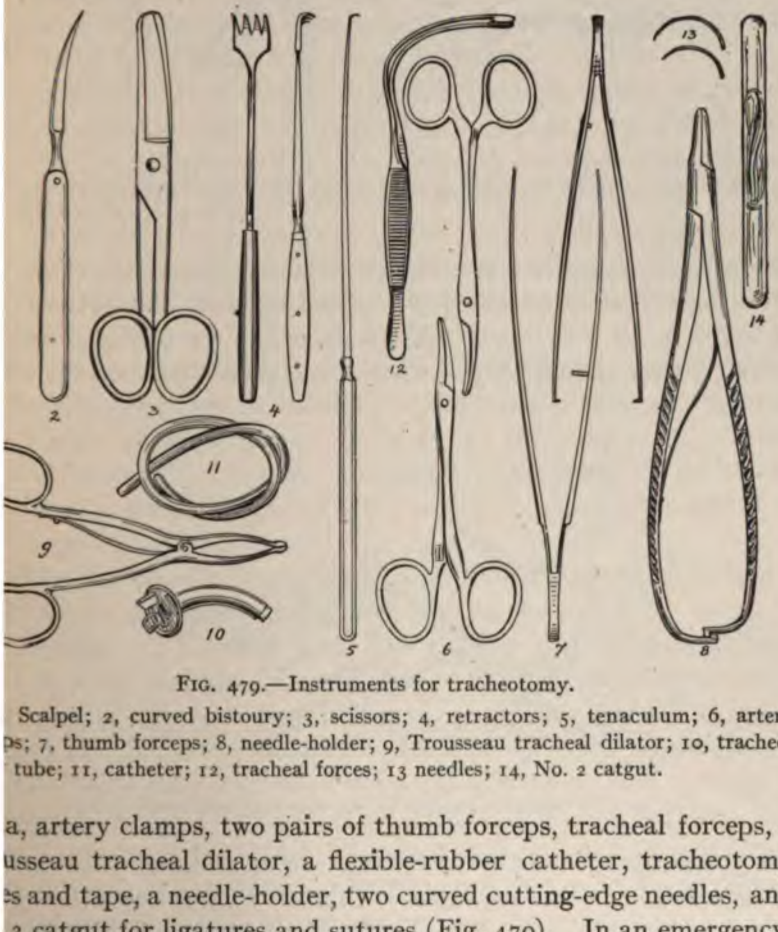


FIG. 479.—Instruments for tracheotomy.

Scalpel; 2, curved bistoury; 3, scissors; 4, retractors; 5, tenaculum; 6, artery ps; 7, thumb forceps; 8, needle-holder; 9, Trousseau tracheal dilator; 10, tracheo- tube; 11, catheter; 12, tracheal forces; 13 needles; 14, No. 2 catgut.

a, artery clamps, two pairs of thumb forceps, tracheal forceps, a usseau tracheal dilator, a flexible-rubber catheter, tracheotomy ᵶs and tape, a needle-holder, two curved cutting-edge needles, and 2 catgut for ligatures and sutures (Fig. 479). In an emergency, re delay would mean the loss of the patient's life, the operation be performed by the aid of a pocket-knife and two hairpins bent in the shape of a hook to hold the trachea open until the proper tube can be obtained.

Tracheotomy tubes of several sizes and with different curves should be provided so that one suitable for the individual case may be at hand. A silver tube, somewhat flattened from side to side, without fenestræ, and with a movable inside tube, is preferable (Fig. 480). With some tubes an obturator is supplied as an aid to insertion. For an adult, a No. 5 or 6 tube will usualy suffice; for a child under two a No. 2, tube should be provided; for a child from two to four, No. 3; and for one over four, a No. 4. In an emergency a tube may be improvised by bending a piece of rubber tubing into the required shape, as shown in Fig. 481. For laryngotomy, a tube shorter than the ordinary tracheotomy tube, and flattened from before backward, is employed.

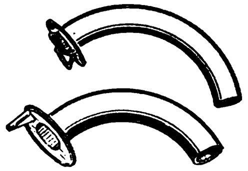


FIG. 480.—Tracheotomy tube.

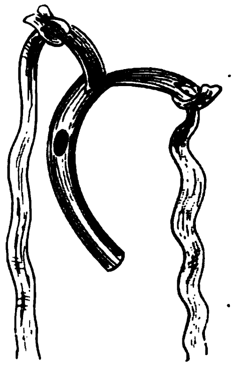


FIG. 481.—Tracheotomy tube improvised from rubber tubing.

FIG. 482.—Position of patient for laryngotomy and tracheotomy.

Asepsis.—The instruments are sterilized by boiling or, in an emergency, by immersion in a 1 to 20 carbolic acid solution. The hands of the operator and his assistants should be prepared with the same care as for any operation.

Position of the Patient.—This should be such as to bring the neck into the greatest possible prominence. The patient is therefore placed in a strong light on a firm flat table with a cushion under his shoulders, thus allowing the head to hang back, but not so far as to put the trachea under tension or to flatten it and impede respiration (Fig. 482). In an emergency, the patient's head may be simply allowed to hang over the edge of the table or a lounge.

A child should be wrapped in a blanket or sheet, with its arms at the sides. The legs should also be secured and an assistant should be provided to hold the head in proper position.

Anesthesia.—In adults, local anesthesia with cocain or procain is sufficient. A 0.2 per cent. solution of cocain or a 1 per cent. procain solution is employed for the skin, and a 0.1 per cent. solution or a 0.5 per cent. procain solution for deeper infiltration. When there is occasion for great haste in the presence of unconsciousness or dyspnea with marked and increasing cyanosis, an anesthetic may be dispensed with, as in such cases the sense of pain is much blunted or abolished.

In young children, local anesthesia is not followed by good results, as the infiltration alone terrifies the child and produces struggling, which adds to the dyspnea. If air enters the lungs at all, chloroform given slowly is the best anesthesia, ether being apt to irritate the mucous membrane and produce laryngeal spasm, thus adding to the dyspnea.

Preparations.—If hairy, the neck should be shaved. The skin is sterilized by painting with tincture of iodin.

Technic.—1. *Laryngotomy.*—The thyroid and cricoid cartilages are identified, and, with the larynx supported between the thumb and forefinger of the operator's left hand, an incision about 1½ inches (4 cm.) long is made through the skin, exactly in the median line of the neck, extending from the lower portion of the thyroid cartilage to below the cricoid cartilage. The superficial fascia, platysma, and deep fascia are divided, and the sternohyoid and sternothyroid muscles are separated at the inner borders and held apart by retractors. The connective tissue and veins underlying these structures are then separated, all veins being clamped or ligated before division. The cricothyroid membrane is thus brought into view. The thyroid cartilage is steadied with a tenaculum, while the cricothyroid membrane is transversely incised by means of a sharp, narrow-pointed bistoury near the upper border of the cricoid cartilage, so as to avoid the cricothyroid artery, which runs along the upper border of the space below the thyroid cartilage (Fig. 483). If the situation of this vessel is such that injury to it or its branches cannot be avoided, it should be tied between two ligatures before the membrane is incised. In opening the membrane, the incision must be carried deep enough to include the mucous membrane lining it, otherwise the laryngotomy tube may be pushed in between the two structures and not into the larynx at all. The wound is held apart with two small retractors or

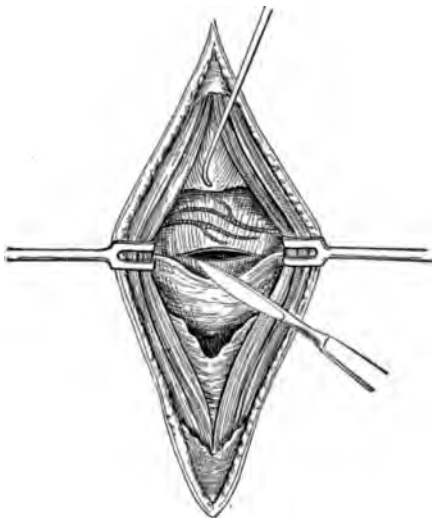


FIG. 483.—Opening the cricothyroid membrane in laryngotomy. (After Bickham.)

a tracheal dilator, and the foreign body which may be causing the obstruction is removed by means of tracheal forceps. If there is not sufficient room to remove the foreign body through this incision, the cricoid cartilage may be cut. The laryngotomy tube is then carefully introduced and is secured in place by tapes passing around the patient's neck, a small square pad, split to its center, being interposed between the skin and the flange of the tube. A stitch or two may be placed at the upper and lower angles of the wound to bring them together, if necessary. Even where the obstruction is immediately relieved, it is preferable in any case to insert a tube for a time until the tissues become more or less adherent, so as to avoid subcutaneous emphysema.

gh *Tracheotomy*.—The thyroid cartilage is grasped between b and forefinger of the left hand, so as to steady the trachea, the right hand a vertical incision 1½ to 2 inches (4 to 5 ; is made exactly in the median line, extending from the cri- ilage to a little below the isthmus of the thyroid gland (Fig. he skin and superficial and deep fascia are incised, and the ugular veins which are encountered in the upper part of the together with any communicating branches of the superior veins, are caught in forceps and ligated. The sternohyoid othyroid muslces are thus exposed, and should be separated ir inner borders and retracted to the sides. As these muscles

FIG. 484.—Exposing the trachea in high tracheotomy.

d apart, the isthmus of the thyroid gland and the deep cervi- covering the trachea appear. This fascia is divided from r border of the cricoid cartilage by a transverse incision ownward at the extremities. The fascia is then stripped trachea and retracted downward, and with it the isthmus of oid gland, thus exposing the rings of the trachea. If the sthmus is very large, two ligatures may be placed about it, on of the median line, to control the hemorrhage, and the isthmus deep fascia is incised vertically and each half retracted to the tenaculum is then inserted beneath the cricoid cartilage, and an assistant so as to steady the trachea. If without a tube, to apply retraction sutures on either side of the trachea

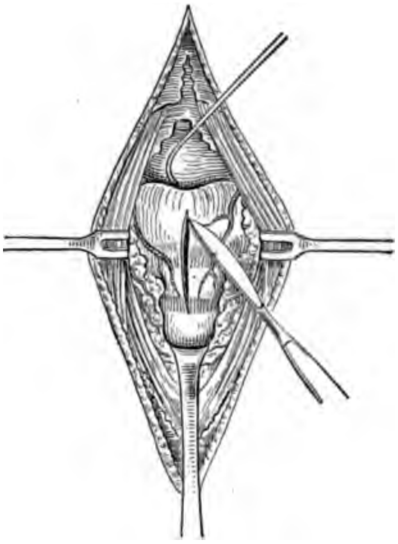


FIG. 485.—Opening the trachea in high tracheotomy. (After Bickham.)

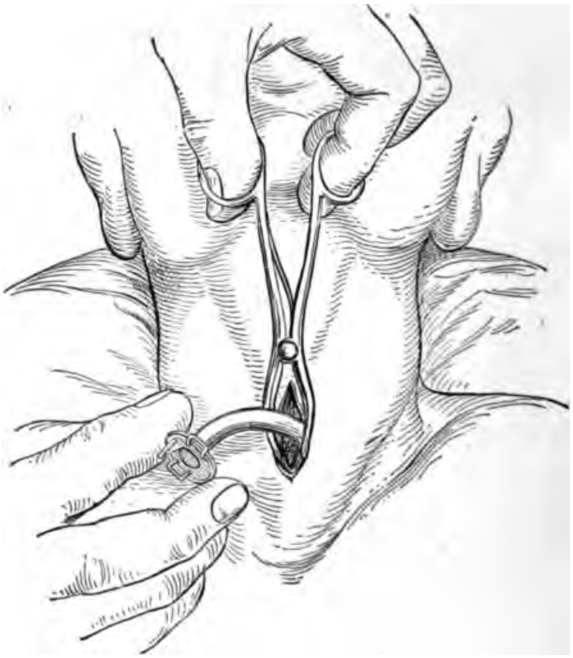


FIG. 486.—Method of inserting the tracheotomy tube.

before opening the latter. For this purpose a full curved needle, threaded with fairly strong silk, is passed on each side through the membrane below the ring to be cut, emerging through the membrane above. A sharp narrow bistoury, with its cutting edge up, is inserted through the membrane below the second ring of the trachea, and the latter is incised in the median line as far up as the cricoid cartilage, care being taken to include the mucous membrane of the trachea in this incision (Fig. 485). The edges of the tracheal opening are separated with tracheal forceps, or the wound is held open by the retraction sutures, if they were previously inserted, and the tracheotomy tube, with its cannula, is carefully passed through the open wound into the trachea (Fig. 486). If there is no great urgency,

FIG. 487.—Showing the tracheotomy tube in place. (Stoney.)

all bleeding should be arrested before the trachea is opened, but where haste is important this may be omitted until the tube is introduced.

When the tube has been properly placed, a pad of gauze is interposed between the skin and the flange of the tube, and the latter is securely held in place by tapes passing from each side of the flange around the neck (Fig. 487).

In cases of diphtheria, as soon as the trachea is opened a large amount of mucus and membrane is usually expelled, and it is of advantage in such cases not to insert the tube at once, but to hold the tracheal wound open and allow the membrane to be expelled. What is not expelled may then be removed, if loose, by forceps. The danger of infection from the patient's coughing bits of membrane from the tracheal opening into the face of the operator should be guarded against by the operator wearing a face mask or by holding a piece of wet gauze over the wound.

3. *Low Tracheotomy.*—The trachea is steadied with the thumb and forefinger of the left hand, and a vertical incision is carried from the thyroid cartilage to within ½ inch (1 cm.) of the sternal notch. The skin and superficial and deep fascia are incised, and the inferior thyroid veins, or other vessels that may be in the way, are ligated and divided. The sternohyoid and sternothyroid muscles are separated in the median line and are retracted to each side. The deep cervical fascia is divided vertically downward from the lower border of the isthmus of the thyroid gland, and is retracted laterally, notching it transversely on each side if necessary to obtain more space. Care must be taken in deepening the incision at the lower angle of the wound not to injure the innominate vein which may bulge up above

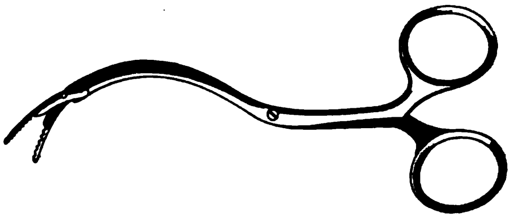


FIG. 488.—Intracannular alligator forceps. (Fowler.)

the sternal notch. The isthmus of the thyroid gland is pulled well up out of the way by means of a retractor, and while the trachea is steadied, an incision is carried upward through two or more of the lowermost rings by means of a narrow bistoury. The edges of the tracheal wound are then retracted, and the tube is inserted and secured in place as previously described.

After-care.—The opening of the tube should be covered with piece of gauze moistened with normal salt solution, and the patient kept in a room at a temperature of about 65° to 70° (18° to 21° C.). If the operation is performed for inflammatory conditions, the atmosphere should be kept moist by the steam from a croup kettle directed so as to play over the tracheal opening (see page 465). At first, the inner tube should be removed every two or three hours and be cleansed; later, less frequent attention will be required. The outer tube should be removed and cleansed as often as necessary, this being done by the surgeon himself. Its reintroduction will be greatly facilitated by the use of a guide. Any membrane or mucus that may collect at the mouth of the tube should be promptly removed. Secretions blocking the tube may be removed by means of a small catheter and a suction syringe. Membrane may be removed from the interior of the tube with alligator forceps (Fig. 488) introduced through the cannula. If this is not possible, the tracheotomy tube should be withdrawn and the obstruction removed.

Removal of the Tube.—In cases of diphtheria the tube may be permanently removed as soon as there is free respiration through the larynx with the tracheal wound closed. This is usually possible in from five days to one week. When tracheotomy is employed for the removal of foreign bodies, etc., the tube should be worn for twenty-four hours at least. This allows time for the oozing to cease and averts the danger of blood entering the trachea and the escape of air into the subcutaneous tissues.

Complications.—Broncho-pneumonia is a common complication even when not due to an extension of the diphtheritic process. Infection of the wound may follow in diphtheria cases and may spread into the loose connective tissue of the neck, producing a cellulitis; or the infection may work down and cause septic pneumonia. An improperly fitting tube frequently causes ulceration of the trachea from pressure. This complication should be immediately remedied by the substitution of a new tube. Emphysema may occur if the tube is removed too soon; it has also been produced from injury to the posterior or lateral walls of the trachea. Hemorrhage from congested veins may at times be severe; in the majority of cases, however, the bleeding, which may be profuse before the trachea is opened, stops spontaneously as soon as respiration is re-established.

CHAPTER XVII

THE ESOPHAGUS

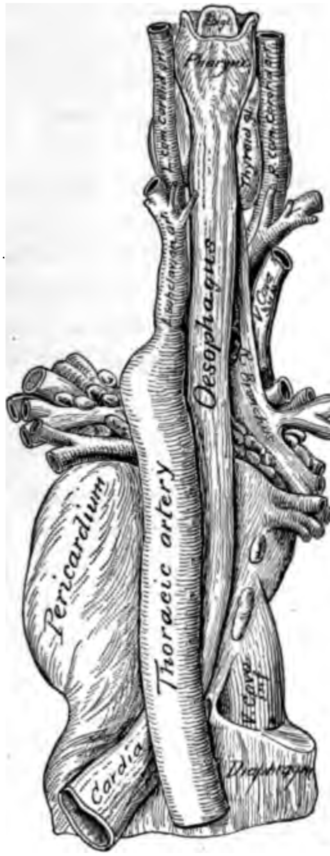
Anatomic Considerations

The esophagus extends from the lower border of the cricoid cartilage to about the level of the ensiform cartilage or, in other words, from the level of the disk between the fifth and sixth cervical vertebræ to the tenth dorsal vertebra. Its entire length is about 10 inches (25 cm.), while the distance from the upper incisor teeth to the cardiac end measures about 16 inches (40 cm.). Antero-posteriorly the esophagus presents a slight curve with the concavity forward, as it follows the direction of the spinal column. Laterally, it has the following curves: from its starting point it turns slightly to the left, projecting as much as ½ inch (1 cm.) to the left of the trachea; it then descends in front of the spine, at first behind the arch of the aorta and then lying to the right of the aorta, finally curving in front, and a little to the left, of the aorta to pass through the diaphragm (Fig. 489). In its course, the esophagus has in front of its upper portion the trachea; while below it is crossed by the left bronchus and the arch of the aorta. The pericardium and the left vagus nerve also lie in front. Posteriorly, it rests upon the spinal column and the thoracic duct; about 3 inches (7 cm.) from the diaphragm it crosses the aorta. On either side it is in relation with the pleura.

The esophagus measures about ¾ inch (19 mm.) in diameter, but a number of constrictions in its caliber have been described, the most marked being as follows: (1) at its commencement, 6 inches (15 cm.) from the incisor teeth; (2) at a point 10 inches (25 cm.) from the incisor teeth, where it is crossed by the left bronchus; and (3) at a point 16 inches (40 cm.) from the incisor teeth, where it passes through the diaphragm (Fig. 490). At these points the caliber of the tube measures about ½ inch (1 cm.). The measurements, curves, and constrictions of the esophagus are important to remember in the passage of instruments and with reference to the lodgment of foreign bodies.

Diagnostic Methods

The methods available for examination of the esophagus include: (1) auscultation, (2) percussion, (3) external palpation, (4) instruıl examination, (5) inspection through the esophagoscope, and .e use of the X-rays. The first three of these methods are of imited clinical value, while the use of the esophagoscope is of ful value except in the hands of an expert, so that in the major- cases we have to rely upon the use of bougies and sounds or the 's.



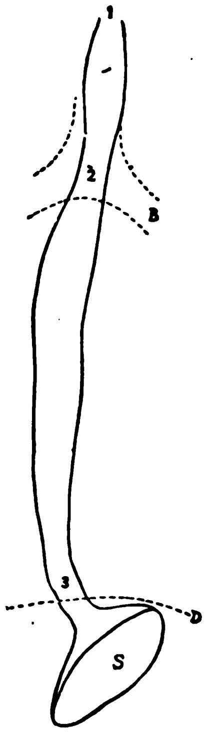


FIG. 489. FIG. 490.

489.—The course and relations of the esophagus viewed from behind.

490.—The normal narrowings of the esophagus. (Eisendrath.) 1, At its ı with the pharynx; 2, opposite the bifurcation of the bronchi; 3, at ›hragm.

in examination of other regions, a careful history of the case l precede any local examination.

AUSCULTATION

ıscultation is performed by listening with a stethoscope over the : of the esophagus while the patient swallows liquids. The usual points for auscultation are upon the left side of the spine opposite the ninth or tenth dorsal vertebra, or just to the left of the ensiform. Normally, duiing the passage of liquids down the tube two sounds are heard: one directly after the patient swallows and the other six or seven seconds later, as the food is forced into the stomach through the cardia. If stenosis exists at the cardia or a stricture be present at some point higher up, this second sound will be absent or delayed; in paralysis of the esophagus it will likewise be absent. At times it may also be possible to recognize by auscultation the stoppage of the fluid when it reaches the point of stricture.

PERCUSSION

Percussion may reveal the presence of large tumors, dilatations, or diverticula. In the latter condition, dulness may be present only after eating and be absent when the sac is empty. A tympanitic note will be obtained when the diverticulum sac contains gas.

PALPATION

External palpation is extremely limited in usefulness, as it is only applicable to the cervical portion of the esophagus. By means of palpation one may be able to discover hard foreign bodies, tumors, enlarged glands, enlargements of the thyroid, as well as any pressure tenderness along the esophagus. Diverticula full of food may be thus distinguished and mapped out, and not infrequently it is possible to empty the diverticulum sac of its contents by pressure.

By internal palpation with the index-finger, foreign bodies lodged in the entrance of the esophagus and strictures, new growths, etc., at the same location may be recognized.

EXAMINATION BY SOUNDS AND BOUGIES

The sound and bougie are employed for diagnostic as well as therapeutic purposes. By their use valuable information may be obtained as to the location of foreign bodies, strictures, diverticula, etc.; furthermore, the degree of a stenosis may be accurately determined. The passage of esophageal instruments is not difficult. Gentleness only should be employed in manipulation, however, since, if due care is not exercised in this direction, a false passage may be readily made through the esophagus into the mediastinum; especially is such an accident possible if the coats of the esophagus are already weakened by disease.

Before any attempt is made to pass instruments, a thorough physical examination—including the vascular system—should be made. In the presence of aortic aneurysm, recent hemorrhage from the esophagus or stomach, acute inflammation of the esophagus, and after recent

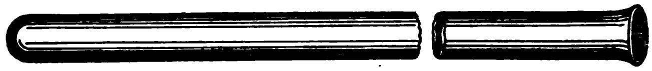


FIG. 491.—Cylindrical esophageal sound.

ulceration, the use of esophageal instruments is contraindicated. In cases of advanced pulmonary or cardiac disease and cirrhosis of the liver, instruments, if used, should be employed with great caution.

Instruments.—For ordinary examination, graduated esophageal bougies and bougies à boule are employed. These instruments vary in length from 24 to 32 inches (60 to 80 cm.). The best bougies are

FIG. 492.—Conical esophageal sound.

hollow and are made of a gum-elastic material, so that when warmed they become flexible and capable of being bent to any desired shape. They may be obtained cylindrical (Fig. 491) or conical (Fig. 492) in form. In their stead, however, a thick rubber stomach-tube is often utilized.

The bougie à boule is an essential instrument if the length of a stricture is to be estimated. It consists of a flexible whalebone shaft,

FIG. 493.—Olivary bougies à boule for the esophagus.

to the end of which metal or ivory olive-shaped tips of different sizes may be screwed (Fig. 493). The shaft should be marked off in an inch or centimetric scale.

In cases of very tight stricture filiform bougies of whalebone or woven material may be employed to determine whether the stricture is permeable. They may be introduced into the stricture through a hollow bougie which is first passed to the face of the stricture, or they may be inserted through an esophagoscope.

Asepsis.—Rubber bougies and tubes may be sterilized by boiling. The gum-elastic instruments, unless of the very best material, are ruined by boiling or by the use of strong antiseptics. They may be rendered sufficiently aseptic by immersion in a saturated solution of boracic acid, after first thoroughly washing with soap and water. The hands of the operator should also be clean.

Position.—The patient is seated in a chair with the head thrown back against the back of the chair, and with the chin raised sufficiently to make the passage between the mouth and the esophagus as straight a line as possible. The surgeon stands in front of the

FIG. 494.—Shows the first step in introducing an esophageal bougie.

patient, while, if desired, an assistant may steady the head from behind. In the case of a child, it will be necessary to confine its arms, either having them held by a nurse or by including them in a sheet wrapped about the child's body.

Anesthesia.—In an adult general anesthesia is only necessary in exceptional cases, but the pharynx and larynx, if very irritable or sensitive, may be brushed over with a 5 or 10 per cent. solution of cocaine.

Technic.—The patient is seated in the proper position with towel about the neck for protection, and is given a basin to catch vomitus or saliva. A soft, flexible sound is passed as follows: the bougie, moistened with water and held in the operator's right hand as one would a pen, is passed into the patient's open mouth back to the pharynx. The patient is then requested to swallow and the instrument is thus advanced, partly by the act of swallowing and partly by the operator, until an obstruction is reached or the sound enters the stomach (Fig. 494).

Sometimes when a rather inflexible bougie is employed or when the tongue is thick or the pharynx is swollen, some difficulty may be encountered in entering the esophageal opening. Under such conditions the operator passes the index-finger of his left hand into the patient's widely opened mouth to a point well back of the tongue and

FIG. 495.—Introduction of an esophageal bougie with the finger holding the tongue and epiglottis forward.

draws the latter forward, and with it the larynx, so that the esophagus may be more easily entered (Fig. 495). The bougie is then passed on the finger as a guide straight back in the median line to the pharynx, and, hugging the posterior wall of the pharynx, it is pushed steadily, but gently, backward and downward into the esophagus, and thence into the stomach, unless some obstruction be encountered.

The patient should be instructed to breathe deeply during the passage of the bougie, even if gagging is produced, and he should be cautioned not to bite the examiner's finger or the tube. There will usually be gagging and some attempts to vomit as the tube is inserted, but, unless very distressing, they may be disregarded. The patient's head, however, should be bent forward over a basin as soon as the tube is well within the esophagus to receive any vomitus, mucus, or saliva (Fig. 496.)

If dyspnea and cough are induced, the instrument has probably entered the larynx. To settle this point, the patient should be told to phonate "ee"; if he can do so, one may be sure the bougie is not in the larynx. If the passage of the tube becomes impeded at any point, the tube should be slightly withdrawn and then again pushed gently onward, when, unless a stenosis exists, it will advance without difficulty. The points of normal constriction at which a bougie may

FIG. 496.—Shows second step in introducing an esophageal bougie.

be arrested without any diseased condition being present should, however, be kept in mind. They are: (1) 6 inches (15 cm.) from the upper incisor teeth; (2) 10 inches (25 cm.) from the incisors; and (3) 16 inches (40 cm.) from the incisors (see Fig. 490). If a large tube can be passed into the stomach, the existence of a stenosis may be ruled out, while if the tube passes very easily without any sense of resistance, atony or paralysis of the canal is presumable.

Any evidences of pain, however, produced by the bougie in its descent should be carefully noted, as pointing to possible inflammation, ulceration, or malignancy. When the bougie meets a real obstruction the cause should, if possible, be learned; that is, whether due to spasm, an organic stricture, a diverticulum, a new growth, or a foreign body. No force should be employed in attempting to overcome the obstruction, but the bougie should simply be held firmly in place for several minutes or be slightly withdrawn when, if a spasm were the cause, it can be advanced as relaxation takes place. A spasmodic stricture will always disappear if the patient is placed under the influence of a general anesthetic. If the obstruction does not yield, the bougie is removed and a smaller one is inserted; and, if necessary, smaller sizes are successively introduced until one is found that will pass completely through the stenosed area into the stomach. In this way the degree of stenosis is ascertained. It is quite important in

FIG. 497.

FIG. 498.

FIG. 497.—Method of estimating the length of an esophageal stricture. The bougie à boule at the face of the stricture.

FIG. 498.—Method of estimating the length of an esophageal stricture. The bougie à boule is withdrawn until its base is arrested at the distal end of the stricture.

making the examination to insert the bougie into the stomach, as, otherwise, a second stricture below the first may be overlooked.

To determine the length of a stricture, a large olive-tipped sound is inserted until it reaches the face of the stricture (Fig. 497), and the distance of the stenosis from the upper incisor teeth is estimated from the markings on the shaft of the instrument. The bougie is then withdrawn and a size that will just pass is inserted well through the stricture. Upon withdrawing the instrument, the base of the bulb catches in the lower rim of the constriction (Fig. 498), and the distance of this point from the mouth is also estimated. By subtracting the first of these measurements from the second, the length (tracture is readily determined.

It is often possible for a practised hand to determine t tency of an obstruction from the sensation imparted by co the tip of the instrument. By means of a metal-tipped boule the consistency of hard foreign bodies, such as te bone, etc., may be readily recognized, and at times a dist may be distinguised when the two come in contact.

If the bougie has entered a diverticulum, it will be p move its end freely in different directions, and, if the divert

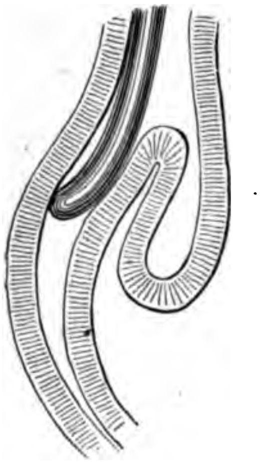


FIG. 499.

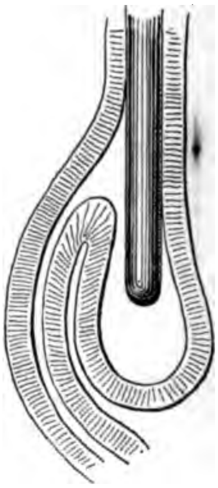


FIG. 500.

FIG. :

FIG. 499.—Shows a sound passing the opening of a diverticu Gumprecht.)

FIG. 500.—Shows the ease with which a sound will enter a diverti the latter is full. (After Gumprecht.)

FIG. 501.—Shows the ease with which a sound follows the esophag diverticulum is empty. (After Gumprecht.)

located high up, the end of the bougie may often be felt in Again, by withdrawing the instrument somewhat so as to the tip, and by changing its direction (Fig. 499), it can fre passed by the diverticulum into the stomach. A bougie w apt to enter a diverticulum if the sac be full (Fig. 500) and] stomach when the sac is empty (FIG. 501). This in obstruction to the passage of a bougie is characteristic (ticulum, and is a point in the differential diagnosis from Another method of differentiating between a stenosis ar ticulum has been devised by Plummer. It is carried out

The patient is instructed to swallow with a little water before bedtime 3 yards (270 cm.) of button-hole silk and in the morning to swallow 3 yards (270 cm.) more at the rate of a foot (30 cm.) an hour. By the afternoon of the same day, if there is an opening in the stricture or diverticulum, the thread will have been carried into the stomach and intestines a sufficient distance to withstand moderate traction without being withdrawn. A whalebone bougie with an olive tip, through which is an opening sufficiently large to accommodate the thread, is then passed down the esophagus on the thread, which is held loosely, until an obstruction is encountered. If this obstruc-

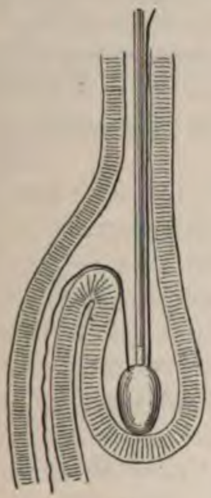


FIG. 502.

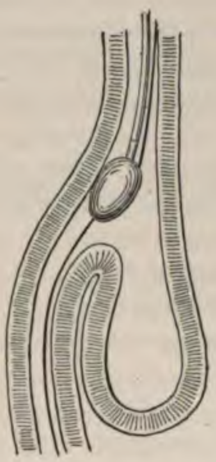


FIG. 503.

FIG. 502.—Esophageal sound passed over a swallowed thread into a diverticulum. (After Plummer.)

FIG. 503.—Sound lifted out of the diverticulum by tightening the thread. (After Plummer.)

tion be due to stricture, the bougie will not change its level when the thread is made taut, but, if the sound is in a diverticulum (Fig. 502), the bougie will be elevated to the level of the opening into the esophagus (Fig. 503). The depth of the diverticulum may be readily determined by the distance the bougie is elevated when the thread is made taut.

The bougie should always be examined after its withdrawal for the presence of blood or pus which may be found adhering to its surface or tip. With the hollow bougie provided with a lateral opening near its tip, fragments of tissue sufficiently large for examination may be brought away by the instrument, which when placed under the microscope may confirm a diagnosis of possible malignancy.

ESOPHAGOSCOPY

Esophagoscopy, a method devised by Mikulicz, consists in direct inspection of the interior of the esophagus by the aid of a long endoscopic tube illuminated by electricity. By the use of the esophagoscope in the hands of an expert, much valuable information may be obtained; foreign bodies may be located and removed; ulcers, new growths, strictures, the openings of diverticula, etc., may be directly inspected; and fragments of tissue may be removed for examination. Still, the discomfort of such an examination for the patient and the experience and skill required in the use of the instrument on the part of the examiner will not allow it to supplant the ordinary methods of examination as a routine.

In the passage of the esophagoscope the same care should be observed as in the passage of any esophageal instrument. The contraindications to its use are practically the same as those mentioned for the sound or bougie, viz., aortic aneurysm, recent hemorrhage from the esophagus, advanced pulmonary or cardiac disease, etc.

Instruments.—Von Mikulicz's instruments (Fig. 504) are cylindrical tubes about 2/5 to 1/2 inch (10 to 13 mm.) in diameter, bevelled at the end and supplied with an obturator to aid in their introduction. On the outside, the tubes are marked off in a centimetric scale. They are made in different lengths, according to the depth to which it is wished to pass the instrument. The illumination is supplied by a panelectroscope at the proximal end of the instrument. Among other instruments of this type may be mentioned those of Killian and Brünings.

Other tubes, such as Jackson's (Fig. 505) or Einhorn's, for instance, are provided with illumination at the distal end of the instrument. These will be found easier to manage, as with the former it is difficult to direct the light properly on account of the length of the tube. To examine the entire length of the esophagus, Jackson uses, for adults, a tube about 21 inches (53 cm.) long and 2/5 inch (10 mm.) thick, and for children, a tube 18 inches (45 cm.) long and 7/25 inch (7 mm.) thick. In addition to the esophagoscope, a Sajous applicator, swabs on holders, various shaped forceps for removing foreign bodies or sections of tissues for examination, etc., are required.

Asepsis.—The tubes and accessory instruments may be sterilized boiling and the lights by immersion in alcohol.

Preparation of Patient.—The patient's stomach should be empty, avoid regurgitation of its contents. Where there is a marked

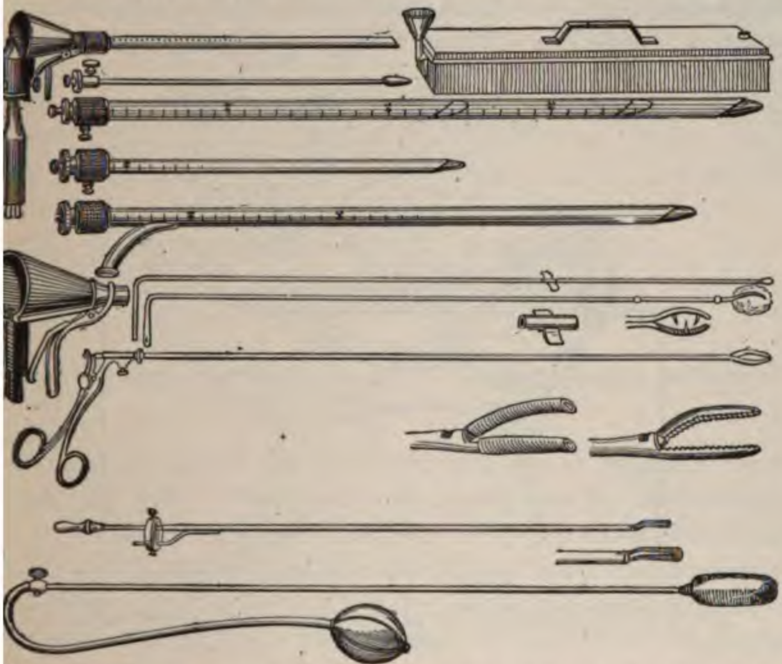


FIG. 504.—Von Mikulicz set of instruments for esophagoscopy. (Gottstein in Keen's Surgery.)

atation of the esophagus, a preliminary lavage (see page 502) may necessary. The clothing should be loosened from about the tient's neck and chest and any plates or artificial teeth should be noved from the mouth.

FIG. 505.—Jackson's esophagoscope.

Position of Patient.—Some operators perform esophagoscopy h the patient sitting up; others, with the patient on a table in a right lateral position, with the head supported and controlled by an assistant. This latter posture, or that known as Rose's posture, viz., the patient recumbent with the head hanging over the end of a

Fig. 506.—The position of the patient and assistant for esophagoscopy.. (After Jackson.)

table, supported by an assistant, who raises, lowers, or turns the head at will (Fig. 506), is preferable.

Anesthesia.—General anesthesia may be required in children. For adults, painting the pharynx, larynx, and entrance of the esopha-

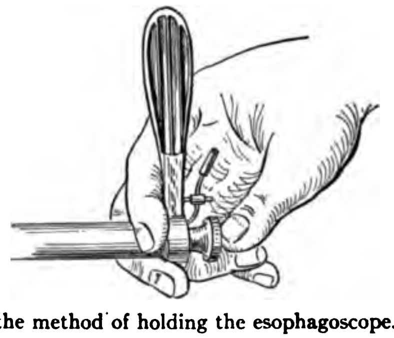


Fig. 507.—Shows the method of holding the esophagoscope. (After Jackson.)

gus with a 10 per cent. solution of cocain by means of a cotton swab held in a Sajous applicator some minutes before the introduction of the tube will suffice. This may be very effectually done through a short split-tube spatula, such as is used in direct laryngoscopy (see Fig. 450).

Technic.—The seat of trouble should have been previously determined by means of a bougie, and if the operator possesses tubes of different lengths this will enable him to select one of the proper length. The tube is lubricated, the patient's mouth is well opened, and, with

Fig. 508.—First step in esophagoscopy, the left index-finger guiding the instrument into the esophagus. (After Jackson.)

the index-finger of the left hand, the base of the tongue is drawn forward (Fig. 508). The operator then introduces the tube, with the obturator inserted in place, backward to the posterior part of the pharynx and then downward, the assistant at the same time extending the patient's head so as to bring the mouth and esophagus nearly in the same straight line. The patient is directed to aid the passage

Fig. 509.—Shows the esophagoscope in place.

of the tube by swallowing. As soon as the esophagus has been well entered, the obturator is removed, the illumination is turned on, and the tube is gently pushed on into the canal by direct sight, the surgeon standing or being seated at the head of the table (Fig. 509). Under direct inspection the direction of the esophagus can be distinguished and the tube advanced accordingly, care being taken to avoid compression of the trachea by a faulty direction of the end of the tube. In the cervical portion, the walls of the esophagus lie in apposition, the canal being represented by a slit extending from side to side. Below the level of the sternum the canal is open. The appearance of the esophageal mucous membrane differs from that of the trachea in that it has not the deep red tint of the latter, but appears pale red or slightly pink. Any mucus or regurgitated matter from the stomach that blocks the end of the tube may be removed by means of swabs upon long applicators or by the aspirating apparatus with which some of the tubes are supplied. In this manner the whole interior of the canal down to the cardia may be minutely inspected, and diseased areas treated by local applications if desired. Following the operation, if there is pain or difficulty in swallowing, cracked ice in small quantities may be administered.

SKIAGRAPHY

The X-rays are useful in locating bones, coins, and other impervious foreign bodies. By having the patient first swallow bismuth or similar metallic substances, which offer resistance to the penetration of the X-rays and are capable of casting a shadow, the presence of a diverticulum, constrictions, or dilatations is readily recognized, and the size and shape may be outlined. For this purpose, a mixture of bismuth subcarbonate, one part to two of mucilage of acacia, milk, or gruel is employed. The bismuth forms a coating in the gullet and the outline of the tube is thus represented upon the skiagraph by a dark shadow.

Therapeutic Measures

LAVAGE OF THE ESOPHAGUS

Lavage of the esophagus is employed chiefly for the purpose of removing collections of mucus and stagnated or decomposing food particles which have become arrested in a diverticulum sac or in a dilated area above a stenosis. In cancer of the esophagus it is frequently employed to remove foul and decomposed products of the ulceration, and gives much relief to the patient.

Apparatus.—An ordinary stomach-tube, about a No. 20 American in size and 30 inches (75 cm.) long, provided with two lateral windows near the tip, and fitted with a small glass funnel at its proximal end, forms the necessary apparatus (Fig. 510). More elaborate apparatus

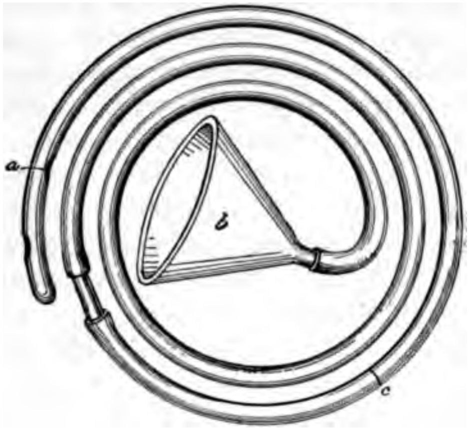


FIG. 510.—Apparatus for esophageal lavage.
nestra in the tip of the tube; *b*, glass funnel; *c*, mark to indicate the distance from the teeth to the stomach.

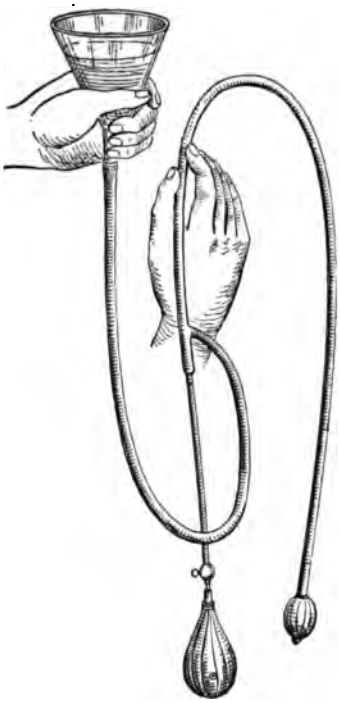


FIG. 511.—Boas' apparatus for esophageal lavage. (After Gumprecht.)

has been devised for esophageal lavage, such as, for example, Boas' tube (Fig. 511), which is provided with an inflatable rubber balloon for closing the lower end of the esophagus, thus preventing solution passing the cardia; but the simple apparatus described above will answer in the majority of cases.

Asepsis.—The tube and funnel should be sterilized by boiling before use.

Solution.—For simple lavage sterile water is sufficient. Solutions with an antiseptic or astringent action are also sometimes employed.

Temperature.—The solution should be introduced warm, *i.e.*, at a temperature of about 100° F. (38° C.).

Frequency.—In some cases the lavage will be required as frequently as every day; in other cases once every other day is sufficient. It should preferably be performed before the first meal of the day.

Position of the Patient.—The patient should sit in a chair, or else should sit up in bed with the head thrown back and the chin elevated. The operators stands in front.

Technic.—The patient is protected by a sheet or a towel fastened about his neck, and is given a basin to hold for the purpose of receiving any vomitus that may be expelled during the passage of the tube. He then opens his mouth widely, and the operator slowly inserts the stomach-tube, moistened with water down to the seat of the dilatation, being careful at first to keep the tip of the instrument close to the posterior wall of the pharynx to prevent its entering the larynx. The funnel end is then raised and through it from 2 to 2 1/2 ounces (60 to 75 c.c.) of warm water are poured into the esophagus. The funnel end is then lowered and the contents are drained off. By alternately pouring in solution and draining it off, the esophagus may be thoroughly cleansed and all particles of food or mucus removed.

THE DILATATION OF ESOPHAGEAL STRICTURES BY BOUGIES

The treatment of an esophageal stricture comprises dilatation by means of bougies, internal esophagotomy, external esophagotomy, and, when the stricture is impassable, gastrostomy. Gradual dilatation by bougies is most frequently employed and, generally speaking, is the best form of treatment, as by this means the majority of strictures may be in time dilated. The tendency, however, is for the stricture to reform after dilatation unless a bougie be passed at ervals during the remainder of the patient's life. When the icture involves the greater part of the canal, dilatation is fre- ently unsuccessful. Dilatation is con- indicated in very recent burns of the phagus. Moderate and carefully per- med dilatation, however, is not contra- licated by carcinoma.

Strictures may be located in any part the esophagus, but the majority are situ- d near the points of normal constriction the canal (Fig. 512). They are usually gle, but may be multiple; and they also ry in form and shape, being valve-like, nular, semicircular, or tortuous. The rtion of the canal immediately above a ht stricture dilates from the accumula- n of food; especially is this the case if stricture is low in the canal, and as a ult inflammation or suppuration may velop. In such cases there is great nger of perforating the walls of the eso- agus unless extreme gentleness in mani- lation is observed.

The danger of passing a bougie through aneurysmal sac should also be kept in nd, and to avoid such an accident a eful physical examination should be de in every case before inserting any phageal instrument. By such examina- n the discovery of other growths within neck or mediastinum producing com- ssion is often possible. It is next neces- y to determine by means of a bougie location, the degree, the approximate gth, and, if possible, the character of stricture before any attempts at dilata- n are made.

FIG. 512.—The most frequent seats of stricture of the esophagus. (Eisendrath.)

A, Aorta, *D*, Diaphragm. 1, Stenosis from carcinoma of lower end of the pharynx and beginning of the esophagus; 2, stenosis from pressure of tumors of the neck; 3, stenosis due to aneurysm of the arch of the aorta; 4, stenosis as the result of caustic or lye burns; 5, stenosis as result of carcinoma of lower end of the esophagus and cardiac end of stomach.

Instruments.—Flexible bougies of woven terial impregnated with elastic gum, which become soft when ced in warm water and rigid when placed in cold water, are erally employed. The bougies vary in size from $\frac{1}{12}$ to $\frac{3}{5}$ inch

(2 to 14 mm.). In a normal esophagus, a bougie ½ to ⅝ inch (13 to 14 mm.) in diameter will pass the narrow portions without difficulty.

For strictures of fair size, say the size of a lead pencil, cylindrical bougies (Fig. 513) may be employed; for smaller strictures the conical (Fig. 514) or bulbous instruments (Fig. 515) are used.

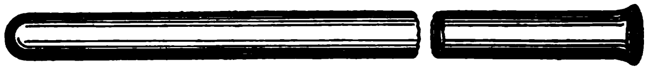


FIG. 513.—Cylindrical esophageal bougie.

In the dilatation of very tight strictures catgut strings, flexible whalebone, or linen filiforms similar to the urethral filiforms are sometimes employed. They are inserted by the aid of the esophagoscope or through a special hollow sound.

Other more complicated instruments are sometimes used, such as Schreiber's and Billroth's sounds. The former (Fig. 516) consists

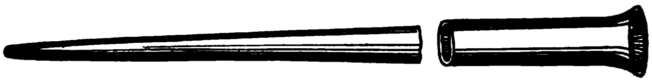


FIG. 514.—Conical esophageal bougie.

of a hollow bougie with a rubber bag on the dilating end, which is capable of being distended with fluid forced in through the distal end of the instrument. Billroth's sound consists of a cloth sound filled with mercury. These instruments, however, possess no advantages over the ordinary flexible bougie.

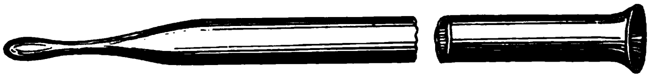


FIG. 515.—Bulbous esophageal bougie.

Asepsis.—The gum-elastic bougies may be sterilized in formalin vapor or by immersion in a saturated boracic acid solution.

Preparation of Patient.—In cases of marked dilatation of the canal above the stenosis full of stagnant food and mucus, preliminary esophageal lavage (page 502), is indicated.

Rapidity of Dilatation.—The stretching should be done gradually. Rapid dilatation or divulsion is dangerous and inadvisable.

Frequency.—As a rule, the bougies may be inserted every second : third day. If the bougies be employed too frequently, irritation : the seat of stricture is produced and the condition is made worse stead of improved. After full dilatation has been reached, the tervals between treatments may be stretched to a week, and then adually to a month. The patient should not be permitted to go nger than this, however, without the passage of a bougie, as con- action is extremely liable to develop. At any signs of recurrence the trouble, more frequent treatments are necessary.

Position of Patient.—The patient should be seated in a chair with e head thrown well back and with the chin raised.

Anesthesia.—Though not absolutely necessary, preliminary co- inization of the pharynx and larynx with a 10 per cent. solution cocain renders the operation easier.

Technic.—A bougie of a size that will enter the stricture is osen. This is determined from the examination of the stricture

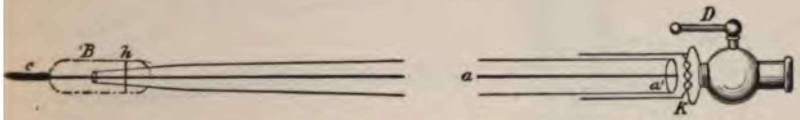


FIG. 516.—Schreiber's esophageal sound. (Gottstein in Keen's Surgery.)

eviously made. The bougie is softened in warm water and bent to gentle curve near its tip. The operator, standing in front of the tient, inserts the bougie into the patient's mouth to the posterior all of the pharynx, and, keeping it close to this latter structure, it slowly advanced into the esophagus (see Fig. 494). If difficulty encountered in entering the esophagus, the tongue may be drawn rward by the left index-finger, as shown in Fig. 495.

When the stricture is reached care must be taken not to use any rce in attempting to pass it, as a false passage may be made or the strument may simply be doubled upon itself. By gently with- rawing and then advancing the instrument, and by moving its tip different directions, the opening will be entered if the particular strument is of sufficiently small caliber. When the instrument is ace within the stricture the operator is acquainted with the fact y the tight grasp upon the bougie exerted by the stricture. The ougie should be slowly passed entirely through the constriction, and ould be allowed to remain in place from five to ten minutes before is withdrawn. At the next sitting, the same size bougie is again serted, and, if the stricture seems very tight, this same instrument may be passed on two or more occasions before a larger one is employed. When there is more than one stricture, no attempt should be made to dilate the lower ones until dilatation of the upper is secured.

Very tight strictures may be dilated by means of a thread passed

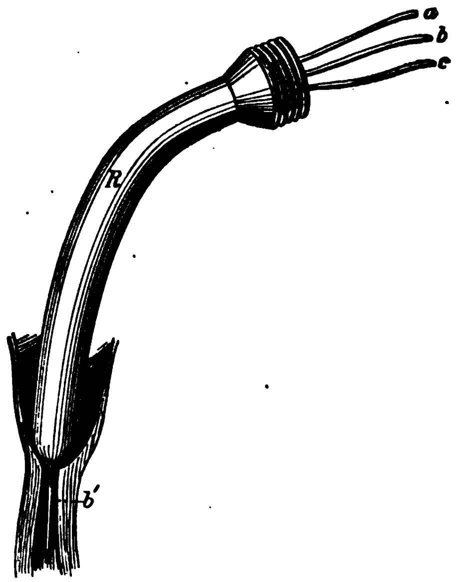


FIG. 517.—Von Hacker's method of introducing thin catgut bougies. (Gottstein in Keen's Surgery.) *a, b, c,* Into the stricture; *b'*, through a wide hollow bougie (*R*).

through the stricture as a guide, over which are passed small olivary bougies or conical sounds (see page 497), by means of filiform bougies inserted through an esophagoscope, or by von Hacker's method of inserting catgut strings. In the latter procedure a hollow sound made especially for inserting catgut strands is passed down as far as the face of the stricture, and through this the catgut strands are insinuated into the opening one after another in a manner similar to the method used for tight urethral strictures (Fig. 517). They are left in place fifteen to thirty minutes, and, as the gut swells, the contracture is stretched. As soon as sufficient dilatation for the passage of a small bougie has been thus produced, bougies of a conical shape may be substituted.

INTUBATION OF THE ESOPHAGUS

This consists in the insertion of a tube into a stenosed esophagus which is left in place continuously for varying periods at a time. It s a method of treatment used in cancer of the esophagus when the patient is unable to swallow food, and sometimes as a means of dilat- ng elastic strictures which are dilatable, but rapidly contract after he withdrawal of a bougie.

Long tubes inserted into the stomach through the mouth or nose r short tubes which can be passed through the stenosed area by the id of a guide are employed. The use of the short tubes is preferable nd is far more agreeable to the patient, as with them it is pos- ible for the patient to swallow saliva and to take food in the natural ray, the ability to taste food being also preserved by the patient. 'hey are, however, more difficult to insert than are the long tubes. nother disadvantage of the short tube is that if it becomes blocked may have to be removed for cleansing. If the obstruction is tuated very near the entrance of the esophagus, the use of short bes is usually impracticable, as the expanded end of the tube

FIG. 518.—Symonds' short tube for intubation of the esophagus.

resses on the larynx and produces laryngeal irritation and spasm. n such cases long tubes are indicated. Long tubes are also indi- ated in the later stages of carcinoma of the esophagus, with a fistu- us opening between the esophagus and air-passages, when it is ecessary to prevent any food from passing through the esophagus in rder to avoid danger of lung complications.

Instruments.—When long tubes are indicated, an ordinary hollow lindrical esophageal tube (see Fig. 491) or a rubber stomach-tube appropriate size may be employed. For the purpose of feeding le patient, a glass funnel that will fit into the proximal end of the tbe will also be required.

Short tubes of gum elastic and hard rubber have been devised Symonds, von Leyden, and others. Symonds' tubes (Fig. 518) e about 6 inches (15 cm.) long, and may be obtained in sizes of arying caliber. The lower end of the tube has a terminal or a teral opening, while the upper extremity ends in a funnel-shaped expansion, which rests upon the superior surface of the stricture or growth and prevents the tube from slipping down the esophagus; to this expanded end silk threads are secured, as shown in Fig. 518, for the purpose of extracting the tube. A special whalebone guide for inserting the tube is also required (Fig. 519).

Asepsis.—Gum-elastic instruments are sterilized by formalin vapor or by immersion in a saturated solution of boracic acid. Rubber tubes, however, may be boiled. Before reinserting the same tube, it should be thoroughly washed with soap and water and resterilized.

Duration of the Intubation.—For dilating a stricture the tube is left in place twenty-four to forty-eight hours, and, if it has then become loosened through stretching of the contracture, it is removed and a larger one is inserted and allowed to remain in place for the same length of time. This process is repeated until full dilatation has been obtained.

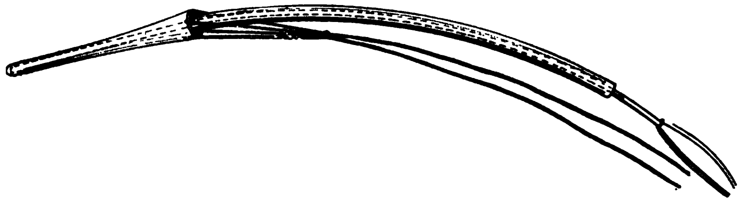


FIG. 519.—Symonds' tube on introducer.

In cancer of the esophagus the tube is worn continuously except when it is removed once every ten days for cleansing. A long tube, however, may be left in place permanently, as it can be kept clean by syringing down its interior.

Position of Patient.—The patient is placed in the same position as for the passage of any esophageal instrument, viz., sitting upright, the head thrown well back, and the chin elevated.

Anesthesia.—As an aid in the introduction of the tube the pharynx and larynx may be sprayed with a 10 per cent. solution of cocain.

Technic. 1. *Long Tubes.*—The site of the stenosis is previously determined by means of a bougie, and a tube that will comfortably pass is selected. The patient widely opens his mouth and the operator gently inserts the tube in the manner already described for the passage of an esophageal bougie (page 492). The tube is passed into the stomach, and the proximal end, which is brought out of a corner of the mouth, is fitted with a cork and is secured to the ear by a piece of silk. It will be necessary for the patient to remain in a recumbent position with the head to one side to allow saliva which collects to escape, as this is prevented from passing down the canal.

FIG. 520.—Shows long esophageal tube passed through the nose.

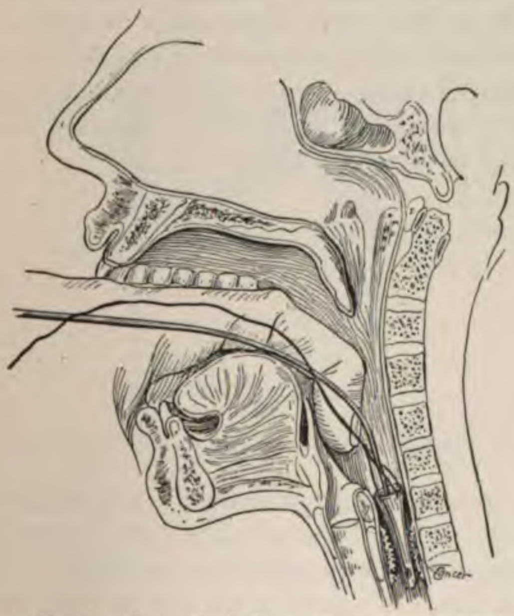


FIG. 521—Showing the method of introducing Symonds' short tube.

Instead of passing the tube through the mouth it may be inserted through the nostril (Fig. 520). The free end, corked as above, is then secured in place by means of adhesive plaster.

2. *Short Tubes.*—A tube of the proper size is selected and placed

upon the introducer, being prevented from falling off by the silk threads which are grasped by the operator with the same hand he employs in introducing the tube. The patient's tongue is then drawn well forward and the tube is passed down the esophagus and is inserted through the stricture by means of the introducer, following the same steps as for the passage of a bougie (Fig. 521). When the tube is in proper position the tension on the threads is relaxed and the introducer is gently disengaged from the tube and removed. The threads are then brought out of a corner of the mouth and are secured to the ear or face with adhesive plaster. If any of the patient's teeth are missing the threads should be made to emerge from the mouth through such a space so as to avoid being cut by the teeth.

Should the tube become blocked, it may be possible to remove the obstruction by passing a very small bougie down through it; otherwise the tube will have to be removed and cleaned. Withdrawal of the tube is effected by making gentle traction upon the threads secured to its proximal end.

Feeding.—While the tube is in place the patient is kept upon a fluid diet, such as milk, broth, eggs beaten in milk, etc. With the short tubes food may be administered by mouth, but when the long tubes are employed the nourishment is introduced through a funnel inserted in the proximal end of the tube. Between feedings the end of the tube may be closed by means of a cork.

CHAPTER XVIII

THE STOMACH

Anatomic Considerations

The stomach may be described as a hollow, inverted, pear-shaped organ, the greater part of which lies in the epigastric and left hypochondriac regions, about one-sixth of the organ extending beyond the right of the median line. When empty it lies deep in the abdomen in front of the pancreas, being covered by the liver and diaphragm

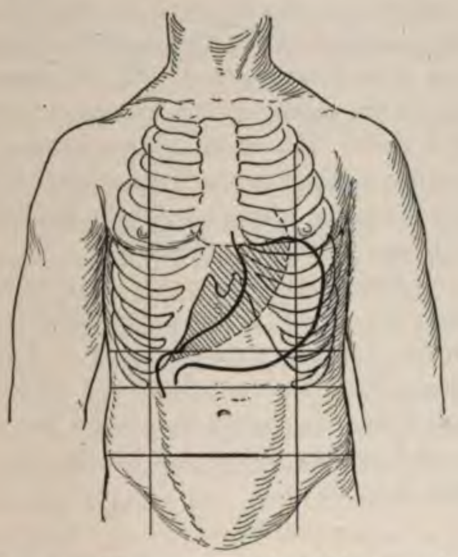


FIG. 522.—The normal position of the stomach.

for about two-thirds of its area and by the abdominal wall over the remaining one-third. The space in which the stomach comes in contact with the anterior abdominal wall is triangular in shape, bounded on the right by the lower border of the liver, on the left by the eighth, ninth, and tenth costal cartilages, and below by the transverse colon.

The upper limit of the stomach, the fundus, reaches the level of the lower border of the fifth rib in the mammary line, being in relation with the diaphragm above and the concave surface of the spleen to the left. The lower limit or greater curvature extends to the level of a line connecting the lowest portions of the ninth or tenth ribs or to within 2 inches (5 cm.) of the umbilicus. In contraction or dilatation of the organ, however, this normal position of the greater curvature may be modified to a marked degree. The cardiac or superior opening lies about ½ inch (1 cm.) to the left of the median line, at the level of the eleventh dorsal vertebra, or anteriorly at the level of the junction of the sternum and seventh costal cartilage. It is situated about 4 ½ inches (11 cm.) posterior to the anterior abdominal wall. The pyloric opening is situated in front of, but on a lower plane than, the cardiac opening, lying to the right of the median line and covered by the right lobe of the liver. It is on a level with the upper border of the body of the first lumbar vertebra or anteriorly on a level with a point 2 or 3 inches (5 to 7.5 cm.) below the sternoxiphoid joint. The long axis of the undistended stomach lies in more of a vertical than a horizontal plane with the lesser curvature directed principally to the right and the greater curvature to the left. When distended, however, the organ changes its position somewhat; the greater curvature is tilted to the front so that the upper surface looks upward and the lower downward; at the same time the pylorus moves 2 inches (5 cm.) or more to the right.

The capacity of the stomach is subject to wide variations. The average is about 2½ pints (1200 c.c.). When the stomach is empty, the longest diameter measures 7 ¼ to 8 inches (18 to 20 cm.) and the transverse diameter 2¾ to 3¼ inches (7 to 8 cm.). When the organ is filled, the longest diameter is increased to 10 or 12 inches (25 or 30 cm.) and the widest point of the transverse diameter to 3¼ or 4 inches (8 or 10 cm.).

Diagnostic Methods

In the diagnosis of stomach diseases a history of the previous and the present condition of the patient should be carefully taken and a general physical examination should be made before the examination of the stomach itself is undertaken. In obtaining the patient's history, in addition to the usual questions common to all histories, inquiry should be directed especially to the following points: the general condition of the health, the appetite, any loss of weight, the date and manner of onset of the symptoms, pain, sensation of pressure or distention, nausea, vomiting, vomiting of blood, etc. Of special diagnostic importance is a history of gastric pain, vomiting, or the vomiting of blood.

As to pain, one should ascertain its character, its location, whether diffuse or circumscribed in area, and especially the time of its onset in relation to the taking of food and the length of time it persists after meals. A simple feeling of pressure or fulness, however, should not be confounded with pain. Patients often confuse the two. It is also important to determine whether the pain is present at all times or only at certain stated periods and whether any special variety of food has an influence. Pain complained of when the stomach is empty is probably due to hyperchlorhydria, in which case it is relieved by eating. On the other hand, the pain of an ulcer or cancer comes on after eating, and the seat of pain is usually localized. In ulcer it is severe, comes on soon after eating, and is often completely relieved by vomiting. Its origin is often located by the patient in the back in the region of the lower dorsal vertebræ on the left side. In cancer the pain is not, as a rule, so severe as that of ulcer nor does it come on so soon after eating, and it is not so uniformly relieved by vomiting.

With a history of nausea and vomiting, the examiner should inquire into the relation of these symptoms to the taking of food, the frequency of occurrence, the character and the quantity of vomitus, and whether the patient is relieved by vomiting. This all has an important bearing upon the case. Nausea, as a rule, but not always, precedes vomiting. In certain conditions, especially when of nervous origin, nausea may be present when the stomach is empty. The time of vomiting is also quite important. In gastric ulcer the vomiting usually takes place soon after feeding, that is, within an hour or so; and, as already pointed out, its occurrence usually relieves the pain complained of. In cancer of the stomach, vomiting may not appear until late in the disease and, as a rule, the attacks of vomiting do not come on at such short intervals after feeding as in the case of ulcer. In dilatation, on the other hand, vomiting occurs at comparatively long intervals, and the amount brought up is correspondingly large. Blood in the vomitus is always of diagnostic importance. A profuse hermorrhage from the stomach generally signifies an ulcer, while the constant vomiting of blood-streaked material points more toward cancer; especially is this true if the vomited matter has a foul odor.

It has been possible here to point out the importance and the significance of but a few symptoms, and for further details the reader is referred to works on diagnosis where these will be found fully discussed. The writer simply wishes to emphasize the importance of a careful history and to point out in a general way the lines of questioning.

A general physical exmination should never be neglected even though the patient refers his symptoms to the stomach alone, for secondary disturbances of the functions of the stomach are present in a great variety of diseases. This examination should include the mouth, the tongue, the chest, the abdomen, an analysis of the urine, an examination of the blood, etc. When all possible information has been obtained from these sources, a special examination of the stomach itself should be made, for which the following methods are available: (1) inspection; (2) palpation; (3) percussion; (4) auscultation; (5) inflation; (6) examination of the gastric secretion; (7) tests for determining the motor and absorptive power of the stomach; (8) transillumination; (9) gastroscopy; and (10) skiagraphy.

INSPECTION

Abdominal inspection in thin individuals may at times give valuable information, but in stout persons the method is of very limited use. In favorable cases it may be possible by this means to determine the size and position of the stomach by tracing the shadow which represents the outline of the greater curvature. Inspection is greatly aided by a preliminary inflation of the organ (page 524). When thus distended the stomach becomes separated from the surrounding organs and its contour is more easily made out. At the same time abnormal positions or new growths may be better recognized.

Position of Patient.—The patient is placed upon a firm flat table, with his head directed toward the source of light, so that the rays will fall from the head toward the feet. The light should be so regulated by adjustment of the window shades that it enters on a plane only a little above the patient.

Technic.—The examiner takes his stand near the patient's feet and, by moving from side to side, is enabled to make out the stomach outlines from the shadows cast by the inequalities of the abodminal wall produced by the stomach beneath (Fig. 523). At times tumors of the body of the stomach or of the pylorus may be observed elevating the abdominal walls, and, if the growth be movable, a change in its position may be noted when the stomach is full and when it is empty. If there be obstruction of the pylorus with dilatation and hypertrophy of the walls, peristaltic movements of the stomach may be observed after taking food. These waves may be seen extending

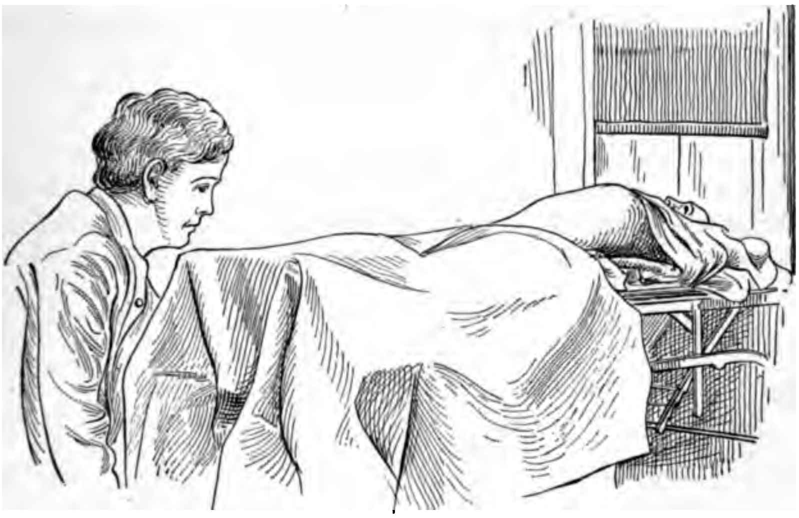


FIG. 523.—Inspection of the stomach.

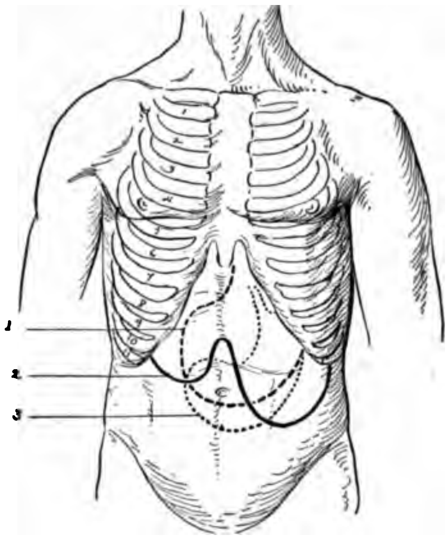


FIG. 524.—Showing the shape of: (1) A dilated stomach, (2) an hour-glass stomach, (3) the stomach in gastroptosis.

toward the pylorus from under the ribs in the left upper quadrant to the right lower quadrant. Peristalsis may be excited by tapping the abdomen or by the application of cold. A dilated stomach may be determined from the great bulging in the epigastrium and by tracing the greater curvature to a point considerably below the umbilicus, and at times an hour-glass contraction may be recognized (Fig. 524). In gastroptosis the epigastrium will be retracted, and the lesser curvature may be seen represented by a groove extending from the umbilicus to the ribs upon the left and above. Depression of the epigastrium will also be seen in stenosis of the cardia.

PALPATION

Palpation is by far the most reliable of the methods of physical examination. The stomach should, when possible, be palpated both

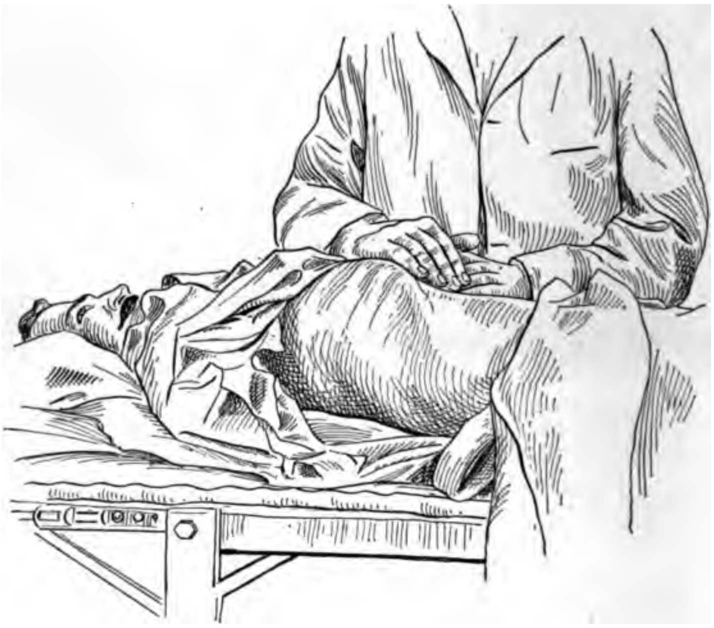
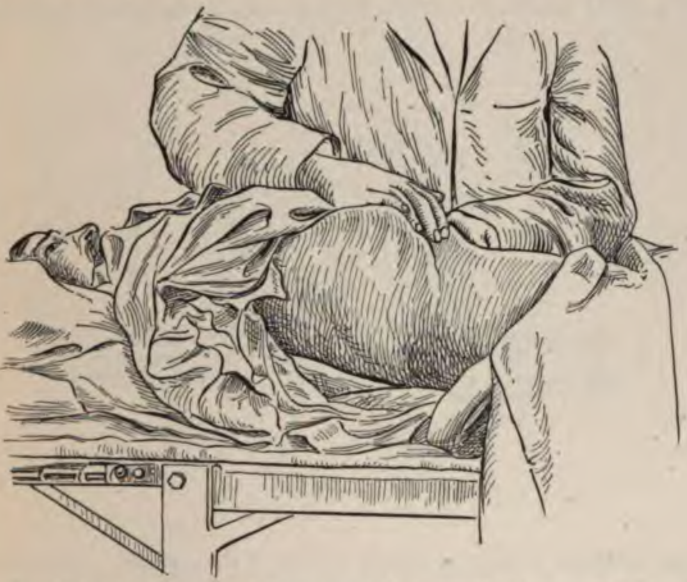


FIG. 525.—Method of palpating the stomach.

before and after taking food, as tumors of the posterior wall are often capable of being felt only when the stomach is empty. The large intestine should be emptied by an enema, if necessary, so as to avoid mistaking feces for new growths. The examination should be carried out systematically, and of course it must not be limited to the stomach alone but all the other abdominal organs should be palpated as well.

Position of Patient.—The patient lies recumbent with the abdominal muscles as relaxed as possible. If it is necessary to obtain ater relaxation than is possible by this posture, the knees should be wn up and the head and thorax should be slightly raised upon a ow. Where there is considerable rigidity of the abdominal muscles n fat individuals, relaxation may be secured by placing the patient warm bath.

Technic.—The examination should be performed in a warm m and the physician's hands should be warmed to avoid the scular spasm produced by cold hands. The patient is instructed eep his mouth open and to breathe regularly and deeply to induce fullest amount of relaxation. The examiner sits or stands beside patient and places both hands flat upon the abdomen, with the



. 526.—Palpating a tumor of the stomach between the fingers of the two hands.

ms down and the fingers slightly flexed, and palpates with the er-tips. Only gentle manipulations should be employed, as erwise spasm of the abdominal muscles will be induced and the of the examiner will be defeated.

When it is desired to perform deep palpation for the recognition deep-seated tumors, one hand is superimposed upon the other, upper hand making the pressure and the lower one performing the lpation (Fig. 525). Deep palpation is greatly aided by having the tient breathe deeply; it then becomes possible for the palpating nd to follow the receding abdominal walls with expiration.

In palpation tumors, one hand is used to fix the growth and the other outlines its size and determines its consistency, fixity, or mobility, and the presence or absence of pulsation, tenderness upon pressure, etc. (Fig. 526).

The examiner should first determine the size and position of the stomach. Inflation (page 524) is a great aid to palpation, as it is usually impossible to palpate the outline of an empty organ. Another method of determining the size or the position of the stomach is by means of a long soft-rubber stomach-tube passed into the organ to such an extent that it lies along the greater curvature. The greater curvature and the pylorus may thus be outlined by palpating the tube through the abdominal walls. All parts of the organ are

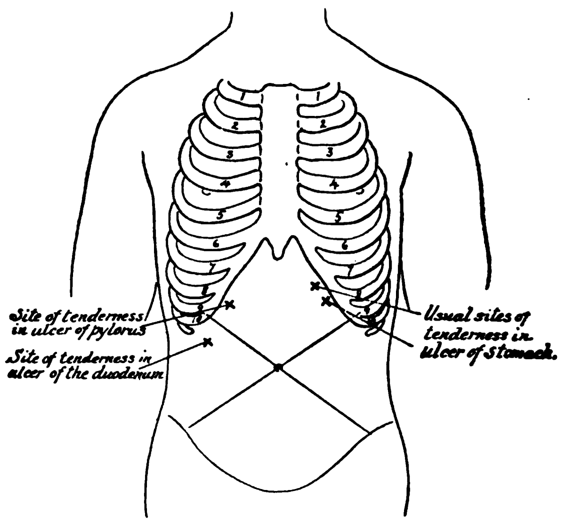


FIG. 527.—Points of pressure tenderness in ulcer of the stomach. (Mayo Robson in Keen's Surgery.)

next carefully palpated with the purpose of determining the presence or absence of new growths, painful spots, etc. Tumors of the pylorus and the greater curvature are readily palpable. The former are usually situated to the right of the median line, between the xiphoid and the umbilicus, but they have a wide range of motion unless adherent. Tumors of the lesser curvature lie to the left of the median line, thus differentiating them from those of the gall-bladder. They are less freely movable than those of the pylorus. Tumors of the cardia are seldom palpable. Changing the position of the patient to a lateral one is often of service in rendering a growth more accessible to the examiner. The knee-chest posture is also of value, as deep-seated movable tumors then fall forward toward the anterior abdominal wall.

Eliciting tender spots on palpation is frequently a diagnostic aid. In organic diseases, such as ulcer, cancer, gastritis, etc., pain is spontaneous and is increased upon pressure, while in nervous conditions it is generally diminished or relieved by pressure. In gastritis and nervous affections the pain is diffuse, while in ulcer and cancer it is usually localized to a small circumscribed area. The most common points of tenderness for ulcer are between the left costal margin and the mid-line (Fig. 527); points of pressure tenderness are also at times found 1 to 2 inches (2.5 to 5 cm.) to the left of the spine, in the neighborhood of the twelfth dorsal vertebra (Fig. 528). In

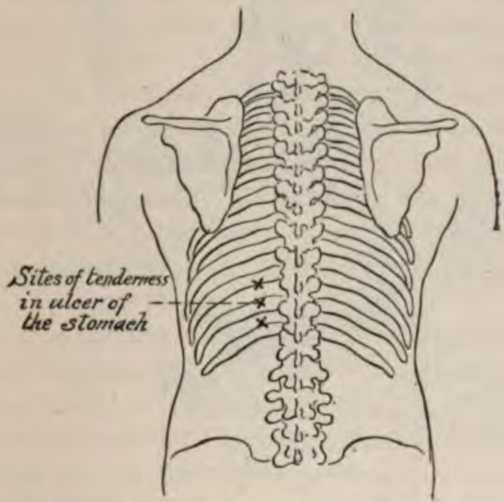


FIG. 528.—Points of pressure tenderness found posteriorly in ulcer of the stomach. (Mayo Robson in Keen's Surgery.)

affections of the gall-bladder similar tender points will be frequently found more to the right of the spinal column.

PERCUSSION

Only the greater curvature and the portion of the anterior surface of the stomach in contact with the anterior abdominal wall are accessible for percussion, consequently the chief use of this method is to determine the shape and size of the stomach. Percussion of the stomach, even under the most favorable conditions, is unreliable, on account of the proximity of other air-containing organs. The chief source of error is the resonance of the transverse colon, which may be confused with that of the stomach. To avoid this the stomach may be distended with gas and the colon with fluid, or the colon may be inflated and the patient may drink one or more glasses of water. In either case a contrast between the tympany of the one and the dulness of the other will be obtained on percussion. The percussion note over the stomach is a high-pitched metallic tympany, but it will vary much, depending upon whether the stomach is empty, whether it is full of food, or simply contains air. Percussion should be performed

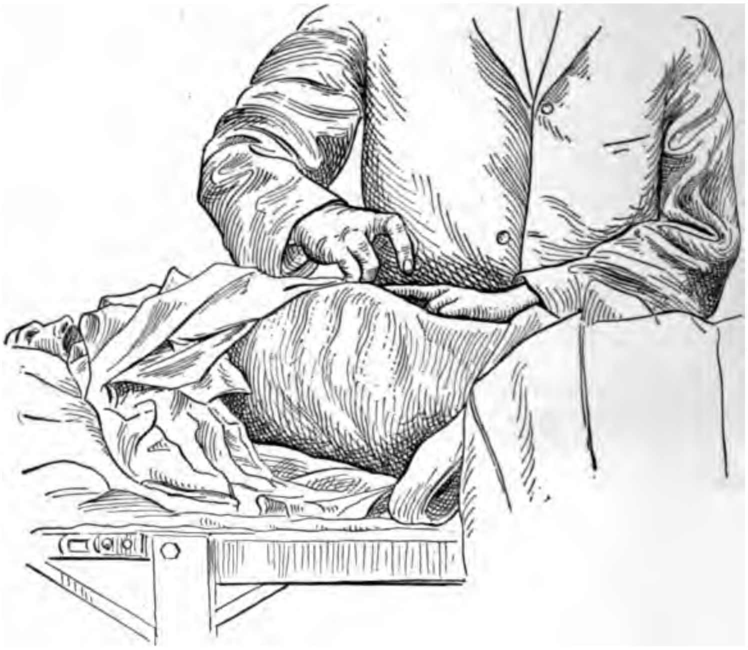


FIG. 529.—Percussion of the stomach.

when the stomach contains some air; under inflation of the organ percussion furnishes even more valuable results.

Position of the Patient.—The patient should lie in the recumbent posture.

Technic—The palmar surface of the middle finger of the left hand is laid upon the area it is intended to percuss and is held firmly against the surface, while with the flexed middle finger of the right hand a number of sharp taps or blows are struck (Fig. 529). The force of the percussion should, as a rule, be very light, but, if it is desired to make out a deeply placed growth, firm heavy percussion will be required. The same is true when the abdominal walls are

thick. Having outlined the stomach with the patient recum-
, the percussion should be performed with the patient upright
etermine if the organ sinks down from its normal position.

AUSCULTATION

3y listening to sounds produced within the esophagus during the
lowing of fluids and to sounds originating within the stomach
f, certain information of diagnostic importance may be obtained.
the first method it is possible to determine whether there be an
ruction of the cardia or not. It is carried out as follows:
The operator listens with his stethoscope placed over the esopha-
that is, to the left of the ensiform cartilage or to the left of the
al column opposite the ninth or tenth dorsal vertebra while the
ent is swallowing fluids. Two sounds are thus heard: first, a
ting sound that immediately follows the act of swallowing, and
cond sound, more rattling in character, known as the "degluti-
murmur," which is heard six or seven seconds (sometimes as
h as twelve seconds) later; it represents the passing of food
ugh the cardiac orifice into the stomach. If this second sound
onstantly absent, more or less complete occlusion of the cardia
resumable.
The succussion or splashing sounds that originate in the stomach
f are of greater diagnostic importance. In order to obtain these
ids the stomach must contain air and be partly filled with fluid.
patient lies recumbent and the operator listens with his ear near
abdomen while he taps the abdominal wall in the region of the
nach with his finger-tips. Succussion sounds may also be elicited
moving the patient quickly from side to side. These sounds
ild be differentiated from other gurgling sounds which are heard
n the stomach contains only air or is empty. Succussion in
f is of no diagnostic importance, for it may be heard in a normal
nach containing a quantity of fluid. It is pathological, however,
btained *when the stomach should normally be empty*, that is, in the
ning before breakfast, three hours after a test breakfast, or seven
rs after a test dinner. It then indicates a condition of atony or
cient motility. When succussion is heard over an abnormally
e area, or beyond the normal boundaries of the organ, it indicates
tation or gastroptosis. The outlines of the stomach may be
pped out with considerable accuracy by tapping first from above
nward, and then from side to side, the examiner listening the

while with a stethoscope placed over the stomach and noting where the splashing sounds stop.

INFLATION OF THE STOMACH

The stomach may be inflated for diagnostic purposes to determine its size, shape, and position, and to establish the presence or absence of tumors. It is of great aid to inspection, palpation, or percussion.

The inflation may be performed by means of effervescent solutions giving off carbonic acid gas or by means of air introduced into the stomach through a tube. Inflation by the latter method is safer, as it is under the direct control of the operator and may be stopped at any moment if desired; furthermore, the distention may be immediately relieved if necessary. On the other hand, distention by means of carbonic acid gas is of great advantage in nervous individuals who fear the stomach-tube. It is not always satisfactory, however, as the dosage may not be large enough to generate sufficient gas in a capacious stomach or, if too much gas is formed, it may produce pain and vomiting. With either method some caution must be observed and the inflation must be immediately stopped if pain be produced. Inflation is contraindicated in recent hemorrhage of the stomach, in suspected gastric ulcer, in advanced cardiac disease, and in advanced arterial disease.

Under distention the stomach is raised from the neighboring organs and its limits thus become more clearly outlined, so that conditions of dilatation, gastroptosis, and hour-glass contractions may be distinguished and tumors may be rendered more pronounced. Before performing inflation in the case of suspected gastric tumor, the abdomen should be carefully examined and the exact situation of the growth noted; by then noting the position of the growth after inflation it may be determined whether the growth is connected with the stomach and whether it is fixed by adhesions or is movable. Frequently under inflation it is possible to determine by sight and by palpation the direct continuity between the stomach and the tumor. Tumors of the pylorus and of the anterior stomach wall become more prominent, while those of the posterior wall become less so when the stomach is inflated. Tumors of the pylorus generally move downward and to the right under inflation. Tumors of the lesser curvature near the cardia are displaced to the right under the liver. At the same time spurious tumors due to spasm disappear.

pparatus.—For inflation with carbonic acid gas no apparatus is ired. A stomach-tube should be at hand, however, for the pur- of relieving the patient of distention from gas if necessary.

'o inflate with air an ordinary stomach-tube, 30 inches (75 cm.) of soft rubber, to the proximal end of which a double cautery or a Davidson syringe is attached, will be required (Fig. 530).

sepsis.—The tube should be sterilized by boiling.

osition of the Patient.—If desired, the tube may be passed with atient sitting up, but the inflation and the examination should rried out with the patient recumbent and with the chest and men well exposed to view.

echnic. 1. *By Carbonic Acid Gas.*—The patient is given 1 (4 gm.) of bicarbonate of soda dissolved in 3 ounces (90 c.c.)

FIG. 530.—Stomach-tube and Davidson syringe for inflating the stomach.

ater, and then a little less than 1 dram (4 gm.) of tartaric acid lved in 3 ounces (90 c.c.) of water. As the two solutions come ntact, carbonic acid gas is generated and the stomach is thereby nded. In dilatation of the stomach, however, it may be neces- to give a second dose to obtain sufficient distention for the pur- of mapping out the outlines of the organ.

. *By Air.*—To inflate a stomach successfully with air through a it is essential that the patient be accustomed to the passage of stomach-tube—the tube should certainly have been passed at once previously. The tube is inserted as follows: The patient structed to open the mouth, and the tube, moistened with water, is passed along the roof of the mouth to the pharynx. From this point it is advanced partly by swallowing efforts on the part of the patient and partly by the operator who pushes it on until it has passed a sufficient distance to be carried beyond the cardia. By alternately compressing and relaxing the inflation bulb the stomach is then gently pumped up with air until it is sufficiently distended for the purposes of the examination. In the case of an insufficiency of the pylorus it may be impossible to distend the stomach, the gas being expelled on into the small gut. This will be evidenced by a generalized swelling of the abdomen, instead of a distention localized in the region of the stomach.

As soon as the examination is completed, the inflation bulb is removed from the end of the tube and the air is allowed to escape so as to avoid the disagreeable distention. The abdomen may be kneaded to facilitate the escape of the air.

EXAMINATION OF THE STOMACH CONTENTS

The contents of the stomach may be removed for purposes of diagnosis when it is desired to examine the gastric secretion chemically and to test the motor functions of the stomach. Such examination often gives results of both diagnostic and prognostic value, but, while gastric analysis is of great importance, *the information obtained by such examination must not be relied upon to the exclusion of other methods of diagnosis, as it is by no means final.* In all cases the history and the results of the physical examination should be given due consideration.

To test the digestive power of the stomach it is necessary to examine the contents at the height of digestion. In other cases, as when hypersecretion or disturbance of the motor power of the stomach is suspected, the contents of the fasting stomach should be examined. Normally, the stomach should be empty of food within eight hours after a full meal. According to Rehfuss, after an all night fast the residuum in the stomach averages between 30 and 50 c.c. (1 and 1⅔ ounces) in amount. It is thin and opalescent, and contains bile in about 50 per cent. of the cases. It has an average total acidity of 30 and an average free acidity of 18. If, therefore, the contents of the stomach, removed in the morning before any food has been taken since the evening before, show the presence of food or if a considerable quantity of fluid containing free hydrochloric acid is obtained, it points in the former case to motor insufficiency and in the latter to hypersecretion.

Test Meals.—To obtain results from which comparisons may be rawn the patient should be given on an empty stomach a meal of a efinite composition and the contents of the stomach should be re-noved after a definite lapse of time. For this purpose either a test reakfast or a mid-day test dinner is employed.

The Ewald-Boas test breakfast consists of one or two rolls—be-ween 35 and 70 gm. (1 and 2⅓ ounces), a cup of tea without sugar or nilk, or 300 to 400 c.c. (10 to 14 ounces) of water. This is given pon an empty stomach in the morning and removed in one hour.

The Riegel test dinner consists of a large plate of meat soup—oo c.c. (about 14 ounces), a large portion of beefsteak or other meat, eighing 150 to 200 c.c. (5 to 7 ounces), mashed potatoes— 50 gm. ½ ounces), and a roll 35 gm. (1 ounce). The contents of the omach are removed and examined three or four hours later.

Examination of the Stomach Contents.—The object of a gastric nalysis is twofold: First, to determine the presence or absence of onstituents which are normally present, and, second, to ascertain hether other substances exist which should normally be absent. ormally, the gastric contents one hour after a test breakfast con-st of from 1 to 2⅓ ounces (30 to 70 c.c.) of acid material which pon filtration yields a clear yellow or yellowish-brown fluid. Upon nalysis this contains a total acidity of 40 to 60 (0.15 to 0.21 er cent.), free hydrochloric acid 25 to 50 (0.1 to 0.2 per cent.), epsin, rennin, albumoses, peptones, maltose, achroödextrin, and ythrodextrin.

The technic of gastric analysis will be found in works upon clinical boratory methods. Such examinations, however, should be made ong the following lines:

1. *Macroscopical examination*, noting the quantity, character, dor, reaction, etc.
2. *Microscopical examination*.
3. *Chemical Examination*.—This should include tests to deter-ine the presence or absence of free hydrochloric acid and of com-ined hydrochloric acid, the degree of total acidity, the presence of ctic acid, the presence of volatile acids, the presence of soluble bumin, the products of digestion, the presence of rennin and pepsin, d the character of the carbohydrates.

The Significance of Variations in the Composition of the Gastric cretion. *Hyperchlorhydria*.—Free hydrochloric acid is found in cess in the early stages of chronic gastritis, in gastric neuroses, in stric ulcer, and in hypersecretion. It points strongly against cancer except in cases where an ulcer is undergoing malignant change.

Hypochlorhydria.—A diminished secretion of hydrochloric acid occurs in the late stages of chronic gastritis, in gastric neuroses, in gastric atrophy, in dilatation of the stomach, in the early stages of gastric cancer, and sometimes in ulcer when associated with chronic gastritis or a cachectic condition. It is also diminished in fevers, wasting diseases, pernicious anemia, chlorosis, neurasthenia, etc.

Anachlorhydria.—Hydrochloric acid is absent when the secreting glands have been destroyed, as in atrophic catarrh and in cancer of the stomach. A diagnosis of cancer, however, cannot be made on this alone; the hydrochloric acid must be constantly absent and other corroborative facts must be present.

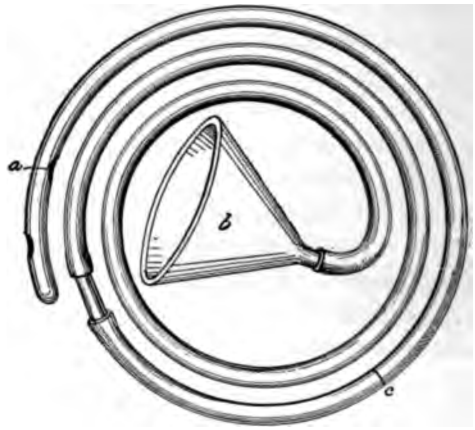


FIG. 531.—Stomach-tube and funnel for expressing the stomach contents. a, Showing the lateral fenestræ; b, funnel; c, mark to indicate the distance from the ncisor teeth to the stomach.

Hyperacidity, or an increase in the total acidity, may be the result of excessive output of hydrochloric acid or it may be caused by organic acids (lactic, butyric, and acetic).

Hypoacidity, or a diminished total acidity, denotes a deficiency in the amount of hydrochloric acid, the significance of which has been mentioned above.

Lactic acid is the result of bacterial fermentation. It is found in appreciable amounts only when hydrochloric acid is absent and in general signifies insufficiency of the motor power and stagnation of the stomach contents, as is found in dilatation, obstruction of the pylorus, and cancer. The presence of lactic acid alone is not diagnostic of cancer, as small amounts may be found after a meat diet and may also be present in other pathological conditions, nor does its absence prove the nonexistence of cancer. When, however, it is found in considerable amount and is associated with an absence of hydrochloric acid and with deficient motility, it is strongly suggestive of cancer, especially if the Boas-Oppler bacillus is also present.

Pepsin and rennin are only absent when profound organic changes have resulted in an almost complete destruction of the gastric mucous membrane as the result of chronic inflammation, severe atrophy, etc. The presence or absence of these ferments is thus of importance in the diagnosis between an organic change and a functional ondition.

Extraction of the Stomach Contents.—The stomach contents may be removed through a stomach-tube either by the aspiration or expression method. The expression method answers in the great majority of cases, but it may fail where the contents of the stomach are not fluid enough to flow through the tube. The use of the stomach-tube is contraindicated in the presence of aortic aneurysm, in patients liable to cerebral hemorrhage, or in those who have recently suffered from gastric or pulmonary hemorrhages, in those who are

FIG. 532.—Boas' aspirating bulb.

very weak, in those suffering from severe pulmonary or cardiac troubles, etc.

Apparatus.—When the expression method of removing the stomach contents is employed the following apparatus will be required: A soft-rubber stomach-tube about 30 inches (75 cm.) long and ¼ of an inch (6 mm.) in caliber, with two smooth-edged lateral openings and a blind end, connected by a piece of glass tubing 3 to 4 inches (7.5 to 10 cm.) long to 2 feet (60 cm.) of rubber tubing, to the end of which a glass funnel is attached (Fig. 531).

When aspiration is employed, the stomach-tube may be connected with a bottle aspirator, with a stomach-pump, or with a rubber-bulb form of aspirator, such as Boas' apparatus (Fig. 532). The bottle-aspirator (Fig. 533) consists of a large glass bottle supplied with a tightly fitting rubber stopper through which two glass tubes pass; one of these is connected with the stomach-tube while to the other a Potain syringe is attached, by means of which the air in the bottle is exhausted.

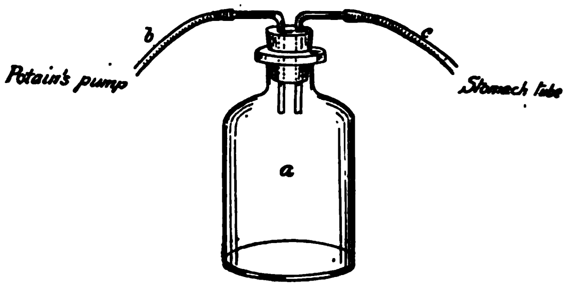


FIG. 533.—Bottle arranged for aspirating the stomach contents. *a*, Large glass bottle; *b*, tubing connected with a Potain aspirator; *c*, the stomach tube.

FIG. 534.—Introducing the stomach-tube. First step, imparting a curve to the end of the tube for its more easy passage.

Asepsis.—The stomach-tube should be sterilized before use.

Position of the Patient.—The patient is seated upright in a chair or in bed.

Technic.—Artificial teeth or plates should be removed from

atient's mouth and he should be protected by a towel or an
fastened about the neck. A small bowl should be provided
he purpose of receiving excessive secretion of mucus or

FIG. 535.—Introducing the stomach-tube. Second step.

which may collect in the mouth. The tube is moistened in water, and is passed into the patient's open mouth back to the

FIG. 536.—Introducing the stomach-tube. Third step.

nx. The patient is then requested to swallow, and the instru-
is thus advanced into the esophagus, partly by the swallowing
and partly by the operator (Fig. 535). During this ma-

neuver the patient is instructed to breathe regularly and deeply, even if a sense of suffocation is produced, and to hold the head slightly forward to allow the escape of the saliva which collects in the throat (Fig. 536). As soon as the tube has passed the entrance of the esophagus it may be readily pushed on into the stomach without any difficulty. The distance from the incisor teeth to the cardia is about 16 inches (40 cm.) and to the lower border of the healthy stomach about 22 inches (55 cm.), but in pathological conditions, as

FIG. 537.—Aspiration of the stomach contents. First step.

in dilatation, for example, it may be more. When the tube has be[illegible] introduced for the proper distance, the contents of the organ a[illegible] removed, either by expression or by suction furnished from one of t[illegible] forms of aspirating apparatus described above.

Expression of the stomach contents is accomplished by pressi[illegible] over the region of the stomach while the patient bends forward a[illegible] strains as if at stool. The proximal end of the tube is in the mea[illegible] time lowered over a dish or bowl to a point below the level of the stomach.

Aspiration with the Boas aspirator is performed as follows: With the clamp closed the operator compresses the bulb (Fig. 537) and then releases it, thus filling the bulb with the stomach contents. The clamp is then opened and the bulb is compressed, causing the contents to be forced out into a receptacle (Fig. 538).

The Fractional Method of Gastric Analysis.—In the fractional method of gastric analysis samples of the stomach contents are withdrawn and examined at frequent intervals during the whole

FIG. 538.—Aspiration of the stomach contents. Second step.

cycle of gastric digestion. For the purposes of this examination Rehfuss has devised a special tube of small size, which may be left in the stomach for a considerable time without discomfort to the patient. Samples of the stomach contents are removed every 15 minutes after the administration of a test meal till the close of digestion, and the results of the analyses are plotted in a graphic chart or curve. In this way the chemical composition of the gastric juice during every phase of gastric digestion, and the progress of digestion at any time after the ingestion of food may be studied. This method consumes more time than the older methods of gastric analysis, but more exact information as to the secretory and motor power of the stomach is thus obtained than is possible from the customary single examination one hour after a test meal.

Apparatus.—The Rehfuss tube is 40 inches (100 cm.) long and No. 10 to 12 French in size. The proximal end is adapted to fit an aspirator, while to the distal end is fitted a metal tip heavy enough to cause it to gravitate to the bottom of the stomach. The tip is provided with slots of the same size as the tubing so that any material which enters the tip will pass through the tube. A glass syringe is employed for aspirating (Fig. 539).

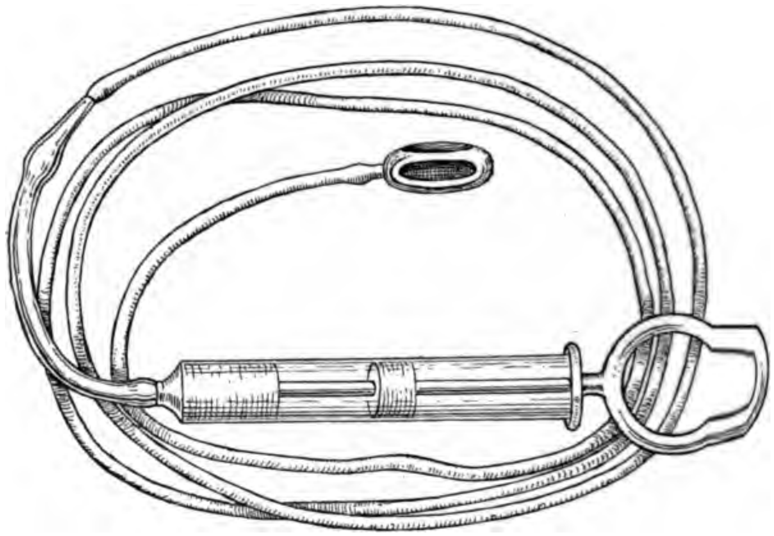


Fig. 539.—The Rehfuss tube for fractional gastric analysis.

Asepsis.—The apparatus should be sterilized by boiling.

Position of the Patient.—The patient is seated upright in a chair or in bed.

Technic.—The patient is given an Ewald test meal (2 slices of bread or toast and 2 glasses of water) on a fasting stomach after removal of the residium. The tube is inserted in the following manner: The patient is directed to open his mouth, and the tip of the tube, lubricated with glycerin, is placed back of the tongue in the pharynx by the examiner. The tube is then carried into the stomach by the patient swallowing. In this he may be aided by swallowing a little water if any difficulty is met in getting the tube down. About 22 to 24 inches (55 to 60 cm.) of tubing is passed. From 1¼ to 2½ ns (5 to 10 c.c.) of the stomach contents are then removed at 15 ute intervals, or 30 minute intervals if digestion is very slow, l the end of digestion, that is, until aspiration shows no further l particles. The specimens are collected in separate containers are labelled and later examined, and the results are tabulated in a 'e.

Variations in Curves in Health and Disease.—There is no one 1 of secretory curve common to all normal stomachs. Rehfuss, geim, and Hawk (*Journal American Medical Association*, Sept. 1914) describe three normal types of curve:

I. *The Isosecretory Type.*—The curve shows a steady rise, reach- a high point of 60 for total acidity and 40 for free acidity. The point is maintained for from ½ to 1 hour and then gradually ines. Food residue disappears in 2 to 2½ hours.

2. *The Hypersecretory Type.*—There is a rapid rise of the curve, hing a high point of 70 to 100 for acidity. The curve shows a slow or no decline in the usual time. Food remnants disappear to 2½ hours, but the gastric secretion often continues for half an r or longer.

3. *The Hyposecretory Type.*—This type is rare. The curve ly rises, reaching a high point of 40 to 50 for acidity. Digestion mplete in 2 to 2½ hours.

Some of the variations in the curves in disease are, according to n (*N. Y. Medical Journal*, Jan. 18, 1919), as follows:

In *Gastric ulcer* the ascent of the curve is rapid and its height is hed within an hour or slightly after. The high point for total ity is between 100 and 110 and for free acidity between 60 and The decline is gradual or sudden. Blood may be present.

In *Duodenal ulcer* the curve shows a gradual ascent. The height ie curve is not reached until 2½ hours when the stomach begins npty. The high point for total acidity reaching 110 or over and ree acidity between 90 and 100.

In *Gastric carcinoma* with obstruction the total acidity may be nal or slightly above normal, while the free acidity is entirely nt or rises to 10 or 15 after an hour. Blood and lactic acid are found. In carcinoma of the cardia with no obstruction, both the l and free acidity are subnormal.

Kahn points out that reflex irritation due to gall-stones, appendi- , colitis, or renal colic may produce a marked influence upon the ric curve, and results similar to those observed in duodenal ulcer be obtained.

TEST OF THE MOTOR FUNCTION OF THE STOMACH

By the motor power of the stomach is meant the ability of that organ to propel its contents into the intestine. When this function is deficient, as from obstruction of the pylorus due to cancer, ulcer, etc., or from impairment of the gastric musculature, food accumulates in the stomach and dilatation finally results. Early recognition of perversion of the motor power is thus of great importance. There are a number of tests for determining the motor function of the stomach, among which are the following:

Leube's Test.—This consists in giving the patient a test meal composed of a plate of soup, a beefsteak, and a roll. If the stomach is empty seven hours later and nothing can be removed by lavage, the motor power is normal; on the other hand, if food remains in the stomach longer, the motor power is deficient, the degree of impairment being indicated by the quantity and the character of the food remaining.

Ewald's Test.—This consists in administering salol to a patient after a meal and noting the length of time before salicylic acid appears in the urine. Salol is unaffected by the gastric juice, but is split into salicylic acid and carbolic acid in the intestine. In performing this test the bladder is first emptied; the patient is then given 15 grains (1 gm.) of salol in two gelatin-coated capsules and is instructed to urinate at intervals of half an hour for two hours and to preserve the specimens separately; these are later tested with neutral ferric chlorid solution for the presence of salicylic acid. In the presence of salicylic acid the test gives a violet-blue color. In normal cases the salicylic acid should be recognized in the urine in from thirty to seventy-five minutes. Delay in its appearance indicates deficient motor power.

Iodipin Test—This drug is unaltered by the gastric juice, but in the intestine it is split up and iodin is absorbed and eliminated in the saliva. Fifteen grains (1 gm.) of iodipin are administe ed in gelatin-coated capsules in the morning with breakfast and the saliva is then tested with starch-paper and nitric acid for iodin every fifteen minutes. In a normal case the iodin is recognized in the saliva within about an hour.

TEST OF THE ABSORPTION POWER OF THE STOMACH

The usual method of determining this is by the test of Penzoldt and Faber. It is performed as follows: 3 grains (0.2 gm.) of chemically

cally pure potassium iodid are given in a gelatin-coated capsule *on an empty stomach*, and the urine or the saliva is then tested with starch-paper and fuming nitric acid every few minutes for iodin. Its presence is indicated by a blue or a violet reaction. Iodin should normally be detected in the saliva and urine in from six and a half to fifteen minutes after the ingestion of the iodid of potassium, while its appearance is considerably delayed if the absorption power is interfered with.

TRANSILLUMINATION OF THE STOMACH, OR GASTRO-DIAPHANY

A method introduced by Einhorn, which consists of transilluminating the stomach by means of a small electric light fastened to the end of a rubber tube. By this method of diagnosis the position and size of the stomach may be determined, and the presence and position of a growth or a thickening of the anterior wall of the stomach may be recognized from the lack of transparency. It is of value in the diagnosis of dilatation and in the differentiation of this condition from gastroptosis. In the former the illuminated area is larger than normal, while in the latter it is small and situated low down. Transillumination, however, is not used as a routine, since it is complicated and requires special apparatus, furthermore, there are simpler methods of determining the size and position of the organ. One advantage of the method is that the organ is seen in its natural condition, whereas under inflation it is apt to be stretched beyond the normal. To employ the method successfully it is necessary that the patient be accustomed to the insertion of the stomach tube, otherwise retching and vomiting will interfere with the examination.

Apparatus.—Einhorn's gastrodiaphane consists of a small Edison incandescent lamp attached to the distal end of a soft-rubber stomach-tube. The wires which convey the electricity to the lamp pass down inside the tube while at the proximal end are two screws for attaching the wires leading from the battery. A six to eight dry-cell battery furnishes the necessary power.

Lynch has modified Einhorn's gastrodiaphane by employing a longer tube—53 inches (135 cm.) long—sufficiently long to pass through the pylorus—and by supplying it with an inner auxiliary tube through which the stomach may be inflated with air or water or the contents of stomach or duodenum may be aspirated (Fig. 540).

Asepsis.—The instrument should be sterilized before use.

Position of the Patient.—The examination is performed with the patient in the erect position.

Technic.—Transillumination must be performed upon an empty stomach; if necessary, the stomach should be first emptied by means of the stomach-tube. The patient is then given two glasses of water to drink to prevent overheating the stomach from the lamp. The tube is moistened with water and is carefully guided into the pharynx and the patient is instructed to swallow, the descent of the tube being aided by the operator who pushes it on as soon as it is well within the esophagus. When the lamp is within the stomach, the illumination is turned on and the room is darkened, while the results

FIG. 540.—Lynch's gastrodiaphane. (Lynch.)

of the transillumination are noted. A bright luminous area will be noted on the anterior abdominal wall which corresponds in size to the outlines of the stomach. In the case of a tumor of the anterior stomach wall, even if too small to be felt, a dark patch will appear in the illuminated area.

Variation in Technic.—In order to increase the brilliancy of the transillumination, Kemp advocates the introduction of fluorescent media into the stomach preliminary to the passage of the gastrodiaphane. It is claimed for this method that it is possible to perform a satisfactory transillumination even when the abdominal walls are very thick.

Two media are employed: Bisulphate of quinin and fluorescein. The former, which gives a pale violet fluorescence, is administered in the proportion of bisulphate of quinin gr. x (0.65 gm.) to 1 pint (500 c.c.) of water with the addition of 5 ♏ (0.30 c.c.) of dilute sphoric or sulphuric acid to increase the acidity and so intensify fluorescence.

Fluorescein, which gives a green fluorescence, is administered as ows: The patient is given 8 ounces (236 c.c.) of water to drink which is dissolved 15 grains (1 gm.) of sodium bicarbonate to der alkaline the acid stomach contents. A second drink is then en, consisting of 8 ounces of water (236 c.c.) in which are mixed to 1/4 grain (0.008 to 0.016 gm.) of fluorescein, 1 dram (4 c.c.) glycerin, and 15 grains (1 gm.) of bicarbonate of soda. After administration of the fluorescent medium the lamp is introduced l the examination is proceeded with as above.

GASTROSCOPY

Gastroscopy consists in the insertion into the stomach of a stiff al tube, illuminated by electricity, through which the interior of organ is inspected. This method of examination was inaugu-d by Mikulicz in 1881, but, on account of its limited value and technical difficulties in the use of the older instruments, it never e into general use. Later, in 1890, Rosenheim devised a gastro-e on similar principles. Both these instruments were made with ms on the principle of the cystoscope, but the fact that they were rted blindly and not under the sight of the operator proved a ous drawback. Chevalier Jackson, in 1906, designed a gastro-pe on entirely different principles employing large tubes with illumination at the distal end, similar to those used in direct cheo-bronchoscopy and esophagoscopy, and he thus made it pos-le to explore a considerable portion of the stomach by direct ion. As a rule, from two-thirds to three-fourths of the stomach, luding the pylorus, is available for examination with this form nstrument, depending upon the range of lateral motion of the hiatus phagei. A stomach which occupies a vertical position presents largest area for exploration while the more horizontally the or-is placed the less of it will be available for examination. Further-re, under direct view gastroscopy lesions may be palpated by ns of a probe passed through the instrument, applications may made to diseased areas, foreign bodies may be removed, and sec-s of tumors may be excised for microscopical examination. A her advance in gastroscopy was made in 1910 by Hill in conjunc-with Herschell, who combined a direct and indirect view esopha-stroscope and added to the instrument a tap for inflating the nach with air.

Gastroscopy, however, cannot supplant other methods of diagnosis. It necessitates that the patient submit to a general anesthetic and requires such experience and dexterity on the part of the operator for its proper performance as to place it outside the domain of any but experts. According to Jackson, gastroscopy is without danger other than that from the anesthesia. At the same time, the operation requires great skill which is best obtained by practising upon the cadaver. He considers the operation unadvisable under the following conditions: "In the profound cachexia of the last stages of malignancy; in the profound anemia of inanition from known or unknown causes; cardiac, pericardiac, or major vascular lesions; general or local, acute or chronic conditions associated with either dyspnea or dropsical effusions; the late stages of organic diseases, as cirrhosis of the liver, etc." Diseases of the esophagus may, of course, interfere with or render gastroscopy out of the question.

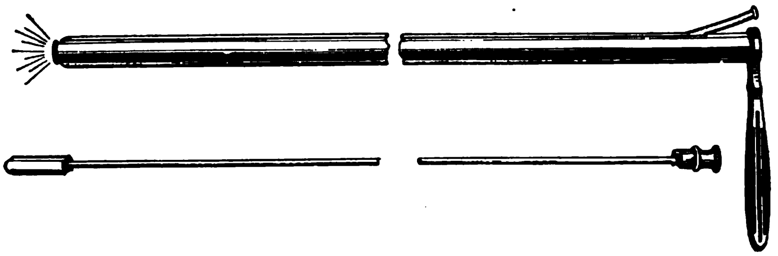


FIG. 541.—Jackson's gastroscope.

Apparatus.—Jackson's gastroscope (Fig. 541) consists of a cylindrical tube about 32 inches (80 cm.) long with a lumen 2/5 inch (10 mm.) in diameter, and with a thickened distal end. In the wall of the instrument are two small accessory tubes; one through which the illuminating apparatus is inserted and the other for the purpose of aspirating fluids that may interfere with the examination. To the proximal end of this latter tube an aspirating apparatus is attached. The instrument is also provided with an obturator having a conical tip to facilitate its insertion.

The Hill-Herschell esophagogastroscope (Fig. 542) for combined direct and indirect gastroscopy consists of a direct view tube with the illumination supplied at the proximal end from a Brünings hand lamp and an indirect view periscopic tube with a terminal lamp, which can be passed through the direct view tube. The direct view tube is supplied with a cap containing a plain glass window and a tap through which air can be forced for the purpose of inflation. A second cap, also with an inflating tap and with a rubber-lined opening for the passage of the indirect view tube, is provided. Both caps are fastened to the proximal end of the tube by means of a bayonet joint.

Asepsis.—The tube may be boiled and the light-carrying apparatus may be sterilized by immersion in a 1 to 20 carbolic acid solution, followed by rinsing in alcohol, or alcohol alone may be employed.

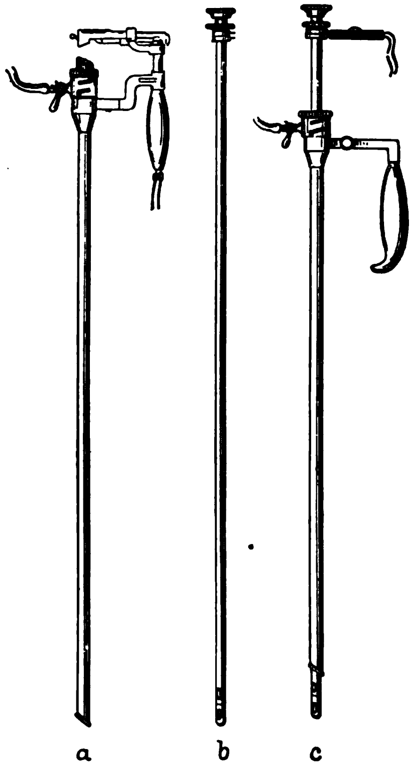


FIG. 542.—Hill-Herschell esophagogastroscope. *a*, Direct view esophagoscope with Brünings lamp; *b*, indirect view periscope; *c*, shows instrument assembled for gastroscopy.

Preparations.—These should include the ordinary preparations for a general anesthetic; that is, the patient is given a cathartic the night before the operation and food is withheld for a period of twelve hours before the operation (see also page 18). It is essential that the stomach be empty when gastroscopy is performed, and, if necessary, lavage of the stomach should be practised three or four hours previous to the operation. In dilatation with atony preliminary lavage is a necessity.

Position of the Patient.—The patient is placed in the recumbent posture with the shoulders brought 4 to 6 inches (10 to 15 cm.) over the edge of the table and the head supported by an assistant seated

FIG. 543.—Position of patient for gastroscopy. (After Jackson.)

at the head of the table and to the right, after the manner shown in the accompanying illustration (Fig. 543). This assistant also controls the mouth gag. Jackson recommends that, as soon as the tube

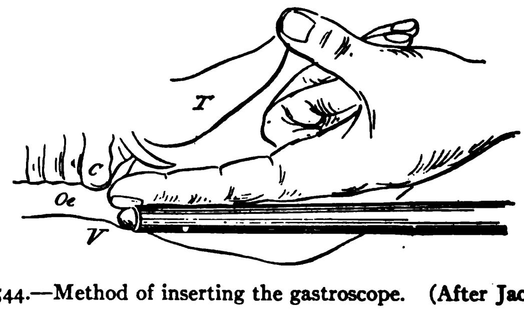


FIG. 544.—Method of inserting the gastroscope. (After Jackson.)

is passed, the head of the table be raised a distance of about 12 inches (30 cm.).

Anesthesia.—General narcosis with ether is employed. Unless the patient is deeply anesthetized, retching will take place, which

ll not only interfere with the examination, but may make the pro-
dure a dangerous one.

Technic.—1. *Direct View Gastroscopy.*—The mouth gag is in-
ted and the operator introduces the left forefinger into the patient's
uth to the base of the tongue or behind the epiglottis and draws
tongue downward. The gastroscope, well lubricated, and held in
operator's right hand, is then introduced, following the fore-
ger, already in the patient's mouth, as a guide (Fig. 544). At
s stage the assistant who controls the patient's head should bend
patient's neck well backward so as to bring the mouth and
phagus in as straight a line as possible. As soon as the instru-
nt has been passed beyond the entrance of the esophagus, the
urator is withdrawn and the light is turned on. The instrument

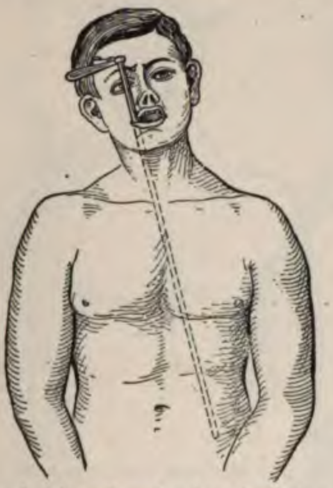


FIG. 545.—Showing the head and neck of patient drawn to the right to allow instrument to pass through the hiatus and abdominal esophagus. (After Jackson.)

passed the rest of the way entirely by sight, care being taken to
oid compressing the trachea by the point of the instrument. To
ss the hiatus at the diaphragm, the instrument is rotated in such a
y that the long axis of a cross section of the tube corresponds to
at of the hiatus (this extends from behind and the right to the front
d the left). To pass the abdominal esophagus as it bends to the
t, the head and neck of the patient are turned to the right (Fig.
5). When the tube has entered the stomach, the interior of the
gan should be systematically explored according to the technic
scribed by Jackson,[1] which the writer takes the liberty of quoting:

[1]Jackson. Tracheo-bronchoscopy, Esophagoscopy, and Gastroscopy, page 149.

"There are two plans of exploration, both of which should be carried out. First, the gastroscope should be passed down carefully and gently to the greater curvature, inspecting the anterior and posterior walls. At times these walls do not seem to be fully collapsed ahead of the tube, and one will have to be examined first, then the other. Then the tube is withdrawn, inclined slightly laterally in the same plane, then pushed gently downward again in a new series of folds. This is repeated until the extreme pyloric limit is reached. To reach this limit the head and neck of the patient are moved to the left, with the tube below the cardia (Fig. 546).

"After the whole possible range has been covered in this way we proceed to the second plan. The tube is passed down until the

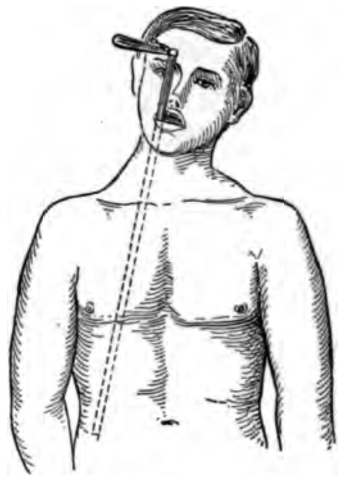


FIG. 546.—Showing the patient's head and neck turned to the left to allow the instrument to reach the pyloric end. (After Jackson.)

extremity touches the wall of the greater curvature, in the extreme left of the possible field. Then the tube is moved slowly along the greater curvature, but not in too close contact therewith, until the extreme right is reached. Withdrawing the tube a centimeter or two, the field is slowly swept again in the same plane, but at a higher level, and so on, upward to the cardia. Next the left fingers of one skilled in abdominal palpation are called upon to manipulate the unexplored portions over the front of the tube. This is sometimes better accomplished by turning the patient on his side, first on one side, then on the other. During all these manipulations the tube must be withdrawn within the esophagus; when the stomach is in its new position, the gastroscope is again pushed downward and the available surfaces are explored. Should retching supervene the tube is in the esophagus, no harm will result, but when the s in the stomach retching is the signal for immediate with-l of the gastroscope until the distal end of the tube is above the ragm.

The vertical diameter of the stomach is easily determined by rement. The depth from the teeth to the cardia is taken, then

Fig. 547.

Fig. 548.

. 547.—The passage of the outer tube of the Hill-Herschell esophagogastroscope the esophagus under direct vision. (Mayo Robson in Keen's Surgery.)

. 548.—Method of performing indirect view gastroscopy with the Hill-Her-strument. (Mayo Robson in Keen's Surgery.)

stroscope is passed on down until the greater curvature is ntered, and the distance from the teeth is again taken. The nce between this and the first measurement gives the vertical ter of the stomach at this point. Care must be used that the rements are not rendered inaccurate by pushing the greater ure downward, which is exceedingly easy to do without know-ing it if the sense of touch is relied upon to determine when the lower wall is reached. If the downward progress of the gastroscope is watched through the upper orifice it is easy to see when the wall at the greater curvature is touched. Having taken our measurements, we then place the obturator externally parallel to the tube within and indicate to the abdominal manipulator the exact position of the lower end of the tube, which he can then mark on the skin, giving thus with absolute accuracy the exact location of the greater curvature of the empty stomach at that point. Care must be taken, of course, to resterilize the obturator should it touch anything unclean."

2. *Combined Direct and Indirect View Gastroscopy.*—The outer direct view tube is passed into the stomach under the sight of the operator (Fig. 547) in the manner previously described for the passage of Jackson's gastroscope (page 543). With the tube in the stomach the cardiac region may be examined by direct vision under inflation. The optical window and the hand lamp are then removed, a handle taking the place of the lamp and the perforated cap the place of the glass window. The indirect view tube is now passed through the perforated cap and outer tube, being careful to begin the inflation before it enters the stomach so that the window of the periscope will not be soiled from contact with the mucous membrane. The pylorus is first located (Fig. 548) and from this as a starting point the remainder of the stomach is inspected in detail, slowly withdrawing and turning the gastroscope so that all portions are brought to view. The region of the cardia, however, can only be inspected by direct view.

SKIAGRAPHY

The X-ray is useful in locating foreign bodies impermeable to the rays and in determining the size, position, and peristaltic movements of the organ. By inserting a long soft stomach-tube, which is filled with bismuth or shot, in the stomach along the greater curvature and then taking an X-ray while the patient is in the erect position, the outline of the stomach and position of the pylorus have been mapped out. Another method of determining the size and position of the stomach is to have the patient swallow keratin-coated capsules of bismuth or to give the patient on an *empty stomach* a pint (500 c.c.) of milk, kumiss, mucilage of acacia, or gruel into which two ounces (60 gm.) of bismuth subcarbonate or the oxychlorid of bismuth is suspended by a thorough mixing. These may be administered shortly before the skiagraph is taken. Pictures should be taken with patient recumbent and in the erect posture. A normal stomach should show an absence of bismuth in from three to six hours after the ingestion of the bismuth meal.

EXPLORATORY LAPAROTOMY

An exploratory laparotomy is the most valuable of all the methods of diagnosis in diseases of the stomach, and in many cases it is the only method by which a correct diagnosis can be arrived at. It is an operation that only requires a small incision and which, if properly carried out, is without danger to the patient. The ease and slight risk with which it may be performed are, however, apt to lead to neglect of other simpler methods of diagnosis and result in its employment in far too radical a manner. It is only justifiable where a careful trial of other means has failed to establish a diagnosis. Thus, for example, in cases where a cancerous growth is strongly suspected but its presence cannot be verified, or where a palpable tumor of the stomach is present, and there is a question as to its character and whether it can be removed or not, an exploratory incision is certainly a justifiable procedure and its prompt performance is clearly indicated, since an early recognition of the trouble furnishes the only hope of cure. The surgeon must be convinced, however, that he can accomplish something for the relief of the patient before it is attempted, and he must be prepared to carry out any operative procedure that seems indicated. To perform an exploratory laparotomy simply for the purpose of making a correct diagnosis in an individual who is manifestly not fit for a severe operation or upon whom it is evident that the performance of a gastroenterostomy would give scarcely any hope for relief of his symptoms is unjustifiable.

Therapeutic Measures

LAVAGE OF THE STOMACH

Lavage consists in washing out the stomach by introducing water or other fluids through a stomach-tube or catheter and then siphoning it off. It is a most useful therapeutic procedure and, if performed with proper precautions, is without danger.

Indications.—Gastric lavage may be required for the following purposes: (1) To remove poison and drugs from the stomach. (2) To remove mucus, undigested and fermenting food from a dilated or atonic stomach when the stomach is unable to empty itself of its contents after eight or ten hours In such conditions lavage is especially valuable, as it cleanses the mucous membrane in preparation for fresh food and thus promotes the appetite; at the same time the stomach is toned and strengthened. (3) To withdraw the irritating material from the stomach in acute gastric indigestion, especially in infants. (4) For the purpose of cleansing the stomach in preparation for gastric operations. (5) In intestinal obstruction and peritonitis with fecal vomiting for the purpose of diminishing the vomiting and at the same time removing toxic material from the digestive tract; and as a preliminary to operation in such cases where it is important to have the stomach empty to avoid the danger of vomited matter entering the air-passages. (6) Finally, lavage may be employed when it is desired to bring medicated solutions in contact with the gastric mucous membrane, though a more efficacious method is by means of the stomach douche.

The contraindications to lavage are practically the same as those given against the use of the stomach-tube for diagnostic purposes, viz., in the presence of recent gastric hemorrhage, in acute inflammation of the stomach, in aortic aneurysm, in advanced uncompensated valvular heart lesions, etc. In cases of marked general arteriosclerosis and in general weakness or prostration it should be used with caution.

Apparatus.—The employment of a stomach-pump is not advisable on account of the danger of injuring the mucous lining of the stomach; instead, an ordinary siphonage apparatus should be employed. This consists of a soft-rubber stomach-tube joined by means of 3 to 4 inches (7.5 to 10 cm.) of glass tubing to a piece of rubber tubing 2 to 3 feet (60 to 90 cm.) long, to the free end of which a glass funnel having a capacity of about a pint (500 c.c.) is fitted (see Fig. 531). The stomach-tube should be about 30 inches (75 c.c.) long, 1/4 to 1/2 an inch (6 to 12 mm.) in diameter, and should be provided preferably with a closed tip and with two lateral openings of fairly large size so as to give passage to solid particles of food (Fig. 549). These openings should be situated as close to the tip as possible. The tube should also have a mark indicating the distance from the upper incisor teeth to the stomach, so that the operator may know when he has passed it a sufficient distance.

For an infant the following apparatus may be employed: A soft-rubber catheter, 16 American (24 French) in size, provided with a large lateral eye and joined by a glass connection to 2 feet (60 cm.) -

:ubing, to the free end of which an 8-ounce (250 c.c.) is attached. In addition, a mouth gag may be required.
—The whole apparatus should be sterilized by boiling or on in an antiseptic solution and then rinsed in water be- After use it should be thoroughly cleansed, care being : that particles of food are not left adher- interior of the tube, especially about the lows.

FIG. 549.—Enlarged view of the tip of a stomach-tube with a closed end and lateral fenestræ.

s **Employed.**—For cleansing purposes warm water is generally employed. To mach of mucus, alkaline mineral waters, or Vichy, or Carlsbad salt, 1 dr. (4 gm.) (1000 c.c.) of water, or sodium bicarbo- ; per cent.), may be employed.

ature.—The solution should be of a tem- from 90° to 100° F. (32° to 38° C.).

r.—The stomach should not be overdis- 1 solution, about a pint (500 c.c.) being at a time. The washing-out process is nued, however, until the contents of the turn clear, provided the patient's con- iits it. In some cases the process must l ten or twelve times before this is at-

or Lavage.—When employed to remove ood from a dilated stomach, lavage may ed either in the morning before the first night, three or four hours after the last former time is preferable, as the stomach en all possible opportunity for assimila- contents and no nourishment is with- some cases, however, when the distress he flatulency is such as to interfere with the night's rest, age is indicated. In very severe cases it may be neces- h out the stomach twice a day, night and morning.

of Patient.—The patient sits in a chair facing the opera- e head slightly bent forward. If the patient's condition : this is not advisable, the operation may be performed tient semiupright in bed. A child should be supported position upon the lap of a nurse with its head held forward by an assistant so as to allow saliva and vomitus to escape from the mouth.

Anesthesia.—In case gagging is excessive, the pharynx may be sprayed or painted with a 5 per cent. solution of cocain. This is rarely necessary, however, after the first passage of the tube.

Technic.—Plates or artificial teeth should be removed from the patient's mouth and an apron or large towel should be fastened about the neck and allowed to hang over the chest and lap for protection. The patient should be given a small bowl to catch any vomitus

FIG. 550.—Showing the method of washing out the stomach. (After Boston.)

or saliva that may escape from the mouth. The tube is then well moistened with water to facilitate its passage. Oily lubricants should be avoided on account of the disagreeable taste. As a rule, with a soft tube it is unnecessary to hold the base of the tongue forward or to guide the tube in place by the fingers. The tube is simply passed along the roof of the patient's mouth until the pharynx is reached, when the patient is instructed to swallow and the instrument, grasped by the pharyngeal muscles, is carried on into the esophagus (see Fig. 535). At first there may be some irritation and gagging, but by having the patient breathe in deeply and regularly this rapidly subsides. When a patient becomes accustomed to the passage of the tube there is very little if any discomfort produced.

As soon as the tube enters the esophagus it is rapidly pushed on into the stomach. Frequently when the tube enters the stomach the contents immediately escape into the funnel; if not, the funnel should be lowered and the contents drained off. To accomplish this

FIG. 551.—Showing the passage of a stomach-tube through the nose in performing gastric lavage upon infants.

it may be necessary, however, to apply some slight pressure over the epigastrium, after the method employed in expressing a test-meal (see page 532).

Having removed the contents of the stomach, or being sure that it is empty, the tube is pinched close to the patient's mouth, and the funnel is elevated slightly and filled with about a pint (500 c.c.) of solution (Fig. 550). The compression is then removed from the tube and almost the entire contents of the funnel is allowed to slowly run into the stomach, enough solution being kept in the funnel, however, to start the siphonage. The funnel is then lowered and the contents of the stomach are siphoned back into the funnel and discarded, care being taken to see that approximately the same quantity returns as was introduced. The process of lavage is continued by alternately pouring solution into the stomach through the funnel and then removing the solution by siphonage. In order to reach all portions of the stomach and more thoroughly cleanse the mucous membrane, it is well to have the patient's position changed during the lavage; for example, after one or more washings in the upright position have the patient lie down and then roll first to one side and then to the other.

At the completion of the lavage the tube is removed as follows: A small quantity of fluid is allowed to remain in the funnel and, as the tube is slowly withdrawn, this is permitted to flow back into the stomach until the end of the tube is in the esophagus. The tube is then tightly pinched to prevent the solution from escaping as the tube is withdrawn over the larynx and through the mouth. The important point is that the tube should not be removed from the stomach empty, as portions of mucous membrane may be drawn into the fenestræ of the tube and be lacerated or otherwise injured.

Variation in Technic.—In insane individuals or unruly children who try to prevent the passage of the tube by refusing to open the mouth or by bitting the instrument, the tube may be passed through a nostril (Fig. 551). As a rule, this method of introduction is not difficult, as the tube hugs the posterior wall of the pharynx and readily enters the esophagus. A smaller-size tube, however, is required, and care should be taken to see that it is well lubricated.

THE STOMACH DOUCHE

Gastric douching consists in irrigating the stomach by means of solutions introduced under pressure. The fluid is preferably introduced through a tube provided with many small lateral openings, so that all portions of the mucous lining of the stomach are irrigated by the solution which flows out in fine streams with considerable force. Either plain water or medicated solutions are employed in the douche.

The stomach douche is useful in slight degrees of motor insufficiency for the purpose of stimulating peristalsis and secretion. It is also employed in neuroses affecting the sensory apparatus of the stomach.

Apparatus.—A glass funnel with a capacity of 1 pint (500 c.c.), a piece of rubber tubing 2 to 3 feet (60 to 90 cm.) long, a glass cong tube 3 to 4 inches (7.5 to 10 cm.) long, and a stomach-tube 30 inches (75 cm.) long, with a large number of side openings 1/12 inch (1 to 2 mm.) in diameter and a terminal opening 1/6 inch (3 to 4 mm.) in diameter, should be provided (Fig. The large opening in the end of the tube is necessary in to drain the solution quickly out of the stomach and at the ime remove any solid particles.

nhorn has devised a douche apparatus which consists of a tube 26 inches (65 cm.) long and 3/8 inch (9 mm.) in diameter,

52.—An enlarged view of a stomach-douche tube.

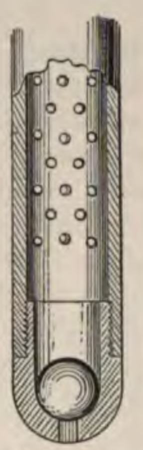


FIG. 553.—Einhorn's apparatus for giving a stomach douche.

nating at the stomach end in a hard-rubber cap with numerous penings and a large end opening (Fig. 553). Within the tip of ap lies a freely movable aluminum ball which is prevented by rossbars from entering the main portion of the tube. This ball ver the terminal opening as the solution flows into the stomach auses the fluid to flow out through the small openings. When rrent is reversed, the ball is driven upward and the solution is d off through the large opening.

Asepsis.—The apparatus should be boiled or immersed in an antiseptic solution and then rinsed off before use, and should be thoroughly cleansed after use.

Solutions.—Plain boiled water is usually employed. For the removal of mucus, alkaline solutions, as sodium bicarbonate (1 to 5 per cent.), Carlsbad salt 1 dr. (4 gm.) to 1 quart (1000 c.c.) of water, etc., are used. As antiseptics and antifermentatives are the following: salicylic acid (0.3 per cent.), sodium salicylate (0.5 to 1 per cent.), boric acid (2 to 3 per cent.), sodium benzoate (1 to 3 per cent.), resorcin (1 to 3 per cent.), creolin (0.5 per cent.), lysol (0.2 to 0.5 per cent.), etc. A solution of silver nitrate in the strength of 0.1 to 0.2 per cent. is sometimes employed as an astringent to diminish sensation and salt solution (0.4 per cent.) to increase gastric secretion. Chloroform water has been recommended as an anodyne in gastralgia.

Temperature.—As a general rule, the solution should be employed warm—at a temperature of 90° to 100° F. (32° to 38° C.). Occasionally, however, the alternate use of a warm and a cold douche is found beneficial.

Time for Douching.—The douche should be employed only when the stomach is empty. The most effective time for its use is early in the morning or three or four hours after the first meal.

Amount of Pressure.—To be most effective the solution should be introduced under considerable pressure. The funnel end is consequently raised 3 feet (90 cm.) or more, as the solution is flowing.

Position of the Patient.—The douching may be performed with the patient sitting upright in a chair or in bed, but in order to bring the solution into contact with all portions of the organ this position may be altered from time to time with advantage; that is, changing from the upright to the recumbent and first upon one side and then upon the other.

Anesthesia.—In the presence of excessive irritation or gagging the pharynx may be sprayed with a 5 per cent. solution of cocain as a preliminary to the passage of the tube.

Technic.—The patient is given a small bowl to receive any vomited matter or an excessive flow of saliva and his chest and lap are protected by an apron. The tube is then moistened with warm water and is inserted into the patient's mouth, being kept in close contact with the roof of the mouth until the pharynx is reached. From this point on the tube is advanced partly by the action of the pharyngeal muscles as the patient swallows, aided by the operator who gently pushes it onward. The tube is inserted only a sufficient distance to bring the perforated tip within the cardia (Fig. 554), which is determined by a mark placed upon the tube for that purpose. The funnel end is then raised and a pint (500 c.c.) of solution is poured into the funnel, the tube being pinched until the funnel is filled; the solution is then allowed to flow into the stomach, the funnel end being elevated high enough to obtain the necessary pressure.

To remove the solution, the tube is pinched while there is still some liquid in it and is inserted some 4 to 6 inches (10 to 15 cm.) further into the stomach, so that its end will lie in the fluid contents. The funnel end is then lowered, the compression of the tube released, and the fluid withdrawn by siphonage.

The stomach should first be thoroughly washed out in the above manner with lukewarm water, using several pints for the purpose.

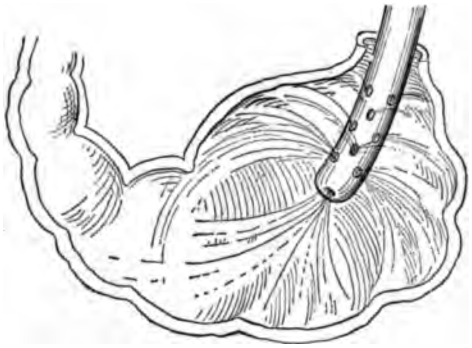


FIG. 554.—Showing the mechanism of the stomach douche. (After Gumprecht.)

The medicated solution is then introduced in the same manner, but should be allowed to remain only from a half minute to a minute. It is then siphoned off, and the stomach is again douched out with warm water. The tube is then removed, care being taken to compress it between the thumb and forefinger to prevent the fluid dripping from it into the larynx as it is withdrawn.

GAVAGE

Gavage consists in introducing food into the stomach by means of the stomach-tube. The tube may be passed through the mouth or through the nose. The latter method may be necessary in the case of infants and when the patient struggles against the passage of the tube and tries to bite the instrument.

This method of feeding may be employed after intubation and tracheotomy, in certain operations about the mouth and throat, in cerebral diseases, when the patient is unconscious, and in acute diseases such as diphtheria, scarlet fever, typhoid fever, etc., when the patient will not take nourishment. It is especially valuable in pharyngeal paralysis when the patient cannot swallow food or liquids. It is a method frequently employed in feeding premature infants, or children suffering from malnutrition, to whom otherwise it would be a difficult matter to give sufficient food.

Apparatus.—The same sort of apparatus as is employed for gastric lavage will be required, viz., a soft stomach-tube 30 inches (75 cm.) long, 2 feet (60 cm.) of rubber tubing joined to the stomach-tube by a

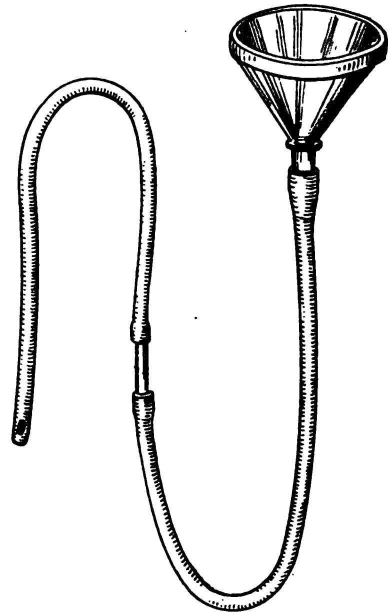


FIG. 555.—Apparatus for nasal gavage.

glass connecting tube 3 or 4 inches (7.5 to 10 cm.) long, and a glass funnel with a capacity of about 1 pint (500 c.c.) (see Fig. 531). If it is intended to employ the apparatus for nasal feeding, a tube of smaller caliber than that ordinarily used will be required. For young children a No. 10 American (16 French) catheter should take the place of the stomach-tube (Fig. 555).

Asepsis.—Strict asepsis should be observed in the care of the apparatus. Before use, it should be boiled or immersed in an antiseptic solution followed by a thorough rinsing off with water, and after use it should be thoroughly cleansed. In contagious cases, as diphtheria, for example, the apparatus should always be boiled.

FIG. 556.—Gavage. First step, introduction of the tube.

FIG. 557.—Gavage. Second step, administering the food.

The Food.—The material employed for feeding will, of course, vary according to the indications in the individual case. When the digestive power of the stomach is impaired predigested food should be employed. The intervals between the feedings of a child should be somewhat increased when gavage is employed.

Position of Patient.—The child should be held flat on its back across the nurse's knees with the head slightly elevated. Its arms

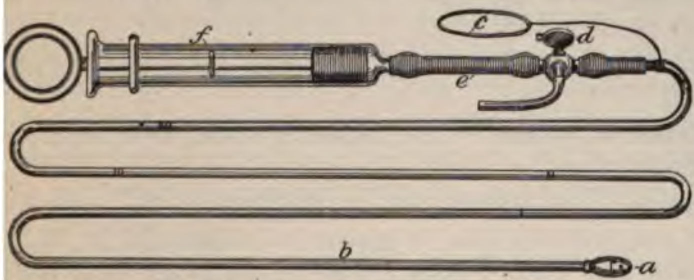
Fig. 558.—Gavage. Third step, showing the tube being compressed as it is removed to prevent leakage.

and legs may be confined by wrapping it in a sheet from the chin to the knees.

Technic.—The tube or catheter is moistened in warm water and is passed into the mouth to the base of the tongue and then gently down the esophagus to the desired depth (Fig. 556). In an infant at birth the distance from the alveolus to the cardia is 6¾ inches (18 cm.); at two years it is 9 inches (23 cm.); at ten years it is 11 inches (28 cm.), and in an adult it is about 16 inches (40 cm.). After the tube has been inserted to the proper depth, the funnel is elevated and quired amount of food introduced (Fig. 557). The tube is then y withdrawn, pinching it the while, so as to prevent any drip- of food into the pharynx and larynx (Fig. 558). The patient l be kept quietly in the recumbent position for some time after troduction of the food. In cases complicated by gastroenteri- c., a preliminary lavage of the stomach with warm water, just giving the food, is often advisable. It removes mucus and any emnants of a previous feeding, cleanses the mucous membrane, the same time stimulates it to a better absorption of the freshly uced food.

DUODENAL FEEDING

odenal feeding consists in the administration of food through a tube introduced into the duodenum through the stomach.



559.—Einhorn's duodenal pump. *a*, Metal capsule, lower half provided merous holes, the upper half communicating with tube *b*; I, II, III, marks of II = 56, III = 70 cm. from capsule; *c*, rubber band with silk attached to end of which can be placed over the ear of the patient; *d*, three-way stop-cock; *e*, col- connecting tube; *f*, aspirating syringe. (Kemp.)

ethod of feeding is sometimes employed in conditions where it red to keep the stomach empty and at rest, as in gastric and al ulcer and gastric dilatation not due to organic obstruction. also been employed in cases where difficulty is found in admin- g the proper amount of nourishment, as in nervous vomiting, miting of pregnancy, and in infants who do not retain the food by gavage.

paratus.—A number of duodenal tubes have been devised that used for feeding purposes. That of Einhorn consists of a French tube to the distal end of which is attached an elongated ated brass capsule weighing 48 grs. (3 gm.). The exterior of be has markings at 40 cm. (16 ins.), 56 cm. (22 ins.), 70 cm. .), and 80 cm. (32 ins.) from the distal end to indicate the po- of the capsule after it has been swallowed. A three-way stop- nd a glass syringe complete the outfit (Fig. 559).

Palefski has modified Einhorn's tube by employing a heavier (105 grs. (6.5 gm.)) and shorter perforated gold plated lead ball, which it is claimed will pass into the duodenum more rapidly.

For infants Hess has discarded the lead ball and employs a No. 14 to 15 French soft Nélaton catheter with a large eye. The exterior of the catheter has markings at 20 cm. (8 ins.), 25 cm. (10 ins.), and 30 cm. (12 ins.) from the eye.

Preparation of the Food.—Milk and eggs are the foods used. Where the patient cannot tolerate milk, barley water is substituted. Einhorn gives the following mixture: milk 7 to 8 ozs. (200 to 250 c.c.), one egg, and a tablespoonful of lactose. If the latter produces diarrhea, it is omitted. The egg is beaten in the milk and the mixture is strained before it is administered.

Temperature of the Food.—The food should be given at a temperature of 100 F. (38 C.).

Frequency of Feedings.—Eight feedings are given a day at 2-hour intervals.

Position of Patient.—The patient is seated in a chair with the head thrown back.

Technic.—The operator places the bulb in the patient's open mouth and instructs him to swallow it. When the 40 cm. (16 in.) mark is at the patient's teeth, the metal ball should be at the cardia, and at this stage of the operation the patient is given a glass of water to drink and is instructed to lie down on his right side to favor by gravity the passage of the ball toward the pylorus. The tube is then slowly pushed onward, and when the 56 cm. (22 ins.) mark is at the teeth the bulb should be at the pylorus. From this point the tube is left to work its way into the duodenum, which is indicated when the 70 cm. (28 in.) mark is at the teeth. From time to time test aspirations are made to determine more certainly the position of the tube, that is, whether it is in the stomach or duodenum. If in the stomach, secretion will be obtained and will be of an acid reaction while from the duodenum but little secretion can be withdrawn and it will be neutral or alkaline in reaction. In a normal case it requires from 2 to 3 hours for the ball to pass through the pylorus and a considerable longer time in the presence of pyloric spasm, gastroptosis, or gastrectasis.

With the bulb in the duodenum, the food, properly heated and strained, is drawn into the syringe and is then slowly injected. After each feeding a small quantity of fluid is forced through the tube and then some air, in order to cleanse the tube and bulb and prevent them from becoming clogged. The tube is left in place during the course of treatment, being fastened to the patient's ear, and, if it does not produce an annoying irritation of the pharynx, it may be left in place from 10 to 12 days. During the time the tube is worn, the patient's teeth and mouth should be frequently cleansed with a mouth wash.

MASSAGE OF THE STOMACH

Massage systematically and properly performed is a valuable therapeutic procedure in certain diseases of the stomach. It is applied to this organ with the same object in view as when used upon other muscular organs; that is, to strengthen weak and atonic muscular walls with imparied contractile power. Massage also aids in the propulsion of the stomach contents into the intestine. It is thus employed with success, chiefly in cases of simple atony and of atonic dilatation, and to a lesser degree in dilatation, due to pyloric stenosis. Massage is advised by some in gastroptosis for the purpose of strengthening the relaxed ligamentous supports. Finally, it is supposed to stimulate the normal secretions of the stomach, and is recommended by some authorities in cases with impaired gastric secretion and in nervous dyspepsia.

Before recommending massage an exact diagnosis is essential. Massage is contraindicated in acute inflammation of the stomach, in recent gastric ulcers, in hemorrhage from the stomach, in great distention of the stomach from gas, and in inflammation of the peritoneum. The massage should be performed by one thoroughly familiar with the technic.

Time for Massage.—This will depend upon the purpose of the treatment. When employed simply for the purpose of toning up and strengthening the stomach wall, massage is best performed early in the morning when the stomach is empty. In cases of dilatation, however, the object is to propel the contents of the stomach into the intestines, and the massage is then performed upon a full or partly full stomach. The best time for this, as a rule, is six to seven hours after the principal meal of the day.

Frequency.—The massage, to be of any value, should be performed every day.

Duration.—During the first treatments the manipulations should be of short duration—about two to three minutes at a sitting—and later, as the patient becomes more accustomed to the treatment, the sitting may be extended to periods of five to ten minutes.

Position of the Patient.—The patient lies upon his back with his head slightly raised and the legs flexed so as to relax the abdominal muscles.

Technic.—Stroking movements (effleurage) and kneading (pétrissage) are the manipulations most employed. In performing effleur-

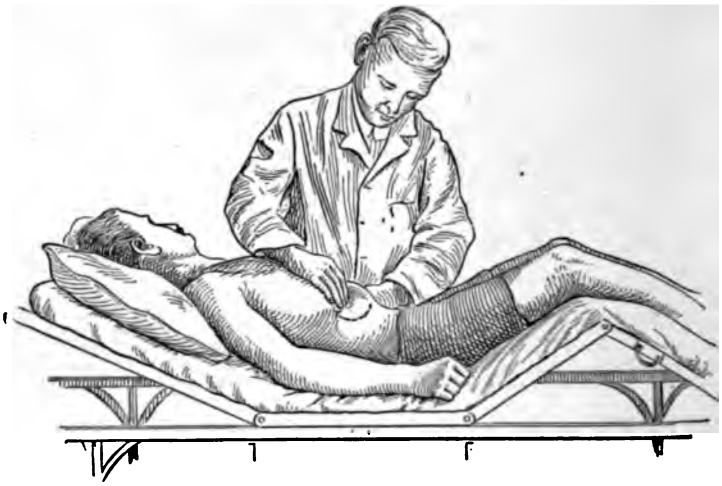


FIG. 560.—Stroking massage applied to the stomach. (After Gant.)

age the operator places his left hand upon the right hypochondriac region for the purpose of counterpressure and with his right hand, the fingers of which are outstretched, he performs stroking movements from the fundus toward the pylorus; *i.e.*, from left to right (Fig. 560).

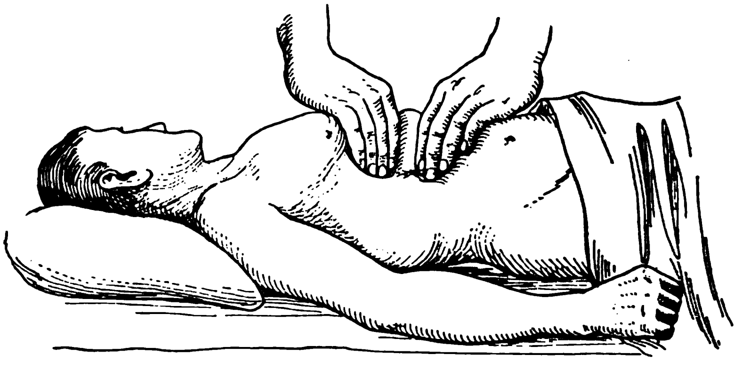


FIG. 561.—Kneading massage applied to the stomach.

Kneading of the stomach may alternate with these stroking movements to advantage. In these manipulations large folds of the abdominal wall, including the stomach, are picked up between the thumb and four fingers of the two hands by deep handgrasps and are eaded by alternately squeezing and relaxing the fingers (Fig. 561). e force used in the various movements of massage will depend upon sensitiveness of the patient, the thickness of the abdominal walls, l the rigidity of the muscles. The manipulations, however, should er produce pain or be disagreeable to the patient.

To accelerate the passage of the stomach contents into the intes-s, the fundus of the stomach and contents are grasped through abdominal walls between the thumb and fingers of the right hand by propulsive movements directed backward an attempt is made hrow the contents of the stomach toward the pylorus.

ELECTROTHERAPY IN DISEASES OF THE STOMACH

Electricity has undoubted beneficial effects upon certain diseases he stomach, although the manner in which the electric current is not well understood, and the experimental evidence of its value oth contradictory and in some cases not in accord with the results ained clinically. It seems probable, however, that electricity eases the motor activity, stimulates the secretion of the gastric e, and increases the absorption power of the stomach. According clinical experience, at any rate, its use is followed by favorable ilts in simple atony, dilatation from atony, hypochlorhydria, vous anorexia, nervous vomiting, paresthesia, hyperesthesia, and tralgias.

Both the faradic and the galvanic currents are employed and they y be used percutaneously or intraventricularly. As to the choice current and the method of its application, authorities again dis-ee. The majority, however, advise the use of the faradic currents en the motor functions are diseased and the galvanic in neuroses d in cases where the secretory apparatus is at fault. The intraven-cular method seems more desirable when the necessary apparatus at hand, as the stomach is thus directly treated. External appli-tion of electricity, on the other hand, is simpler to carry out and is ess disagreeable method for the patient.

Apparatus.—For the percutaneous application there will be quired two curved flat electrodes of about 9 square inches' surface o to 600 sq. cm.) (Fig. 562). For intrastomachic application a ecial gastric electrode, such as Bardet's, Stockton's, or Wegele's, erted within a stomach-tube, may be employed or Einhorn's deglu-le electrode may be used. The latter (Fig. 563) consists of a hard-ber shell, shaped like an egg, with numerous small perforations piercing its surface, and within this capsule is a button of copper or brass. A small rubber tube $\frac{1}{25}$ inch (1 mm.) in diameter carries fine wires leading from the button to the instrument. A curved plate electrode is connected with the other pole of the battery.

FIG. 562.—Large flat sponge electrode.

Duration of Application.—Each treatment should consume about ten minutes.

Frequency.—At first treatments are employed daily; after two or three weeks, twice weekly; and, finally, applications are made at weekly intervals until the treatments are discontinued.

FIG. 563.—Einhorn's deglutible electrode.

Strength of Current.—For galvanism from 15 to 20 ma. are ordinarily used. With the faradic current it is not possible to measure exactly its strength; the current should be sufficient, however, to produce strong and visible contractions of the abdominal wall and back muscles without causing pain.

Position of Patient.—The patient should be in the recumbent ition with the head slightly elevated and the legs flexed so as to x the abdominal muscles.

Technic.—1. *Percutaneous Application.*—The two electrodes are l moistened and the negative pole is placed over the region of the orus, the positive over the spine in the region of the seventh or th dorsal vertebra. The negative electrode may be held station- for short periods or may be moved about over the parts with tion during the treatment. Either the faradic or the galvanic rent may be employed.

2. *Intrastomachic Application.*—The treatment should be given on mpty stomach, preferably one or two hours after a light breakfast. ecessary, the stomach should be emptied by means of a stomach- e. When an electrode, such as Wegele's or Stockton's, is em- yed, it is introduced in the same manner as a stomach-tube. One wo glasses of water are then introduced into the stomach through tube or, if Einhorn's electrode is used, before the electrode is llowed. In introducing this latter the patient should be re- sted to open the mouth widely and the electrode is placed well k in the patient's mouth and the patient is then instructed to llow. If there is any difficulty in accomplishing this, drinking a s of water will be of material assistance.

The gastric electrode is connected with the negative pole of the tery, the positive pole is connected to a plate electrode. This trode is applied for part of the séance over the region of the stom- , held in one place for a few moments at a time. A smaller nge electrode is then substituted and is moved about over the ion of the stomach from left to right for several minutes, and is n shifted to the spine in the region of the seventh or eighth dorsal tebra where it is allowed to remain a minute or more, and finally s applied once more to the epigastrium over which it is gently ved for a minute or so. The current is then gradually decreased d the gastric electrode removed.

CHAPTER XIX

THE COLON AND RECTUM

Anatomic Considerations

The Colon.—The colon is that portion of the alimentary canal lying between the small intestine and the rectum. It is 5 to 6 ft. (150 to 180 cm.) long and in its widest portion, the cecum, measures 3⅛ inches (8 cm.) in diameter. The average capacity of the colon in infants is 1 pint (500 c.c.), at 2 years 2½ pints (1.25 liters), and in adults 9 pints (4.5 liters).

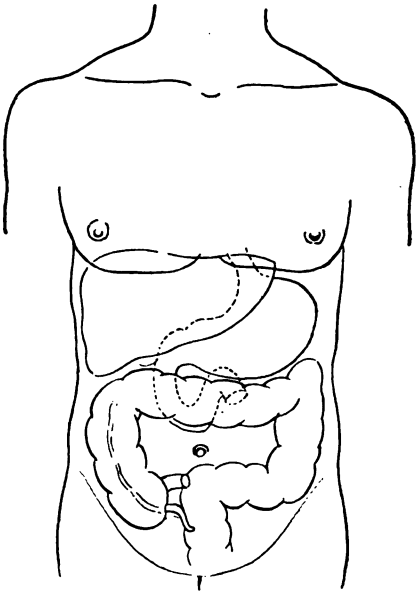


FIG. 564.—The course and position of the colon.

It is divided into the cecum, ascending colon, transverse colon, descending colon, and sigmoid colon.

The cecum, lying in the right iliac fossa below the ileocecal valve, is 3⅛ inches (8 cm.) broad and 2½ inches (6 cm.) long. It is usually completely covered by peritoneum. From its inner and posterior portion is given off the vermiform appendix, a small blind tube with an average length of 3¼ inches (8 cm.). The ileum opens into cum at a point just above the origin of the appendix. Regurgi- of fluids and gases into the small intestine is prevented by the :al valve, a slit-like opening at right angles to the long axis of wel.

e *ascending colon* is 8 inches (20 cm.) long. It extends ver- up the right side of the abdomen from the cecum to the infe- rface of the liver to the right of the gall-bladder, where it turns left as the hepatic flexure. It passes in front of the posterior inal muscles and the lower pole of the kidney, and is bound to mer by connective tissue. Anteriorly and laterally it is cov- y peritoneum.

e *transverse colon* is about 20 inches (51 cm.) in length. It ex- rom the hepatic flexure across the abdomen below the liver and curvature of the stomach, with a slight downward curve at ter, to the spleen, where it turns downward as the splenic . The transverse colon is the most movable portion of the ut, being fastened to the posterior abdominal wall by a long ery.

descending colon is 8½ inches (21 cm.) long. It extends down t side of the abdomen from the splenic flexure to the sigmoid, n front of the left kidney and posterior abdominal muscles. rly and laterally it is covered by peritoneum.

sigmoid colon is the narrowest portion of the large gut. It is 17½ inches (44 cm.) long and extends from the left iliac crest -shaped curve to the third sacral vertebra. In the first por- its course it passes downward almost to Poupart's ligament, rns from the left to the right to enter the pelvic cavity near the e, and passing to the right side, it turns upward as far as the nargin of the right iliac fossa. From this point it makes a turn and passes downward, backward, and inward to become ous with the rectum. The sigmoid is very movable, having lete peritoneal covering and mesosigmoid. At the junction e rectum the gut exhibits a marked narrowing from an increase nuscular fibers, known as the sphincter of O'Beirne.

Rectum.—The rectum commences at the sigmoid flexure, e the third sacral vertebra, and descends in the middle line of rum and coccyx. As it descends it forms a curve with the ity forward until it reaches a point about 1 inch (2.5 cm.) he tip of the coccyx where it turns, forming a sharp angle and continued downward and backward through the thickness of vic floor as the anal canal (Fig. 565). The antero-posterior curves of the rectum are distinct and a knowledge of their direction is important for the proper introduction of the finger or instruments in making an examination. There are also two slight lateral curves, first to the right and then to the left, but of less practical importance.

For purposes of description the rectum may be divided into the rectum proper and the anal canal.

The rectum proper extends from the middle of the third sacral vertebra to the upper border of the internal sphincter muscle, or to about the level of the apex of the prostate gland, and measures 3 to 4 inches (7.5 to 10 cm.) in length. This portion of the rectum is

FIG. 565.—Sagittal section of the rectum.

sacculated in form, exhibiting three pouches or dilatations, of which the lowest and largest, called the ampulla, measures in some cases nearly 10 inches (25 cm.) in circumference. The constrictions between which lie these dilatations are produced by an infolding of the coats of the bowel in the formation of the so-called rectal valves. In the male, the rectum is in relation anteriorly with the recto-vesical pouch, the trigone of the bladder, the seminal vesicles, and the prostate gland, while in the female, the vagina and the recto-vaginal pouch with the small intestine therein contained lie anteriorly.

The anal canal is about 1½ to 2 inches (4 to 5 cm.) long. It extends downward and backward, terminating at the surface of the body as the anus. This portion of the rectum has no peritoneal covering. It is embraced by the internal sphincter muscle and is d by the levatores ani muscles. At the anus the skin is dark color and puckered up into radiating folds. The anal canal tion anteriorly in the male with the bulb and membranous of the urethra; and in the fe- perineal body separates it lower end of the vagina.

rectum is lined with a dark scular mucous membrane, thrown into a series of folds, t important of which are s Houston's valves, or the alves. These are three— es two or four—semilunar projecting like transverse nto the cavity of the bowel is distended. According to l arrangement the inferior ects from the left wall of the t a point about 2 inches (5 cm.) above the anal orifice; the nd most constantly present one projects from the right point situated 3 inches (7.5 cm.) from the anus, while the superior fold projects from the left wall near the third sacral vertebra, or at a point about 1 inch (2.5 cm.) above the middle fold (Fig. 566). These valves are attached to the walls of the rectum for a distance of from ⅓ to ½ its circumference and protrude into its cavity to varying degrees. Their function seems to be to assist the sphincters and to serve to support the fecal mass. They may be the cause of difficulty in making digital examinations and they may act as obstacles to the passage of a rectal tube.

FIG. 566.—The rectal valves as seen through the proctoscope. (After Gant.)

67.—The anal canal, columns and valves i.

In the anal canal the mucous membrane is thrown into a series of longitudinal folds, five to twelve in number, called the columns of Morgagni. They t ½ inch (1 cm.) in length, and are prolonged upward radiating folds about the anus. Stretched between these columns at their inferior ends are semilunar folds of mucous membrane forming pouches that open upward, known as the valves of Morgagni (Fig. 567).

Diagnostic Methods

Assuming that the usual lines of inquiry common to all histories have been followed and it having been ascertained whether there is a past record of syphilis, gonorrhea, dysentery, typhoid fever, appendicitis, peritonitis, pelvic inflammation, gall-stones, etc., which might result in adhesions, ulceration, stricture, or tumor, inquiry is then directed to special symptoms.

In the presence of pain, its location, whether in the abdomen, rectum, pelvis, or neck of the bladder, its character, whether sudden in onset, acute and cutting, or a dull ache; and the time of day it is felt, that is, before or after stools or with every stool, will often furnish a clue as to the cause. Pain in the upper part of the abdomen is suggestive of gastric, duodenal, or gall-bladder affections. Pain in the right iliac fossa may be due to appendicitis or to involvement of the cecum. Pain situated in the central portion of the abdomen is frequently caused by colic from gas, or mechanical obstruction, though not infrequently early in appendicitis the pain is in this locality. Colic is characterized by short, sharp pains coming on suddenly and often shifting in location; furthermore, the passage of gas or feces usually gives relief. Constant or prolonged pain is more apt to signify some organic lesion. Frequently in place of pain patients will complain of more or less discomfort or tenesmus in the anus or rectum. It is a frequent symptom in dysentery and in many other affections of the rectum.

If abdominal distention is complained of, it should be ascertained whether it is general or localized and whether there is any passage of gas from the bowels, and, if so, whether it relieves the condition. A total absence of flatus with obstinate constipation suggests obstructon.

Finally, the habitual state of the bowels should be determined, that is, whether they are normal, constipated, or loose, or whether constipation and diarrhea are alternately present. The examiner should also inquire as to the color, odor, and character of the movements, whether soft or hard, large or small, and whether they contain mucus, pus, or blood. The amount and contour will vary much in health as well as in disease, depending upon the form of food taken, the quantity of water imbibed, etc.

When all possible information has been obtained from a history and general physical examination, a local examination is made to determine more accurately the cause of the symptoms complained of and the proper line of treatment to pursue. Especially is it important to make a systematic examination in the presence of rectal symptoms. On account of the close relation and anatomic proximity of other pelvic organs, as the uterus, tubes, and ovaries in the female and the bladder, urethra, prostate, and seminal vesicles in the male, it is necessary to be able to differentiate between many affections the symptoms of which may reflexly simulate an abnormal condition of the rectum. It is not uncommon for a stricture of the urethra, an enlarged prostate, a stone in the bladder, or a displacement of the uterus, for example, to produce a set of symptoms which point to the rectum as their seat.

The methods available for examination of the colon and rectum include abdominal inspection, palpation, and percussion, auscultation, inflation of the colon, skiagrapy, rectal inspection and palpation, proctoscopy, examination by sounds and bougies, examination by the probe, lavage of the bowel, and examination of the feces.

I. Abdominal Examination

INSPECTION

In a thin individual it is often possible to make a diagnosis of ptosis, tumors, or constrictions of the colon from the appearance and shape of the abdomen. Abdominal inspection is of but very limited use in stout individuals.

Position.—The patient lies with the body symmetrically placed upon a firm flat table with the light falling obliquely from the head toward the foot (see Fig. 523). It is of advantage when examining for ptosis to have the patient also assume the erect positon.

Technic.—The patient's abdomen being fully exposed, inspection is performed from the side and from the foot of the table (see Fig. 523). The examiner notes first the general appearance of the abdomen, whether distended or flat and whether the abdominal walls are well developed and capable of supporting the contents. In enteroptosis the upper part of the abdomen is concave and more or less of a "pot-belly" is evident with a sulcus between the two recti above the umbilicus. This characteristic appearance is accentuated with the patient in the erect position—the abdomen appears more pendulous and the abdominal contents may project like a hernia through the space between the two recti. The examiner then makes more careful inspection for the presence of hernia, visible swelling, or tumor. A tumor may produce sufficient bulging of the part affected to be recognized by inspection. Likewise, if the individual is thin, in the presence of stenosis of the bowel it may be possible to recognize distention of the portion of the bowel proximal to the seat of obstruction and the strong peristaltic waves. Inflation of the bowel (see page 573) is of considerable value in making more prominent a tumor or the seat of an obstruction.

PALPATION

The cecum and parts of the ascending, transverse, descending, and sigmoid colon are accessible for palpation, depending upon the stoutness of the individual. It is thus possible to recognize local tenderness, thickening of the gut, and a tumor, and, in the presence of the latter, its size, mobility, and consistency.

Preparations of the Patient.—When feasible, the patient's bowels should be emptied by a cathartic given the night before.

Position.—The examination is performed with the patient in the dorsal position upon a flat table with the knees flexed and a small pillow beneath the head and shoulders to secure relaxation of the abdominal muscles. Shifting the patient from side to side will often furnish more complete information in the presence of a tumor or other mass.

Technic.—The examiner stations himself by the side of the patient and places his right hand, *well warmed*, flat upon the patient's abdomen, at first performing gentle circular palpation over all parts. Gradually deeper palpation may be employed, but sudden poking of any region should be carefully avoided. In performing deep palpation reinforcing one hand with the other is of great aid. Tender spots, rigidity of the muscles, and the presence of masses should be looked for. Tenderness suggests inflammation or ulceration of the bowel. In eliciting tenderness it is well to watch the patient's face, as this is often a better guide than questions as to his sensations. Rigidity of one or both recti is of diagnostic importance signifying some local peritoneal irritation in the first instance and general peritonitis if both recti are involved. A rigid right rectus is not uncommon, however, in right-sided pneumonia and pleurisy. The sensation a mass gives to the palpating hand is frequently a guide to its character. Thus, a cancerous growth is generally hard to the touch, cannot be indented, and is frequently uneven; a benign growth is generally smooth; a fecal impaction is movable, has a doughy feel, and can be indented with the fingers. In intussusception the mass is smooth and has the characteristic sausage shape. Often more valuable information as to the source and mobility of a mass may be elicited by changing the position of the patient from time to time and by inflation of the bowel (see below).

PERCUSSION

The chief use of percussion is to confirm the results obtained by palpation. The percussion note over the empty colon is tympanitic and of a higher pitch and less volume than over the stomach, and over the small intestine the note is of a still higher pitch and less volume. When the bowel contains fluid or fecal matter or in the presence of a solid tumor the percussion note is flat. Percussion is thus of value in differentiating between the empty intestine and a solid tumor, and, in the presence of the latter, in determining its size and shape. By first inflating the bowel with air or fluid it is possible to trace its course and thus recognize the presence and degree of ptosis. This method is also of value in locating the seat of a stricture of the bowel by the contrast between the percussion note obtained over the inflated portion and that over the empty bowel.

AUSCULTATION

Auscultation is of but little diagnostic importance in diseases of the large bowel. Various splashing, gurgling, and whistling sounds are to be heard normally in the intestines and are due to the movements of gas and fluids. In chronic obstruction of the large bowel gurgling sounds are also to be heard in the region of the obstruction, and, if they are always heard in the same location, they are of considerable diagnostic importance. An entire absence of intestinal sounds would suggest intestinal paresis. By injecting into the bowel small quantities of fluid (about a pint (500 c.c.)) it is possible to map out the course of the bowel by the splashing sounds heard on auscultation. This procedure may be employed to advantage in cases of suspected ptosis.

INFLATION OF THE COLON

This procedure is performed both as a diagnostic and as a therapeutic measure (for the latter see page 616). The bowel may be inflated either by means of air or fluids. For diagnostic purposes, however, air is preferable, as there is thus produced a contrast on percussion between the tympany of the air-distended bowel and the flatness of a tumor. It has the disadvantage, however, that the amount injected cannot be measured as can fluids, and consequently the degree of distention is not so well regulated.

The colon may be distended as far as the cecum, provided there be no obstruction and the inflation be slowly and carefully performed. When thus distended, the bowel is raised from the surrounding parts and is caused to stand out against the abdominal wall so that it may be readily mapped out by palpation and by percussion, and its size, shape, position, and mobility may be determined. It thus becomes possible to locate the seat of a stricture or an obstruction by noting the limits of the distended area—the part below the seat of stenosis becomes prominent, while the portion of the bowel above will be but slightly distended or not at all so, depending upon the degree of occlusion. Under inflation, tumors of the large bowel are made more prominent and it is frequently possible to recognize that a growth is located in or is in connection with the colon by tracing the distended bowel directly into the tumor mass. Finally, inflation is also of great aid in determining the probable seat of other abdominal tumors, the distention of the bowel causes a change in the position of the tumor, displacing it in the direction of the normal position of the organ from which it takes origin, so that tympany is obtained where there was originally dulness; for example, a tumor of the stomach is pushed upward; a tumor of the gall-bladder and liver is pushed upward and forward, a tumor of the pancreas becomes less noticeable; a tumor of the kidney is pushed upward toward the normal position of the kidney and lies behind the distended colon; a tumor of the spleen will lie in front of the colon and the growth will become more readily palpable from being pushed forward, etc., etc.

Apparatus.—The injection of fluids is effected by means of a fountain syringe or a graduated glass irrigating jar as a reservoir, and a rectal tube attached to the reservoir by about 6 feet (180 cm.) of rubber tubing 1/4 to 3/8 inch (6 to 9 mm.) in diameter.

For the injection of air a special inflation apparatus may be employed, but a rectal tube attached to a Davidson syringe, cautery bulb (Fig. 568), hand bellows, or bicycle pump will answer equally well. The pumping apparatus may be dispensed with if oxygen or carbonic gas is used. In the case of the former the rectal tube is simply attached to the oxygen tank (Fig. 569), while, if the latter gas be employed, the tube is attached to a syphon of carbonic, and the latter is inverted so that the gas escapes without the water following.

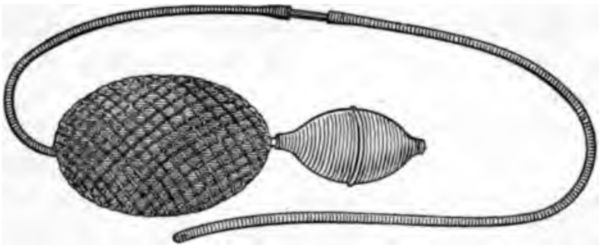


FIG. 568.—Rectal tube and cautery bulb for inflating the colon.

Media for Inflation.—Of fluids, warm normal salt solution (dr. i (4 gm.) of salt to a pint (500 c.c.) of water) is best. Air, oxygen, or carbonic acid gas may be used when gaseous distention is desired.

Amount Injected.—When inflating with gas there is no way to determine accurately the amount of gas injected, and the patient's

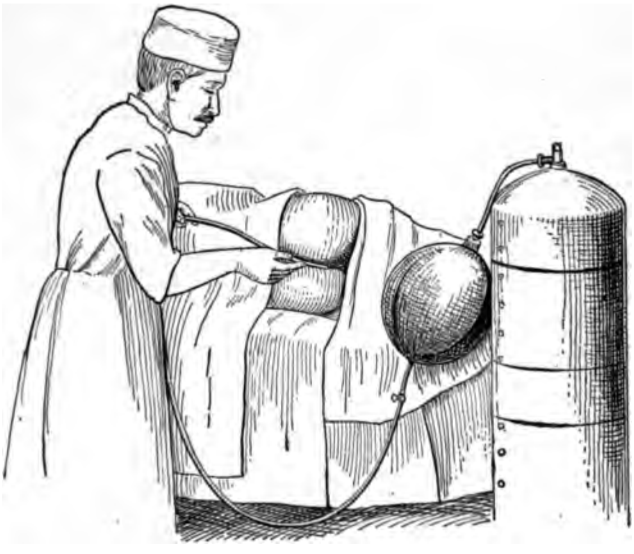


FIG. 569.—Inflation of the colon with oxygen. (After Gant.)

sensations and the degree of distention of the bowel must be the guide. Never inject sufficient to cause pain, and care must be taken not to endanger the gut.

As much as 3 quarts (3 liters) of fluid may be injected with safety.

Rapidity.—Fluid or gas should be injected slowly and steadily; rapid distention of the bowel is to be avoided. From fifteen minutes to half an hour should be consumed in performing the operation. If the reservoir be not elevated above 3 feet (90 cm.), the fluid will not enter the bowel too rapidly.

Position of Patient.—The tube may be inserted with the patient upon his side, but as soon as the inflation is begun the dorsal position should be assumed.

Technic.—If there is an accumulation of fecal matter in the bowels, a simple enema should be given and an evacuation produced before attempting the operation. The rectal tube is then well lubricated with vaselin and is inserted 4 or 5 inches (10 to 12 cm.) within the rectum. If fluid is employed, the reservoir is then elevated between 2 and 3 feet (60 to 90 cm.) and the solution is allowed to distend the bowel slowly, cotton being tightly packed about the anus and the buttocks being held in close apposition to prevent leakage. As the rectum becomes distended there will be some spasm and an almost irresistible desire on the part of the patient to expel the fluid, but if the flow be temporarily stopped, or the reservoir lowered, and time be given for the fluid to pass upward, this feeling soon passes off and the inflation may be then continued. When the colon has been sufficiently distended and the purposes of the examination are accomplished, the fluid is allowed to escape from the bowel through the tube.

The technic of introducing gas is practically identical with the above, great care being taken, however, not to force the gas in too rapidly or in excess, and at the completion of the examination to draw off as much of it as possible, so as to avoid unpleasant distention. Its escape may be aided by inserting two fingers into the rectum and holding the anus open.

SKIAGRAPHY

The X-rays are of value in recognizing the presence of foreign bodies in the intestinal tract, and for determining the position of the colon and the seat of strictures, dilatations, angulations, or adhesions that may be causing obstruction. For recognizing the latter conditions a preliminary rectal injection of a bismuth mixture or the ingestion of a bismuth meal is essential. When the bismuth is given by mouth, its passage may be traced through the intestinal tract by means of repeated X-rays, and valuable information as to the motility of the intestinal contents may be secured.

In preparation for an X-ray examination of the large intestine, the patient is given a purge for two nights before and an enema on the day of the examination to thoroughly empty the colon. Two ounces (60 gms.) of bismuth subcarbonate are mixed with a little starch in 2 quarts (2 liters) of warm water and are injected into the bowel with the patient in the Sims position with the hips elevated, or while in the knee-chest position, and a radiograph is immediately taken; or, the patient may be given by mouth an ounce (30 gms.) of bismuth subcarbonate or oxychlorid in 12 ounces (360 gms.) of milk or koumiss, and the radiograph be taken at the end of 24 hours when all the bismuth should be in the large bowel. A second picture should be taken at the end of 48 hours in order to judge of the motility of the bowel. Exposures should be made with the patient in the recumbent and in the upright posture

II. Internal Examination

Preparation of the Patient.—In order to make a satisfactory examination of the rectum the latter should be emptied of its contents by means of a cathartic given the night before or by an enema administered just before the examination is begun. In some cases, however, more useful information as to the usual condition of the rectum may be obtained by making a preliminary examination of the patient in just the condition he presents himself. The presence of blood, pus, or mucus will thus be revealed, of which there would often be no trace after a cleansing enema. If necessary, an enema may then be given and a more complete examination may be made later. The bladder should likewise be evacuated, and tight clothing, such as bands, belts, or corsets, which tend to force the intestines into the pelvis, should be loosened.

Position of the Patient.—Four positions are employed for rectal examinations, each of which has its own advantages under special conditions. These are: (1) the Sims, (2) the lithotomy, (3) the knee-chest, and (4) the squatting posture.

The *Sims*, or left lateral position, is obtained by placing the patient upon the left side with the left side of the face, the left shoulder, and the left breast resting upon a flat pillow. The left arm lies behind the back and the thighs are well flexed upon the body with the right knee drawn up nearer the body than the left. The buttocks lie near the edge of the table and are elevated upon a hard pillow (Fig. 570). This position will be found most useful for routine examinations, and probably will be found less objectionable to the patient than the lithotomy or knee-chest positions.

The *lithotomy position* is secured by placing the patient flat on the back and flexing the thighs upon the abdomen and the legs upon the

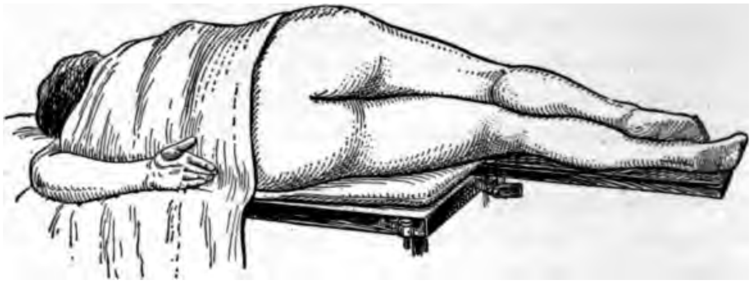


FIG. 570.—The Sims position.

thighs. The buttocks, which are elevated upon a hard flat pillow, project over the end of the table (Fig. 571). In very stout individuals this position will permit of a more satisfactory examination than will the Sims.

The *knee-chest position* is obtained by having the patient kneel upon a table with the thighs at right angles to the legs with the body

FIG. 571.—The lithotomy position.

well flexed upon the thighs, the chest resting upon a pillow plac upon the same level as the knees (Fig. 572). The knee-chest positi favors displacement of the coils of intestine upward, thus allowing t rectum to be distended by the entrance of air upon the insertion of speculum or proctoscope. The mucous membrane of the rectum, which in the dorsal position lies in folds, becomes expanded, and thus a more thorough inspection of all portions of the canal is possible.

The *squatting posture* is only suitable for digital examination. The patient assumes an attitude similar to that taken while at stool. Portions of the rectum may be thus palpated which in the Sims or the dorsal position would be out of reach of the examiner's finger. By a slight straining effort protrusions or moderate degrees of prolapse will be revealed.

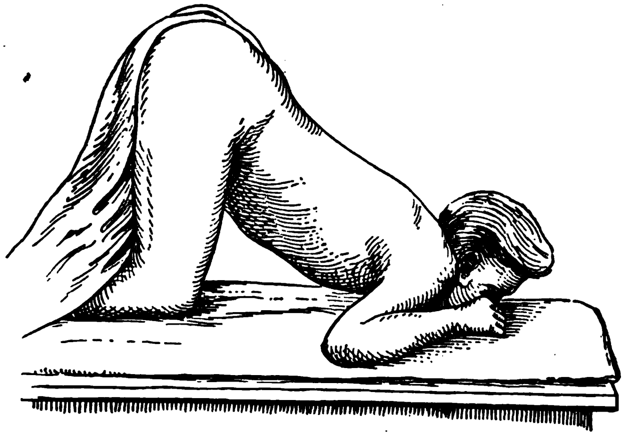


FIG. 572.—The knee-chest position.

INSPECTION

The anus is first inspected. The presence of discharges from the rectum, excoriations, eczema, thickening of the epidermis, scars, ulcerations, fistulous openings, condylomata, the swelling of an abscess, and external hemorrhoids are carefully looked for. Then, by separating the buttocks and placing the thumbs on either side of the anus and drawing it apart while the patient strains slightly, inspection of the anal canal for at least an inch (2.5 cm.) will be possible (Fig. 573). Slight degrees of prolapse, fissures, ulcers, hemorrhoids, and polypi or other growths may be readily demonstrated in this way.

PALPATION

Palpation of the rectum may be performed by means of the finger or by the whole hand. With the index-finger one may examine the anus, the anal canal, and the ampulla of the rectum. The first 4 inches (10 cm.) of the rectum may be thus explored.

Introduction of the whole hand into the rectum, as advocated by Simon, for the purpose of palpation of portions of the canal out of reach of the finger, may be practised if the hand is moderately small. Tuttle states that a hand requiring a kid glove larger than 7¾ should never be introduced into the rectum except in a life or death emergency. Manual palpation is rarely required, being only necessary for examining tumors high up that cannot be inspected by means of a speculum or a proctoscope. In addition, it is a serious procedure, as there is danger of rupture or undue distention of the bowel in careless hands.

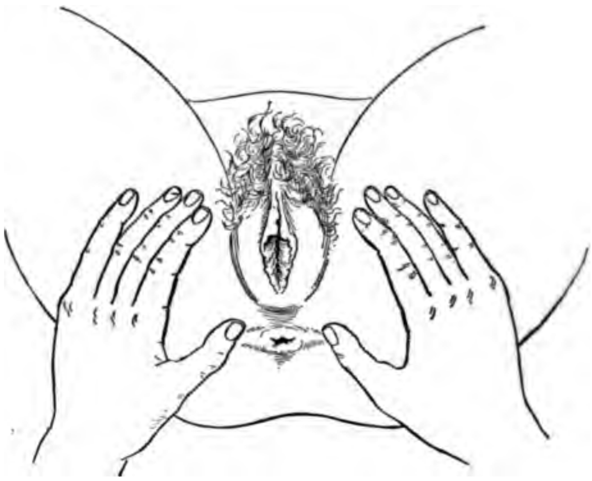


FIG. 573.—Inspection of the anus. (Ashton.)

Anesthesia.—General anesthesia will be required for palpation by the whole hand, as complete dilatation of the rectum is essential.

Technic.—1. *By the Finger.*—No anesthesia will be required. The direction of the rectum, which is at first slightly forward from the anus, then back into the hollow of the sacrum, then to the right, and finally to the left toward the sigmoid flexure, should be kept clearly in mind. The index-finger of the right hand is covered with a rubber finger cot. If, however, it is desired to preserve the tactile sense of the finger, a covering is dispensed with, in which case soap should be forced under the nail. The finger is well lubricated with sterile vaselin or with one of the preparations of Irish moss made for the purpose and is then introduced slowly and with a rotary motion, the patient being requested to strain gently to facilitate its passage through the sphincter. Roughness in inserting the finger or disregard of the natural direction of the canal will be liable to cause spasm of the sphincter and give the patient such pain that a thorough examination will be impossible.

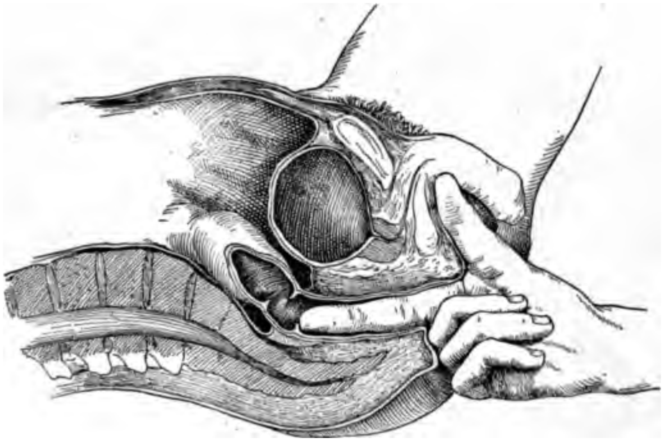


FIG. 574.—Palpation of the rectum. (Gant.)

As the finger passes through the anal canal the condition of the sphincter should be noted, the examiner observing whether it is closed, rigid, and resisting, or loose and patulous. When the internal sphincter has been passed, the finger is swept lightly over the mucous

FIG. 575.—Method of dilating the anus by means of one finger of each hand.

membrane, palpating the rectal wall in all directions. The size and sensitiveness of the rectum is thus ascertained. The examining finger will readily detect the presence of impacted feces, polypi, large hemorrhoids, malignant growths, ulcerations, fissures, and strictures if a systematic examination is made. In the male, enlargement, induration, degrees of sensitiveness, or softness of the prostate should be carefully noted, and likewise information regarding the condition of the seminal vesicles and bladder should be obtained. A vesical calculus may frequently be discovered by such examination. In the female, the uterus, tubes, ovaries, and broad ligaments are carefully examined for displacements or signs of inflammation. Finally, the coccyx should not be overlooked, as this bone may be responsible for considerable rectal disturbance.

If pus, blood, or mucus be present in the bowel there will be an escape of the material from the anus when the finger is withdrawn or the finger will come away coated. In all cases it is important to note

FIG. 576.—Method of dilating the anus by means of two fingers of each hand.

the odor of the examining finger upon its withdrawal. The foul odor of cancer is characteristic and will not be mistaken for anything else once it is recognized.

2. *By the Whole Hand.*—Stretching of the sphincters is commenced by introducing into the anus the two forefingers with the palmar surfaces out, and separating them slowly and gently in all directions, care being taken to avoid injury to the mucous membrane if possible (Fig. 575). As soon as a little dilatation has been secured, two and then three fingers of each hand may be introduced, carrying them to a point well above the internal sphincter. The fingers are then gradually separated until sufficient dilatation is obtained to allow the hand to pass (Fig. 576). The hand is then well lubricated and, with the fingers formed in the shape of a cone, it is gradually introduced past the sphincter muscles until it enters the dilated ampulla. From this point on only two fingers should be used in palpa-

tion, and great care and gentleness are necessary to prevent injury, as the canal gradually narrows down.

EXAMINATION BY THE SPECULUM OR PROCTOSCOPE

By the aid of suitable specula and reflected light, the whole inner surface of the rectum up to the sigmoid flexure may be inspected. The openings of glands and the condition of the valves and any alteration in color or unevenness of the surface of the mucous membrane are noted. Ulcers, polypi, new growths, malignant disease, strictures, the internal openings of fistulous tracts, hemorrhoids, and congestion or inflammation of the rectal mucosa may be distinguished by the experienced examiner.

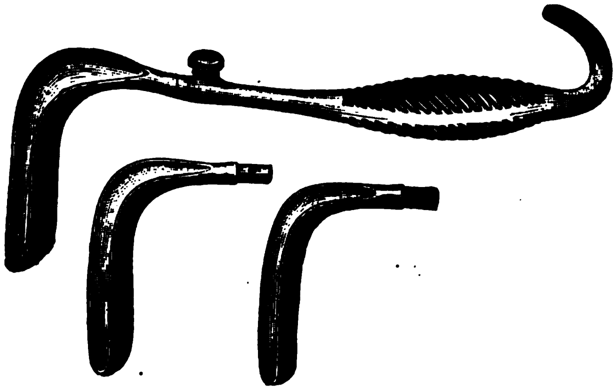


FIG. 577.—The Sims rectal speculum. (Hirst.)

Instruments.—The ordinary rectal specula are made in various shapes and styles, such as the Sims (Fig. 577), the bivalve, the duckbill (Fig. 578), the fenestrated-blade (Fig. 579), the conical, etc. These are all useful instruments for inspection of the lower 4 or 5 inches (10 to 12 cm.) of the bowel, but their usefulness is limited to that region.

For examination of points higher up Kelly has devised tubular specula (Fig. 580) which permit a thorough inspection of the entire rectum and the sigmoid flexure. This set of instruments consists of: (1) a sphincteroscope, (2) a long and (3) a short proctoscope, and (4) a sigmoidoscope. The sphincteroscope is short and slightly conical; the diameter of the lower end of the tube is 1 inch (2.5 cm.) and of the upper end 1⅕ inches (3 cm.). The cylinder of the short proctoscope is 5½ inches (14 cm.) long, and ⅞ inch (22 mm.) in diameter. The long proctoscope is 8 inches (20 cm.) long and of the same diameter as the short proctoscope, and the sigmoidoscope is of like diameter and 14 inches (35 cm.) long. Each speculum consists of a cylindrical metal tube, at the outer end of which is a funnel-shaped rim about 2 inches (5 cm.) in diameter to which a handle is attached. A blunt obturator is provided to facilitate the introduction of the instrument into the bowel. Illumination is secured from an electric light held close to the sacrum, which is reflected by a head mirror into the speculum, or else an electric head light or the direct sunlight may be employed.

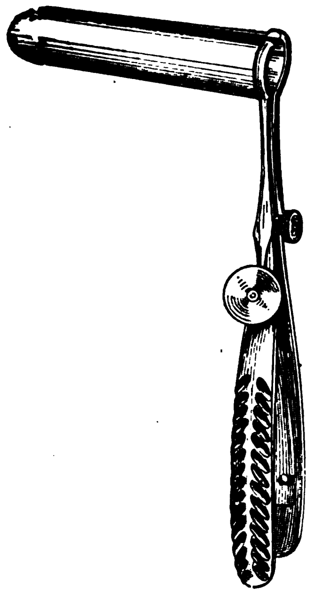


FIG. 578.—Duck-bill rectal speculum.

FIG. 579.—Fenestrated-blade rectal speculum.

Murphy has modified Kelly's instrument in such a way that the specula telescope, the proctoscope fitting into the sphincteroscope, etc. This does away with the necessity of withdrawing and inserting a speculum through the anus each time a smaller size is used. The sphincteroscope is used first, and into this the next smaller size is passed without withdrawing the original instrument, until all have been introduced in succession.

The pneumatic proctoscope, such as Tuttle's modification Law's instrument (Fig. 581), is not dependent upon atmosph pressure as a means of dilatation, this being accomplished by a spec inflation apparatus connected with the instrument. Tuttle's proctoscope consists of a long cylinder, to the circumference of which is fitted a small metallic tube closed at its distal extremity by a flint-

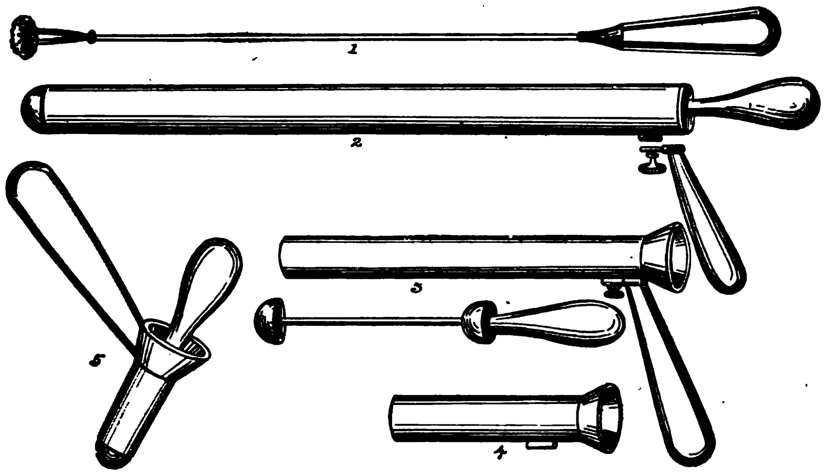


FIG. 580.—Kelly's set of tubular specula. 1, Swab and holder; 2, sigmoidoscope; 3, long proctoscope; 4, short proctoscope; 5, sphincteroscope.

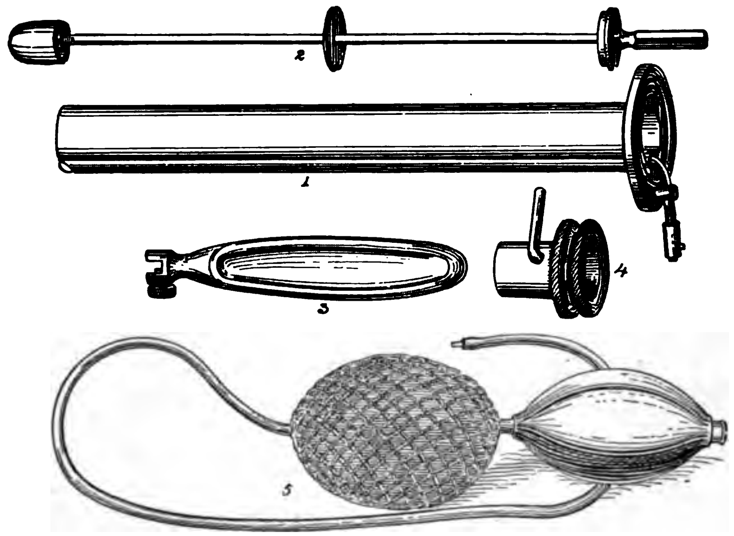


FIG. 581.—Tuttle's pneumatic proctoscope. 1, Proctoscope with obturator removed; 2, obturator; 3, handle; 4, air-tight plug with glass window; 5, inflating apparatus.

glass bulb. An electric light fitted upon a long metallic stem is carried through the small accessory cylinder to the end of the speculum.

An obturator fits into the distal end of the large cylinder to facilitate the introduction of the instrument. In addition, there is an air-tight-fitting plug containing either a plain glass window or a lens focused to the length of the instrument to be inserted in the procto-

FIG. 582.—Method of holding the proctoscope.

scope when the obturator is removed. This plug is in connection with an inflating apparatus. An adjustable handle is supplied with the instrument. These specula vary in length from 4 to 14 inches (10 to 35 cm.). Tuttle recommends a 4- and a 10-inch (10 and 25 cm.) tube for ordinary use. The light is furnished by a four or a six

FIG. 583.—Proctoscopy. First step, method of inserting the instrument.

dry-cell battery. In using the specula and proctoscope long dressing forceps and cotton balls with which to swab out the bowel will be required.

Asepsis.—The specula may be sterilized by boiling or by immersion in a 1 to 20 carbolic acid solution. In case the latter is employed, the instrument should be rinsed off with alcohol or sterile water before use.

Position of the Patient.—The patient should be placed in the knee-chest position, so that the rectum will balloon up upon the entrance of air through the instrument.

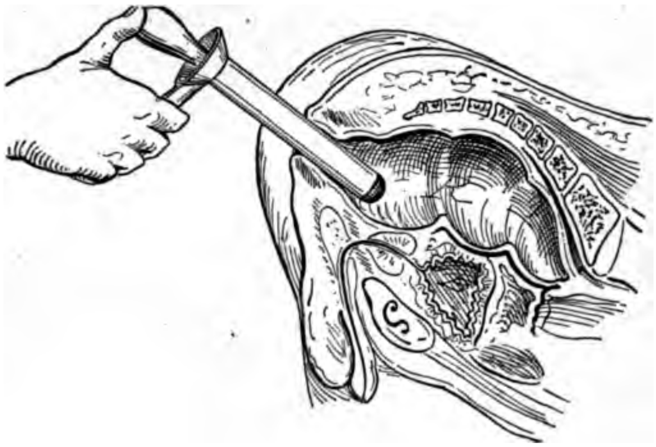


FIG. 584.—Proctoscopy. Second step, showing the direction of the instrument in passing through the anus.

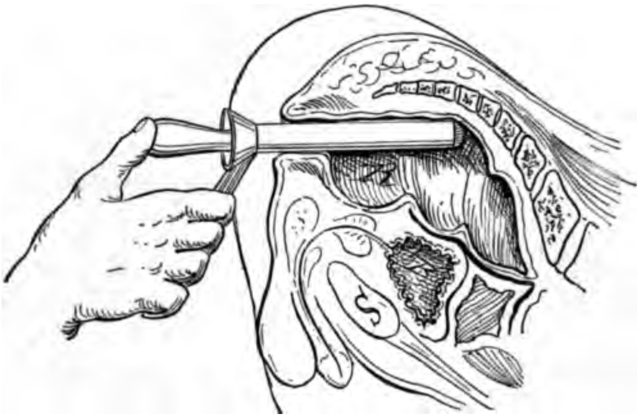


FIG. 585.—Proctoscopy. Third step, showing the direction of the instrument in entering the ampulla.

Anesthesia.—An anesthesia is not required, as a rule, unless the patient is extremely hyperesthetic.

Technic.—1. *With the Kelly Instrument.*—The instrument should always be warmed and lubricated with sterile vaselin before its introduction. In using the sphincteroscope the handle of the instrument is grasped in the right hand with the right thumb pressing against the obturator, as shown in Fig. 582. The buttocks are then drawn apart, and with the end of the obturator held against the canal orifice (Fig. 583), the patient strains slightly and the speculum is slowly pushed into the bowel in a direction downward and forward (Fig. 584) until the funnel-shaped rim prevents its further progress. The obturator is then removed, allowing air to pass in and distend the bowel. The light is reflected into the instrument in such a way as to thoroughly illuminate the interior, and, as the instrument is slowly withdrawn, the whole of the anal canal is carefully inspected.

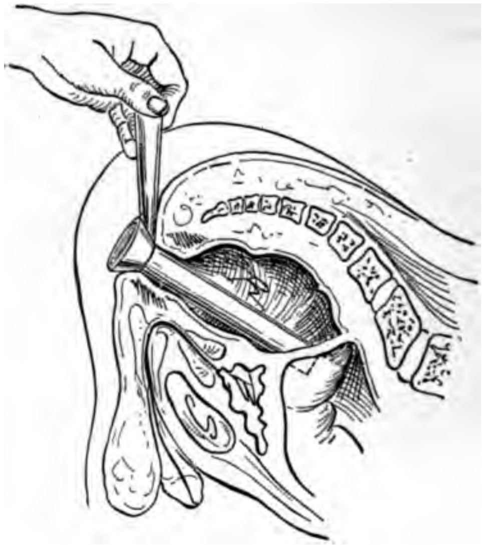


FIG. 586.—Proctoscopy. Fourth step, showing the instrument inserted to its full extent.

The proctoscope is inserted in precisely the same manner, first pushing the instrument in a direction downward and forward (Fig. 584) and then upward toward the sacral hollow (Fig. 585). As soon as the tube enters the ampulla, the obturator should be withdrawn allowing air to enter and expand the bowel. The light is then thrown into the instrument and the ampulla is inspected. From this point the instrument is advanced past the valves entirely *by sight*. Some difficulty may be experienced in following the direction of the canal from a valve or fold of mucous membrane occluding the end of the instrument. In such a case the distal end of the instrument should be gently moved from side to side until the opening of the canal is found. In this manner the whole interior of the rectum may be inspected. As the instrument is withdrawn, the condition and character of the ucous membrane as it falls over the end of the instrument is noted Fig. 587).

587.—Showing the method of performing proctoscopy by the aid of a head mirror and an electric light.

In introducing the sigmoidoscope it is to be remembered that the per portion of the canal gradually turns to the left, hence the point

IG. 588.—Showing the method of inserting Tuttle's instrument with the finger in the rectum and the auxiliary tube pressing against it.

f the instrument is turned in that direction as it slowly ascends the owel.

2. *With Tuttle's Proctoscope.*—The proctoscope, warmed and well lubricated, is introduced in much the same manner as is Kelly's instrument. To avoid causing the patient any discomfort from the presence of the auxiliary tube, however, it is well to insert the index-finger of the left hand into the bowel first and than to introduce the instrument with the end of the auxiliary tube pressed against the finger (Fig. 588), as the tube enters the bowel the finger is withdrawn. When the internal sphincter has been passed, the obturator is withdrawn and the plug containing the glass lens is substituted. This makes the instrument air-tight. Very slight pressure upon the bulb of the inflating apparatus distends and straightens out the canal as the instrument is advanced. Should the lamp become obscured by feces or mucus, the plug is removed from the instrument and, without removing the instrument, the glass is wiped off with a cotton wipe held in long dressing forceps. At the completion of the examination the cap at the end of the tube is withdrawn and the air is allowed to escape from the bowel before the instrument is removed.

EXAMINATION BY SOUNDS AND BOUGIES

The employment of the rectal sound or bougie for the diagnosis of stricture has been superseded to a large extent by the use of the proctoscope. The bougie, furthermore, is not a very reliable instrument, as strictures that do not exist may be imagined to be present from the point of the instrument catching in the folds of mucous membrane or in a diverticulum, or from being arrested by fecal matter, the promontory of the sacrum, a retroverted uterus, or an enlarged prostate. Again, the instrument may bend or curve upon itself.

Instruments.—There are many varieties of sounds and bougies made for diagnostic purposes, but the only instrument that should be employed is a soft-rubber one, the Wales bougie (Fig. 589) being a type. Metal or hard-rubber sounds are dangerous, even in the hands of an expert, unless they are inserted by the aid of a proctoscope, as they may easily be pushed through the rectal wall into the peritoneal cavity, especially if the rectum is weakened by some pathological condition. The Wales bougie is made of soft rubber in different sizes, and in length measures about 12 to 14 inches (30 to 35 cm.). It is perforated by a canal running through its center for the purpose of allowing fluid to be injected into the bowel to aid in its passage. In using this instrument a Davidson syringe should be provided.

Technic.—The bougie, well lubricated, is gently inserted into the bowel until its further progress is impeded by some obstruction. The Davidson syringe is then attached and a stream of warm water or oil is forced through the instrument for the purpose of dislodging any fecal matter or folds of mucous membrane that may be interfering with its passage. In this way the whole length of the bowel may be explored without danger, and the instrument may be passed into the sigmoid provided no stricture exists.

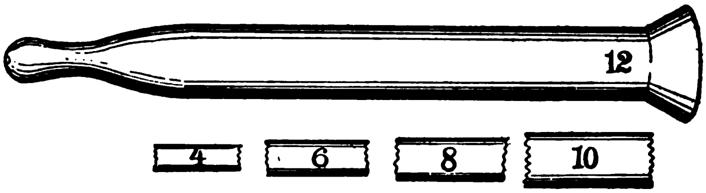


Fig. 589.—Wales' bougies.

EXAMINATION BY THE BOUGIE À BOULE

The rectal bougie à boule is made use of in diagnosis to determine the size and length of a stricture.

Instruments.—The bougie à boule consists of a flexible wire or rubber shaft with a handle to the extremity of which acorn-tips of various sizes may be screwed (Fig. 590). The bougie à boule is used to best advantage in connection with a cylindrical speculum or a proctoscope.

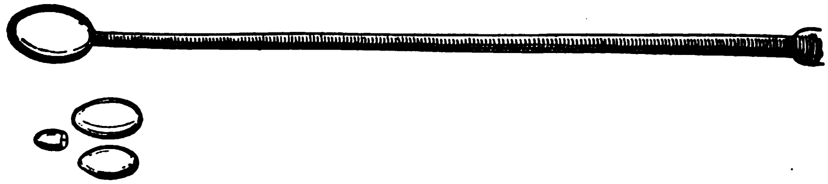


Fig. 590.—Rectal bougie à boule.

Technic.—A speculum is introduced into the anus and is carried up to the seat of the stricture so that a clear view of its opening may be secured. The examiner begins by selecting a large bougie and passing it through the speculum to the opening in the stricture (Fig. 591). If it is found to be too large to enter the stricture, smaller instruments are selected until one is found that will just pass through the contracture. This is inserted entirely through the stricture, using gentleness only in manipulation, and as it is withdrawn its base catches the distal opening of the stricture (Fig. 592). From this examination the exact length and size of the contracture may be readily ascertained.

FIG. 591.

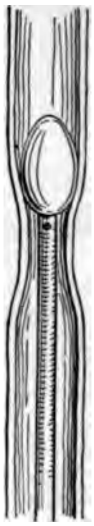


FIG. 592.

FIG. 591.—Method of estimating the length of a rectal stricture, the bougie à boule at the face of the stricture.

FIG. 592.—Method of estimating the length of a rectal stricture. The bougie à boule is withdrawn until its base is arrested at the distal end of the stricture.

EXAMINATION BY THE PROBE

Probing has but little utility in the diagnosis of rectal diseases except as a means of determining the situation and course of a recto-vaginal or ischiorectal fistula.

Instruments.—A silver probe 8 or 10 inches (20 to 25 cm.) long with a flat handle is employed (Fig. 593). The probe should be flexible that it may be bent in any direction if desired. When examining for a recto-vaginal fistula a Sims speculum will be required in addition to expose the fistulous opening in the vagina.

FIG. 593.—Rectal probe.

Technic.—The index-finger of the left hand, well lubricated, is first introduced into the rectum. The probe, grasped in the right hand, is then passed through the external opening in the supposed direction of the fistulous tract. The tract of the sinus is thus slowly explored, removing the probe and bending it so as to alter its shape to correspond with the direction of the sinus if necessary. The internal finger at once recognizes the tip of the probe as it enters the rectum (Fig. 594).

FIG. 594.—Showing the method of probing an ischiorectal fistula. (Ashton.)

LAVAGE OF THE BOWEL

As a diagnostic measure, irrigation of the bowel is sometimes employed for the purpose of securing samples of the contents for examination. The presence of blood, pus, amebæ, tumor fragments, etc., in the material thus obtained, will often lead to the recognition of ulcerative or suppurative processes or malignant conditions which from their location high up in the bowel might otherwise escape notice.

Apparatus.—There will be required a rectal tube connected with a glass funnel by about 3 feet (90 cm.) of rubber tubing.

Position of the Patient.—Irrigation may be performed with the patient in the dorsal position or lying upon the left side with the knees drawn up.

Technic.—The tube, properly lubricated, is inserted into the rectum a short distance, and about a pint (500 c.c.) of warm boiled water is slowly allowed to run into the bowel through the funnel, which is elevated 1 to 2 feet (30 to 90 cm.) above the level of the patient. As soon as any discomfort is felt by the patient, the funnel is lowered and the contents of the bowel are syphoned off and preserved for examination.

EXAMINATION OF THE FECES

Examination of the stools is of distinct diagnostic value in many of the diseases of the digestive tract. Besides furnishing information as to the functional activity of the various organs associated with the process of digestion and absorption of food, it is a valuable aid in the recognition of those diseases of the rectum and large intestine which are due to infection by parasites and bacteria. Without attempting to enter into the technic of such examination, the details of which will be found fully described in manuals on clinical laboratory methods, the lines along which the investigation should be conducted may be briefly referred to. There are four methods of examination available: macroscopical, microscopical, chemical, and bacteriological.

Macroscopical examination.—The amount, color, odor, consistency, and form of the stool and the presence or absence of mucus, blood, or pus should be carefully noted.

Microscopical examination is made for the purpose of detecting intestinal parasites or their ova, fat globules, undigested meat fibers, blood, pus, or tumor fragments.

Bacteriological examination will identify pathogenic bacteria if present.

Chemical examination should include tests for mucin, albumin, carbohydrates, fat, blood, bile pigments, etc.

Therapeutic Measures

ENEMATA AND ENTEROCLYSIS

Hydrotherapy of the lower bowel may be carried out by means of enemata or by enteroclysis. These two measures are often unnecessarily confused and, while in general they are employed for the relief of much the same conditions, yet in practical application they are quite distinct. By an enema is understood the introduction into the bowel of clysters of fluid to be retained some little time at least. The quantity of fluid so injected is usually small in amount, rarely exceeding 1 to 2 pints (500 to 1000 c.c.). Enteroclysis, on the other hand, is an irrigation of the lower bowel, the fluid returning almost rapidly as it is introduced. In this procedure, large quantities fluid are made use of—frequently several gallons at an irrigation. ie enema and the irrigation may be administered either low or gh, according to whether the fluid is introduced a few inches up e rectum or high in the colon.

Enemata.—Enemata may be of several kinds, according to the rpose for which they are employed. They may be designed nply to secure an action of the bowels in ordinary constipation or to load the bowel of long-standing fecal accumulations or impactions d at the same time relieve the accompanying tympanites. These e known as purgative enemata. Such injections owe their action to e stimulating effects upon intestinal peristalsis and to the softening oduced in the hardened fecal matter. In the treatment of consti- ition, however, the use of enemata should be restricted as much as ssible; they should not be advised for long-continued use, as they adually lose their potency, and constantly increasing quantities are cessary to produce an effect. For the local effects in colitis, dysen- ry, catarrhal and ulcerative conditions of the rectum and colon, iall enemata of antiseptic, astringent, or sedative solutions to be ained some little time are administered after each movement or lowing a cleansing irrigation. While used mainly for purgative d cleansing effects, enemata have other valuable uses in thera- itics. Rectal injections of saline solution are made use of in the atment of shock, hemorrhage, sepsis, etc. (see Saline Infusions, 607). Rectal enemata are likewise employed as a means of intro- cing fluids and nutriment into the bowel (see Rectal Feeding, 613) and for the administration of drugs which affect the general tem after absorption.

In employing the rectum as an avenue for the administration of igs, however, certain facts are to be kept in mind. The drug uld always be given in such a state that the active principle is in an ieous solution or else is capable of being dissolved in the fluids of rectum. It should also be remembered that, while the absorption wer of the rectum may be great, drugs are taken up but slowly and rapid effect is desired, this method should not be employed. As a e, unless the drug is very powerful and is capable of being rapidly sorbed, the dose is twice the amount given by mouth.

Apparatus.—The simpler the apparatus, provided it is efficient, e better. A fountain syringe or a glass irrigating jar, capable of lding a quart (1000 c.c.) of solution, will be required as a reservoir, it in an emergency a large funnel will answer. A rubber tubing about ¼ to ⅜ inch (6 to 9 mm.) in diameter and at least 6 feet (180 cm.) long is connected with the outlet of the reservoir, and to the free end an appropriate nozzle is attached (Fig. 595). For low enemata the ordinary hard-rubber rectal nozzle provided with every douche-bag will answer, but if the injection is to be given high up in the bowel a flexible-rubber rectal tube about 20 inches (50 cm.) long will be more convenient. The tube should be smooth and from ⅜ to ½ inch (9 to 12 mm.) in diameter. A very simple apparatus consists of a long colon tube and a funnel (Fig. 596).

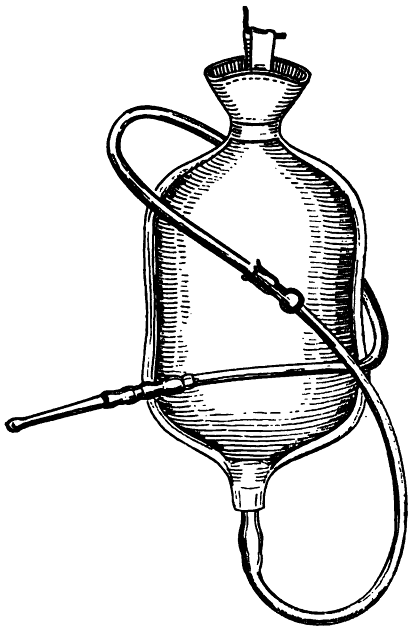


FIG. 595.—Fountain syringe and nozzle for giving a low enema.

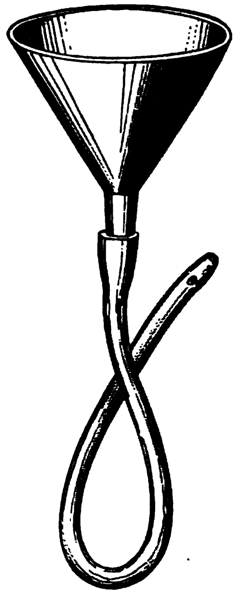


FIG. 596.—Colon tube and funnel.

Rectal tubes are made with the openings at the side, or with one opening at the end (Fig. 597). The latter are better, as the fluid may be injected directly through the tube for the purpose of dislodging any feces or folds of mucous membrane that may obstruct the passage of the tube. In addition, a bed-pan or a douche-pan should be provided.

Formulary.—For simple cleansing purposes or to produce an evacuation in mild cases of costiveness an enema consisting of normal salt solution (dr. 1 (4 gm.) of salt to 1 pint (500 c.c.) of warm water) or the soap-suds enema, made by adding to 1 quart (1000 c.c.) of

›t water sufficient castile soap scrapings to make suds, may be used. he continued use of the latter is not advisable, however, as some ritation may be caused by the lye which is apt to result in proctitis · skin eruptions.

In habitual constipation the injection of from 2 to 6 ounces (60 to ło c.c.) of warm sweet oil into the bowel or the use of the flax-seed ıema will often give good results. The latter is prepared by adding ounce (30 gm.) of flax-seed to 1 pint (500 c.c.) of cold water and ıen boiling the mixture for ten minutes. The resulting muci- ginous mixture is strained and injected while warm. Another ›od enema consists of equal parts of milk and molasses. When more profound effect is desired there are a number of drugs that

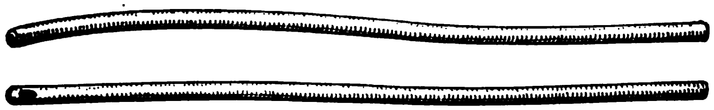


FIG. 597.—Rectal tubes.

.ay be incorporated in the enema. Of these may be mentioned ive oil, castor oil, glycerin, ox gall, turpentine, magnesium sulphate, arlsbad salt, etc. The following combinations of the above will ≥ found useful:

℞ Olive oil or castor oil,	oz. ii (60 c.c.)
Warm soapy water,	oz. iv (120 c.c.)
℞ Glycerin,	oz. 1 (30 c.c.)
Olive oil,	oz. iii (90 c.c.)
Warm soapy water,	oz. iv (120 c.c.)
℞ Ox gall,	dr. ii (8 gm.)
Warm water,	O i (500 c.c.)
℞ Ox gall,	dr. ii (8 gm.)
Glycerin,	oz. iv (120 c.c.)
Warm water,	O i (500 c.c.)
℞ Magnesium sulphate,	oz. i (30 gm.)
Glycerin,	oz. ii (60 c.c.)
Warm water,	oz. iii (90 c.c.)
℞ White of egg (beaten),	
Oil of turpentine,	dr. i (4 c.c.)
Olive oil,	oz. i (30 c.c.)
Warm water,	O i (500 c.c.)

℞ Magnesium sulphate,	oz. ii (60 gm.)
Oil of turpentine,	dr. ii (8 c.c.)
Glycerin,	oz. ii (60 c.c.)
Warm water,	oz. iv (120 c.c.)

For the relief of tympanites a turpentine enema or an enema consisting of 3 ounces (90 c.c.) of milk of asafetida may be used. For irritability of the rectum the use of a small flaxseed enema or the starch-water enema, to which 10 to 20♏ (0.6 to 1.25 c.c.) of laudanum are added, will often give great relief. The starch-water enema is prepared by mixing an ounce (30 gm.) of starch and sufficient cold water to form a thick paste; enough boiling water is then added to dilute this mixture to the consistency of mucilage.

Temperature.—The enema should be given warm—at a temperature of about 100° F. (38° C.)—unless contraindicated.

Rapidity of Flow.—The solution should always be injected slowly to avoid discomfort and spasm from a sudden distention of the bowel. The reservoir is consequently elevated 2 to 3 feet (60 to 90 cm.) above the patient.

Quantity.—To stimulate peristalsis and produce an evacuation of the bowels a bulk of liquid sufficiently large to distend the walls of the intestine should be injected. For this purpose between 1 pint (500 c.c.) and 1 quart (1000 c.c.) of fluid is made use of at one injection. Enemata to be permanently retained for absorption, such as those containing drugs or nutriment, should be small in amount, as a rule containing only 2 to 3 ounces (60 to 90 c.c.) of fluid.

Position of the Patient.—The dorsal, the Sims, or the knee-chest position may be utilized. When employing the dorsal or the Sims position the hips should be elevated upon a hard pillow; especially is this necessary if the enema is to be injected high into the bowel. Infants can be best controlled lying on the back upon the attendant's lap.

Technic.—The tube is first well lubricated with vaselin, and any air is expelled. The left hand then separates the buttocks, and, while the patient strains slightly to relax the sphincter, the tube is inserted into the anus, guided by the right hand in which it is held at a distance of about 2 inches (5 cm.) from its extremity, the operator using a slight boring motion, and bearing in mind that the direction of the anal canal with the patient recumbent is upward and slightly forward. Having traversed the anal canal, the tube enters the rectum proper, and is then slowly advanced in an upward and slightly backward direction. From this point some difficulty may be met with in passing the tube, as it often doubles upon itself from the point catching in a fold of mucous membrane or one of the valves or from being obstructed by feces. Withdrawing the tube slightly and advancing it will often suffice to free it; in other cases allowing the fluid to flow as the tube is advanced displaces or removes any obstruction and at the same time causes the tube to straighten out. In this manner the tube may be passed into the colon, if desired, without causing the patient any great discomfort, provided gentleness and no force be employed.

When the tube is introduced to the desired height, the reservior is elevated a distance of 2 or 3 feet (60 to 90 cm.), and its contents are allowed to enter the bowel slowly (Fig. 598). The patient is apt to

FIG. 598.—Method of giving a low enema. (Macfarlane.)

complain of fulness in the rectum as the fluid enters and distends it, but, by temporarily stopping the flow, this feeling soon passes off, and, as the rectum becomes tolerant to the pressure, more fluid can be injected. When the desired amount has been introduced, the flow is shut off by pinching the tube, which is then withdrawn. The patient is directed to hold the enema for five or ten minutes if possible before using the bed-pan.

Enteroclysis.—Like enemata, irrigations are used mainly for cleansing purposes, to remove putrefying material or toxins from the bowels, and to bring medicated fluids into contact with diseased mucous membrane. Large irrigations are not advised, however, in the treatment of habitual constipation; the use of small enemata is just as efficacious, and there is less danger of producing atony of the bowel than where it is continually overloaded and distended with large quantities of fluid. In the treatment of intestinal toxemia by enteroclysis, the bowels are thoroughly cleansed and absorption of the toxins from the decomposing contents is prevented. At the same time, more or less fluid is absorbed, the activity of the skin, kidneys, and liver is consequently stimulated and general absorption and autointoxication are greatly lessened. For the same reasons enteroclysis has a wide field of usefulness in the treatment of renal insufficiency, uremia, toxemia, general septic conditions, etc., producing marked diuresis, and not only diluting the toxins in circulation, but favoring their elimination.

Enteroclysis with hot normal salt solution, through the stimulating effect on the circulation and the elevation of bodily temperature, produces marked and beneficial results in shock due to whatever cause (see Saline Rectal Infusions, page 607).

In proctitis and in catarrhal, dysenteric, and ulcerative conditions of the large bowel irrigations are employed for cleansing purposes, removing foreign substances, mucus, and pus, and thus rendering bacteria less active; they also serve as a means of bringing medicinal agents in contact with the diseased surfaces. For the local effect upon diseases of the rectum or adjacent organs irrigations are used either hot or cold; for example, in the treatment of internal hemorrhoids or hemorrhage from ulcers situated in the rectum or lower bowel. Such irrigations are likewise employed in genitourinary and gynecological practice for the treatment of congestion and inflammation located in the bladder, prostate, and deep urethra, or the uterus and its appendages.

Apparatus.—The reservoir for the solution may be either a quart-glass irrigating jar or a fountain syringe, attached to which is about 6 feet (180 cm.) of rubber tubing 1/4 to 3/8 inch (6 to 9 mm.) in diameter. Irrigating tubes are made in two styles: a single-flow tube, in which the fluid enters and escapes through the same opening, and a double-current tube, in which the inflow enters and the outflow escapes through different compartments.

In irrigating with a single tube, it will prove most satisfactory to use a colon tube about 20 inches (50 cm.) long and 3/8 to 1/2 inch (9 to 12 mm.) in diameter, with the opening at the end. With this form of tube fluid may be deposited high in the colon or low in the rectum at will. For infants, a catheter, 16 to 18 French, may be used. The irrigating tube is connected to the end of the rubber tubing of the irrigator by a T-shaped glass tube, to the long arm of which is attached a short piece of rubber tubing closed by a clip (Fig. 599). The solution is passed into the bowel with this clip closed, and when it is to be drawn off the inflow of solution is temporarily stopped by pinching the tubing between the glass connection and the irrigator, the clip is opened, and the fluid returns through the same tube and escapes through the long arm of the T-tube into a waste-pail ready for that purpose. The same thing may be very simply accomplished with a long colon tube and a funnel (see Fig. 596). The solution is forced in through the funnel, and, when

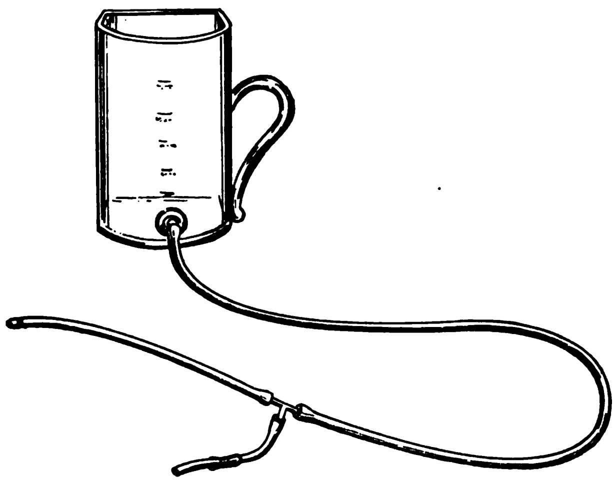


FIG. 599.—Apparatus for enteroclysis.

sufficient has entered the bowel, the funnel is depressed and the fluid allowed to escape.

With a double-flow tube irrigations may be carried out far more conveniently, especially when several gallons of fluid are used at each irrigation. A very efficient double-flow apparatus, especially for high irrigating, may be improvised by passing a moderate-sized

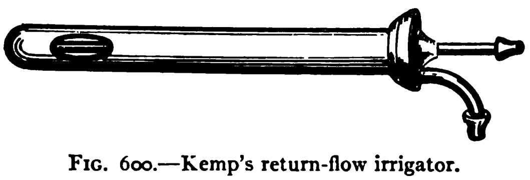


FIG. 600.—Kemp's return-flow irrigator.

single-flow tube high into the bowel, alongside of which is inserted a second tube of larger caliber to carry off the return flow. There are any number of excellent double-flow irrigators on the market, of which Bodenhamer's, Kemp's (Fig. 600), or Tuttle's tubes are satisfactory models. These instruments are made of hard rubber so that they may be readily sterilized. Tuttle's irrigator (Fig. 601) consists of a cylinder enclosing a smaller tube which opens at the end of the irrigator. This smaller tube conducts the fluid into the bowel. The outside cylinder has numerous openings in its sides to carry off the outflow. It ends in a discharge tube to which a long piece of rubber tubing is attached to carry off the waste.

A bath-thermometer, a douche-pan or a bed-pan, a slop-pail, and rubber sheeting to protect the bed complete the necessary equipment.

Solutions for Irrigation.—In the great majority of cases, unless a specific action is required from direct contact of remedies with the surface of the intestine, normal salt solution (dr. 1 (4 gm.) of salt to a pint (500 c.c.) of warm water) is used. For cleansing purposes and to aid in the expulsion of flatus, 5 to 15 ℳ (0.3 to 1 c.c.) of oleum cinnamomi or oleum menthæ piperitæ may be added to each pint of solution.

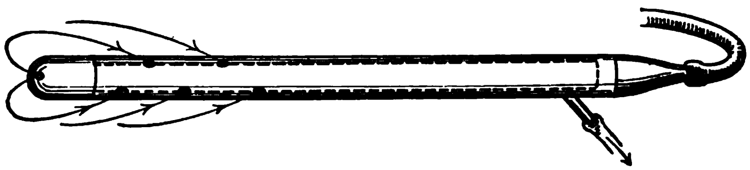


FIG. 601.—Tuttle's return-flow irrigator.

The following solutions will be found useful in catarrhal or ulcerative conditions of the lower bowel, according to whether a soothing, antiseptic, stimulating, or astringent action is desired: aqueous extract of krameria, 1 to 20; fluid extract of hydrastis, 1 to 50; fluid extract of hamamelis, 1 to 50; boric acid, 1 to 20; hydrogen peroxid, 1 to 10; thymol, 1 to 50; carbolic acid, 1 to 500; bichlorid of mercury, 1 to 10,000; permanganate of potash, 1 to 500; salicylic acid, 1 to 500; quinin, 1 to 1000; argyrol, 1 to 1000; tannic acid, 1 to 500; silver nitrate, 1 to 2000, etc. In using the more powerful and poisonous drugs, such as carbolic acid and bichlorid of mercury, for instance, any excess of solution remaining in the bowel at the completion of the irrigation should be drained off before withdrawing the tube.

Temperature.—This will depend upon the condition for which the irrigation is employed and upon the action desired. For simple cleansing purposes and in the treatment of colitis and dysentery the irrigation should enter the bowel at a temperature of 100° to 105° F. (38° to 41° C.). Hot irrigations (110° to 115° F. (43° to 46° C.)) are indicated when the stimulating action of heat is desired, or for the diuretic effect and to increase the eliminative action of the skin, and for the effect of heat upon inflammations of neighboring organs.

Cold enteroclysis (65° to 70° F. (18° to 21° C.)) has a beneficial action upon the whole intestinal tract, toning up the mucous membrane and stimulating the muscular tissue, and so increasing peristalsis. This is indicated in the treatment of internal hemorrhoids, inflammatory conditions of the rectum, prostate, deep urethra, etc. In hemorrhage from the bowel, very cold (50° F. (10° C.)) or very hot (120° F. (49° C.)) irrigations are used. It should not be forgotten, however, that prolonged enteroclysis with very hot or very cold fluid will cause a rise or lowering of the bodily temperature amounting to several degrees.

Rapidity of Flow.—The fluid should enter the bowel with comparative slowness, to avoid exciting peristalsis and to allow the fluid to be well distributed over the intestinal wall. Elevation of the reservoir 2 to 3 feet (60 to 90 cm.) for a low irrigation and 3 to 4 feet (90 to 120 cm.) for the high will give the proper flow.

Quantity.—A continuous irrigaton of from ten minutes to one-half an hour or more at a time gives the best results in septic conditions, toxemias, inflammations in the organs adjacent to the bowel, etc. Several gallons of solution are needed for such an irrigation. On an average, from 1 to 1½ pints (500 to 750 c.c.) of solution in high enteroclysis, and from 2 to 8 ounces (60 to 240 c.c.) in the low irrigation are kept in the bowel continuously. For cleansing purposes, and in the treatment of diseases involving the mucous membrane of the bowel, the irrigation is continued until the solution returns clear.

Position of the Patient.—Enteroclysis may be performed with the patient (1) in the dorsal position, with hips elevated; (2) in the Sims, or left lateral prone position; and (3) in the knee-chest posture.

When it is desired to irrigate the whole colon, the position of the patient may be altered to advantage from time to time in order to allow the force of gravity to act upon the fluid and permit it to reach all portions of the colon. Elevation of the patient's hips causes the fluid to gravitate toward the transverse colon, and thence along this portion of the bowel to the ascending colon if the patient is shifted from the left side to the right.

Technic.—The apparatus is properly connected and the reservoir is filled with the solution, first allowing a little to escape from the nozzle to expel any air and to see that everything works properly. Practically the same steps are followed in inserting the tube for enteroclysis as were detailed for giving an enema. The tube, well lubricated with vaselin or oil, is grasped in the fingers of the right hand not far from its extremity, while the left hand separates the patient's buttocks The patient is instructed to strain sufficiently to relax the sphincter, and the tube is inserted at first upward and forward for a distance of 2 to 3 inches (5 to 7.5 cm.) and then upward and slightly backward toward the sacrum. There is very little difficulty in passing a rectal tube or an irrigating nozzle the necessary distance for a low irrigation, if the normal direction of the bowel is

FIG. 602.—Showing one method of irrigating the bowel with a single tube.

followed, a well-oiled tube almost slipping in of its own accord at times. To pass a flexible tube the remainder of the way into the sigmoid is not so simple, as it is not possible to guide the tube after it gets 3 or 4 inches (7.5 or 10 cm.) into the bowel, and it has to practically find its own way along. It will be found a distinct aid, however, in accomplishing this if the solution is allowed to flow gently as soon as the anal canal is passed. This tends to make the tube stiffer and at the same time it straightens out the folds of mucous membrane and carries the valves out of the way, which might otherwise form obstructions. When the tube has been inserted to the desired distance, the reservoir is raised 3 or 4 feet (90 or 120 cm.), and the washing-out process begins.

In performing enteroclysis with a single tube, 1 to 1½ quarts (1 to 1.5 liters) of solution—depending upon the capacity and tolerance of the individual—are allowed to flow into the bowel before the fluid is permitted to return. If the fluid enters the bowel slowly and the desire on the part of the patient to expel it be resisted a few

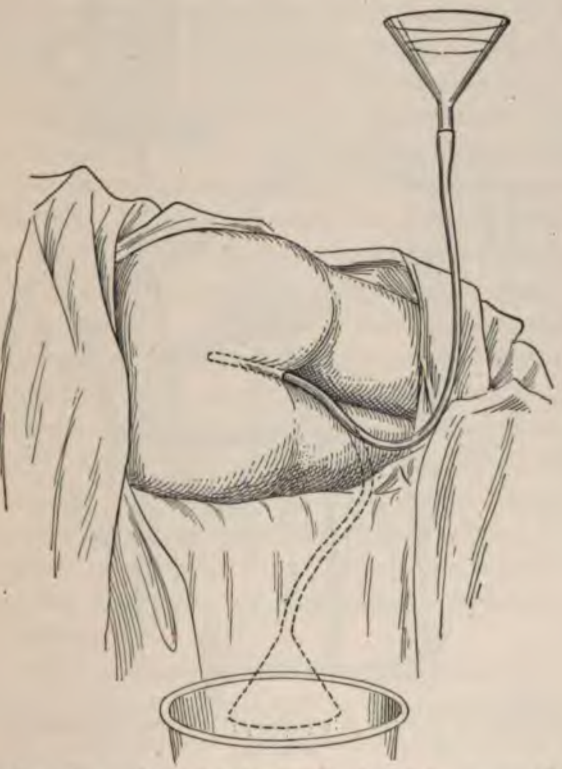


Fig. 603.—Showing the method of irrigating the bowel by means of a funnel and colon tube.

moments until it passes well into the colon, no great difficulty will be encountered. To withdraw the fluid, the outlet placed in the tube leading from the reservoir is opened (Fig. 602), or, if a funnel constitutes the reservoir, this is simply lowered below the level of the patient, and the solution escapes through the same tube by which it entered (Fig. 603). This process of lavage is repeated until the fluid returns clear.

The colon may be more thoroughly irrigated, as already mentioned, by altering the patient's position as follows: With the patient in the Sims position, for instance, and with the hips elevated, the descending colon is first thoroughly washed out. About $1\frac{1}{2}$ to 2 pints (750 to 1000 c.c.) of solution are then retained, and the patient is gradually rolled to the dorsal position and then to the right side. This permits the fluid to pass from the descending colon to the transverse and ascending colon. To allow the solution to gravitate down

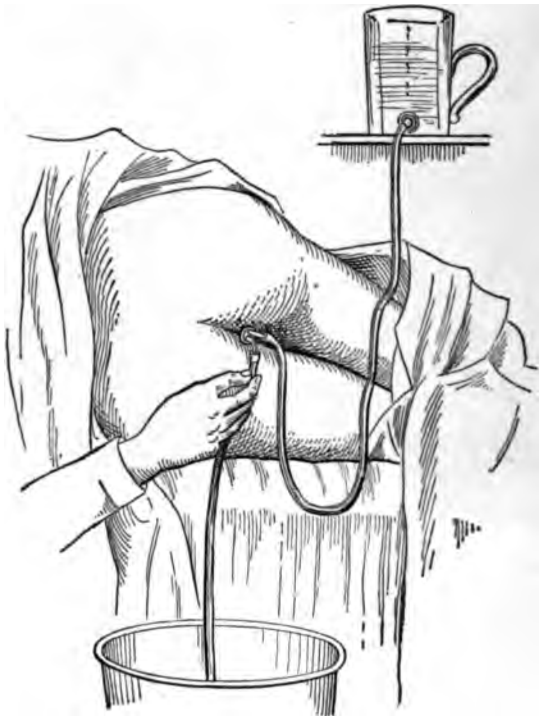


FIG. 604.—Showing the method of irrigating the bowel by means of a return-flow irrigator.

the ascending colon to the caput coli, the patient's shoulders are raised slightly higher than his hips. The process is then exactly reversed: the shoulders are first lowered, the patient then rolls to the dorsal position, and finally to the left side again.

In using the double-flow style of irrigator, the outflow tube is compressed until a pint (500 c.c.) or more of solution runs into the bowel (Fig. 605), when it is released, the solution still continuing to flow in. In this way a current is soon established, and the descending colon and rectum are thoroughly washed out. During the irrigation the reservoir should not be allowed to become empty, the supply being replenished as often as necessary. In withdrawing an irrigator or a tube with openings upon the side, care should be taken to rotate the instrument slightly to prevent the mucous membrane from being caught in the fenestræ.

SALINE RECTAL INFUSIONS.

The value of saline infusions in the treatment of hemorrhage and in the prevention and relief of surgical shock has already been considered in Chapter V. The rectal infusion, being a somewhat slower and less effective method of introducing salt solution into the circulation than either the intravenous or the subcutaneous methods, is used with greater success in the milder forms of shock and hemorrhage, and in the severe cases as an adjunct to intravenous infusion or hypodermoclysis. It has, however, the distinct advantage of simplicity over the other two methods, requiring no preparation of the patient and but the crudest form of apparatus; hence its value as an emergency measure. In septic conditions, toxemias, renal insufficiency, uremia, etc., the fluid thus introduced into the bowel is rapidly absorbed, and the skin, kidneys, and liver are stimulated to increased activity, with the rapid elimination of poisonous products as a result. Rectal infusions are also indicated when it is desirable to increase the quantity of fluid in the tissues, as, for example, in cases where large quantities of fluid are lost from purging, as in dysentery or cholera. It is, furthermore, a most valuable means of relieving the thirst so frequently complained of after abdominal operations.

Apparatus.—The equipment will not differ from that used in giving an ordinary enema. There will be required a thermometer; a graduated glass irrigating jar or fountain syringe; 6 feet (180 cm.) of rubber tubing, about 1/4 to 3/8 inch (6 to 9 mm.) in diameter; and a rectal tube, 20 inches (50 cm.) long and 3/8 to 1/2 inch (9 to 12 mm.) in diameter. In an emergency, a large funnel will answer as a reservoir, and a large long soft-rubber catheter will take the place of the rectal tube.

Solution.—Normal salt solution, (dr. 1 (4 gm.) of salt to a pint (500 c.c.) of water) is used. For a stimulating effect, whisky or brandy, oz. ss. to oz. 1 (15 to 30 c.c.) may be added. In surgical shock 30 ♏ (2 c.c.) of a 1 to 1000 solution of adrenalin chlorid may be added to the enema for the purpose of raising blood-pressure.

Temperature.—The solution should enter the bowel at a temperature of 110° to 115° F. (43° to 46° C.). As there is but little loss of heat on account of the rapidity of the flow, the solution in the reservoir should be at the same temperature at which it is desired to have it enter the bowel, or not more than one or two degrees higher.

Rapidity of Flow.—The fluid should be introduced slowly and not with such rapidity as to excite intestinal spasm. With this in view, the reservoir is held not over 3 to 4 feet (90 to 120 cm.) above the patient.

Quantity.—Small amounts are more apt to be retained by the bowel. From ½ pint (250 c.c.) to a quart (1000 c.c.) may be given at a single injection.

Position of the Patient.—The infusion may be given preferably with the patient in the Sims position with the hips raised or else in the knee-chest position. If it is not expedient to move the patient about, the dorsal position with the hips elevated and with the knees drawn up may be substituted.

Technic.—The reservoir is filled with the required amount of solution of the proper temperature, and a thermometer is placed in it that the temperature may be kept uniform. The rectal tube should be well lubricated with vaselin or oil. Some of the solution is allowed to escape from the tube to expel any air or cold fluid. The flow is then shut off and the tube is grasped in the fingers of the right hand about 2 inches (5 cm.) from its extremity while the left hand separates the buttocks. As the patient strains slightly, relaxing the sphincter, the tube is gently inserted into the rectum. In doing this the normal direction of the bowel with the patient in the dorsal posture—first upward and forward, and then upward and backward—must be kept in the mind of the operator. When the internal sphincter is passed, the solution is again allowed to flow gently, in order to displace any feces, folds of mucous membrane, etc., that might act as an obstruction, and the tube is pushed on into the bowel for a distance of at least 8 to 10 inches (20 to 25 cm.). The reservoir is then raised from 3 to 4 feet (90 to 120 cm.), and the required amount of solution is introduced. If it is injected slowly and the tube is passed high up, no difficulty will be found in introducing and having retained often as much as a quart (1000 c.c.) of solution. At the completion of the operation the tube is withdrawn and the patient is instructed to remain quiet in the recumbent position.

CONTINUOUS PROCTOCLYSIS

By this method a continuous stream of saline solution is instilled into the rectum at very low pressure. Given slowly, so as not to irritate the rectum, enormous quantities of salt solution may be thus absorbed. It was originally employed by Murphy in the treatment of septic peritonitis in conjunction with free abdominal drainage, on the theory that the large quantity of fluid absorbed reverses the lymph currents, so that, instead of absorption taking place from the peritoneal surface, the lymphatics pour out fluid and wash out the

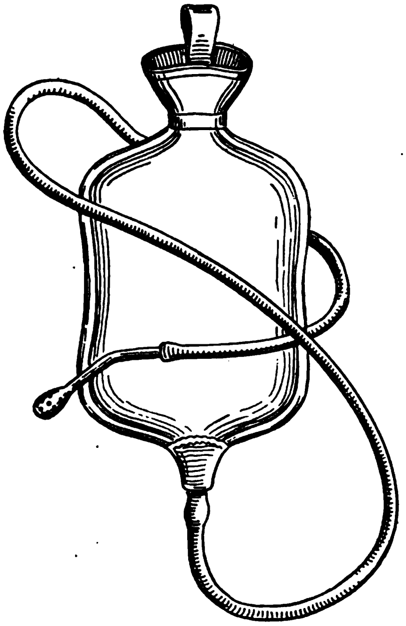


FIG. 605.—A very simple apparatus for continuous proctoclysis.

peritoneum, as it were. At the same time, stimulation of the heart and kidneys results, and with the latter an increased elimination of toxins and septic material. While employed mainly in cases of peritonitis, where the results have certainly been marvelous, continuous proctoclysis will be found an excellent means of infusing salt solution in any septic condition or general toxemia, shock, uremia, etc.

Apparatus.—A glass reservoir or a fountain syringe with a capacity of at least 2 quarts (2 liters), 3 to 4 feet (90 to 120 cm.) of rubber tubing 1/4 to 3/8 of an inch (6 to 9 mm.) in diameter, and a vaginal nozzle of hard rubber with numerous openings on the sides, bent at an angle of 35 degrees about 2 inches (5 cm.) from the tip (Fig. 605) forms the simplest apparatus. A soft-rubber catheter may be used in place of the hard nozzle, if desired. Hot-water bags or hot-water cans, which surround the reservoir and prevent the solution from cooling, should also be provided. An indicator, placed in the outflow tube to show the rate of flow, is a great convenience. A simple one is described by Dewitt (*Surgery, Gynecology and Obstetrics*, February, 1911). The plunger is removed from a 6-inch (15 cm.) metal-topped glass syringe and the metal top is perforated with from 2 to 4 holes for the escape of gas, and through the opening for the plunger is inserted a glass medicine dropper. The upper end of the dropper is connected with the reservoir by a short piece of rubber tubing carrying a screw clamp (Fig. 606), while the tip of the syringe is attached to the rectal tubing. By means of this simple device the rate of flow may be observed and an outlet is provided for flatus.

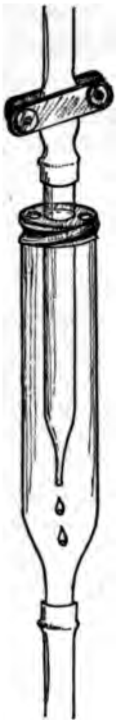


FIG. 606.—Modification of Dewitt's appliance for regulating the flow of solution in proctoclysis. (Crandon and Ehrenfried.)

Saxon has devised an apparatus especially for proctoclysis (Fig. 607), consisting of a copper bucket, inside of which is placed a glass reservoir for the salt solution. Between the copper bucket and reservoir is provided a space of 2½ inches (6 cm.) for hot water. A thermometer is placed in the tubing which leads from the reservoir, and a vent pipe for the escape of flatus is also provided.

A very simple apparatus is described by Iversen (*Journal of the American Medical Association*, June 12, 1909) in which the solution is kept at the required temperature by means of an 8-candle-power electric lamp. The mechanism is sufficiently clear from the accompanying illustration (Fig. 608). There are a number of more elaborate forms of apparatus made, however, in which the heat is furnished by a thermolite warmer or by electricity.

Solutions.—Normal salt solution (dr. 1 (4 gm.) of salt to a pint (500 c.c.) of water), glucose solution, or plain boiled tap water may be used. The latter has been employed to a great extent in the last few years, as it has been found that the large bowel tolerates warm water as well as it does saline solutions; furthermore, thirst is more quickly and effectively relieved.

Glucose may be used in a watery solution in the strength of 2 drams (7.5 gm.) to the quart (liter). Solutions of glucose are especially valuable as not only are fluids thus supplied, but the patient also receives a certain amount of carbohydrate food.

Temperature.—The solution should be at a temperature of about 100° to 105° F. (38° to 41° C.) as it enters the rectum, and it must therefore be at a temperature of from 120° to 130° F. (49° to 54° C.)

FIG. 607.

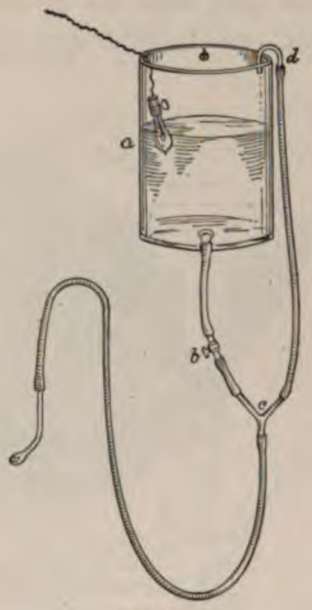


FIG. 608.

FIG. 607.—Saxon's apparatus for continuous proctoclysis.

FIG. 608.—Iversen's apparatus for continuous proctoclysis. *a*, Eight-candle-power electric bulb; *b*, cock; *c*, Y-shaped glass connection; *d*, vent tube for the escape of gas.

in the reservoir. The solution must be kept at a uniform degree of heat by either constantly replenishing with hot solution or by surrounding the reservoir with hot-water bags, unless one of the special heating devices is employed.

Rapidity of Flow.—The salt solution just trickles into the bowel, not much faster than it is absorbed, at about the rate of 30 to 120 drops a minute. In this way ½ to 1½ pints (250 to 750 c.c.) will flow into the rectum in about an hour. The reservoir should be elevated only from 4 to 18 inches (10 to 45 cm.) above the level of the rectum, depending upon the rate of absorption, and the elevation of the reservoir must be so regulated that no accumulation of fluid occurs in the bowel.

Quantity.—The instillation is practically continuous, and the quantity of fluid introduced is limited only by the absorbing power of the rectum. From 6 to 15 quarts (6 to 15 liters) may be absorbed in twenty-four hours. Murphy has given as much as 30 pints (15 liters) in twenty-four hours to a child of eleven. It was all retained. Monroe, however, sounds a note of warning against over-use of this method, claiming that it is possible for a patient to absorb more fluid than can be elminated, shown by an overfull pulse, cough, and by râles from edema of the lungs.

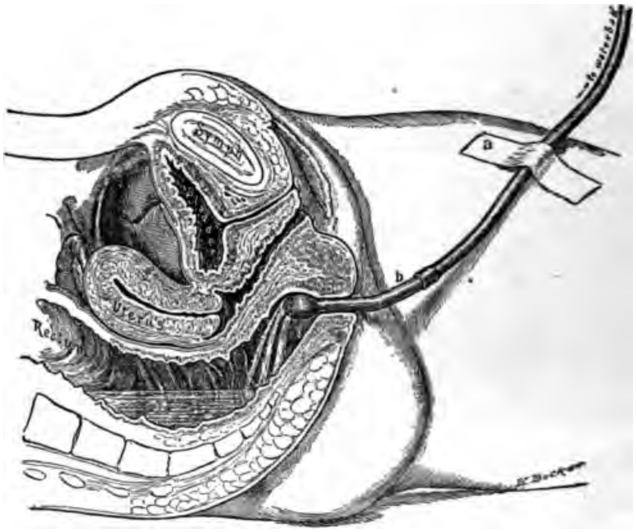


Fig. 609.—Showing the method of administering continuous proctoclysis. (Kelly and Noble.) *a*, Adhesive strap fastening the tubing to the thigh; *b*, vaginal nozzle bent at an angle of 35 degrees.

Technic.—The reservoir is filled with solution and sufficient fluid is allowed to escape to expel any air from the tubing. The right-angled noozle, well-lubricated, is introduced into the rectum just beyond the sphincter muscle, so that the angle fits closely to the anus, and is secured in place by adhesive plaster passing to the thigh (Fig. 609). The reservoir is then raised about 6 inches (15 cm.)—just sufficiently high to overcome the intraabdominal pressure and allow the fluid to trickle into the bowel. *Forceps or other means of constriction should not be applied to the tube to regulate the flow,* unless the apparatus be provided with an accessory vent to carry off the flatus, as they interfere with the free expulsion of gas through the tube or the return of fluid to the reservoir should the patient strain or vomit. The injection may be stopped every few hours if the pulse becomes too full or the rectum irritable; in such cases the tube is not disturbed. Murphy advises that the tube should not be removed except for defecation, as the constant reinsertion will prove irritating to the rectum. It is rarely necessary to continue the proctoclysis for more than three or four days. Exact technic and almost constant attention on the part of the nurse are necessary to gain success with this method.

NUTRIENT ENEMATA

The nutrient enema is employed in cases when feeding by the natural way is undesirable or impracticable. Rectal feeding has its time limitations, however. The capacity of the rectum is small and absorption is considerably slower than by the natural way, so that only about a quarter of the amount of nourishment necessary for sustenance can be given in this way. As a temporary expedient or as an adjunct to natural feeding it is most useful, but for permanent feeding it is quite impracticable. If it alone is depended upon for nourishment, life can rarely be prolonged for more than four to six weeks, though it is true that certain exceptional cases have been reported where patients have lived exclusively upon rectal feeding for longer periods.

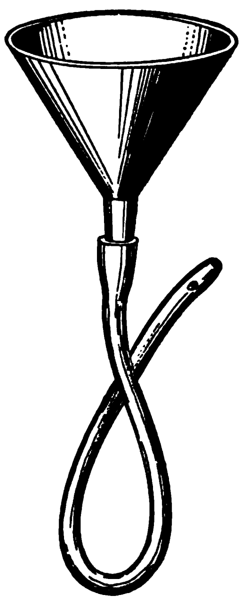


FIG. 610.—Funnel and colon tube for administering nutrient enemata.

Indications.—1. In cases where some impediment to the passage of food exists, as esophageal stricture, new growths encroaching upon the esophagus, and in pyloric or duodenal stenosis. 2. In incessant and uncontrollable vomiting. 3. In any condition where it is desirable to give the alimentary tract a rest, as in acute inflammation or ulceration of the upper part of the alimentary canal, acute gastritis, gastric ulcer, typhoid fever, and lesions of the small intestine. 4. As an adjunct to natural feeding in any condition when the patient cannot receive sufficient nourishment by mouth.

Apparatus.—A large glass funnel, 2 to 3 feet (60 to 90 cm.) of rubber tubing 1/4 to 3/8 of an inch (6 to 9 mm.) in diameter, and a plain rectal tube 20 inches (50 cm.) long, No. 35 French in size (Fig. 610) make a simple and very effective apparatus, and one that can be easily cleaned. If desired, a hard-rubber syringe with a capacity of from 4 to 6 ounces (120 to 180 c.c.) (Fig. 611) or a Davidson syringe attached directly to the rectal tube may be used. In children a No. 18 to 20 French ordinary rubber catheter is substituted for the rectal tube.

Asepsis.—The tube should be boiled before using, and it must be carefully cleaned after each injection. Syringes, if employed, should

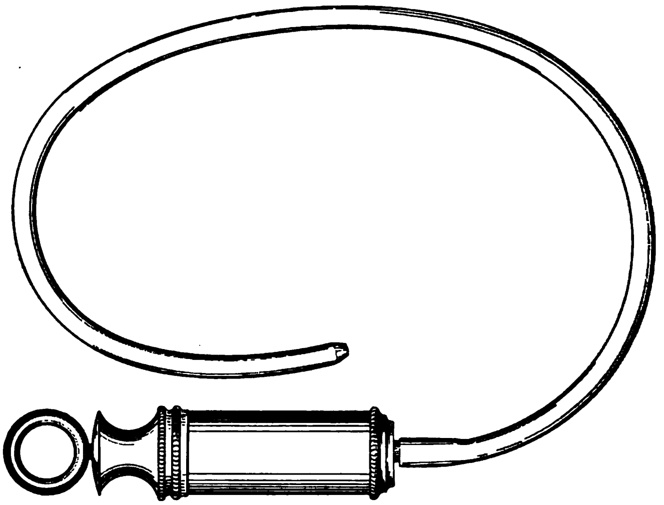


FIG. 611.—Colon tube and syringe for administering nutrient enemata. (Ashton.)

likewise be very thoroughly cleansed with soap and water every time they are used.

Material Employed for Feeding.—Whatever the form of nourishment used, it must be free from all irritating properties and should be small in bulk, or it will be immediately expelled. As the lower bowel secretes no digestive ferments, the substances injected must be of such a nature that they are readily absorbed, otherwise the enema acts as a foreign body and proves irritating to the bowel. The food should always be fluid in character and, as far as is possible, predigested. As a general thing, starches and fats are to be avoided. Combinations of pancreatinized meat extracts, peptonized milk, and egg albumen will be found to be most readily taken up by the bowel. The addition of a small quantity of salt to each egg aids in its absorption. Alcohol in the form of red wine, brandy, or whisky may be incorporated in the enema when a stimulating effect is desired. A good stimulating enema consists of brandy oz. ii (60 c.c.), ammonium carbonate gr. xx (1.3 gm.), and beef tea q.s. ad oz. viii (240 c.c.). A pint (500 c.c.) of black coffee alone has also a marked stimulating effect.

One of the most easily absorbed foods which is not irritating to the bowel is glucose. It may be used in a 10 to 15 per cent. solution

The following formulæ (Ashton) will be found very useful. In continued rectal feeding it is well to use them in rotation.

(1) Beef juice oz. iii (90 c.c.), and liquor pancreatis dr. ii (8 c.c.).

(2) One raw egg; salt, gr. xv (1 gm.); brandy or whisky oz. ss. (15 c.c.); and peptonized milk oz. iii (90 cc).

(3) One egg; liquor pancreatis dr. ii (8 c.c.); and beef juice oz. iii (90 c.c.).

(4) One raw egg, and peptonized milk oz. iii (90 c.c.).

(5) Salt, gr. xv (1 gm.); beef juice oz. i (30 c.c.), and peptonized milk oz. iii (90 c.c.).

(6) Yolk of one raw egg; brandy or whisky dr. vi (24 c.c.); liquor pancreatis dr. ii (8 c.c.); and beef-tea oz. iii (90 c.c.).

Temperature.—Give the injection at a temperature near that of the body, about 95° F. (35° C.)—never cold or very hot—as peristalsis may be excited and the rectum will probably reject the feeding.

Quantity.—Only a small amount of food should be injected at one time, usually 1 to 6 ounces (30 to 180 c.c.), depending on the retaining capacity of the rectum and whether the patient is a child or an adult. Large quantities are liable to be expelled by the bowel.

Frequency of Feedings.—This will depend upon the quantity taken at one time. A patient who can retain as much as 6 ounces (180 c.c.) need only be fed every six hours. Cases where but small amounts are retained will require three- to four-hour interval feedings.

Care of the Rectum.—A cleansing enema, consisting of salt dr. ii (8 gm.) to a quart (1000 c.c.) of lukewarm water or, if there is much mucus present, sodium bicarbonate dr. i (4 gm.) to a quart (1000 c.c.) of warm water, is given each morning at least an hour before the first feeding. This serves to wash out of the bowel any particles of waste matter or mucus; it furthermore cleanses the mucous membrane and prepares it for more thorough absorption by stimulating the circulation.

Position of the Patient.—In giving any retained enema the patient should preferably be in the Sims position with the hips elevated or in the knee-chest position. If it is inexpedient to move the patient, the dorsal position with hips elevated and knees drawn up will suffice.

Technic.—The tube is well lubricated with sterile vaselin or with sweet oil to facilitate its passage and to avoid irritating the rectum. The tube is slowly and gently introduced, according to the directions already given for the introduction of the enema or enteroclysis tube (see page 598), well into the bowel for a distance of 10 to 12 inches (25 to 30 cm.), so as to prevent expulsion of the food and furnish an extensive surface for absorption. To avoid injecting air, the tube and the reservoir of the syringe are filled with the material to be injected before the tube is inserted into the rectum. The fluid must be injected very slowly. When the proper amount is introduced, the tube is carefully removed and the patient is instructed to remain quietly in the recumbent position with the lips elevated for at least half an hour, to lessen the chances of the food being expelled. In cases of marked irritability of the rectum, 5 to 10 ♏ (0.3 to 0.6 c.c.) of the tincture of opium may be added to the enema.

INJECTIONS OF FLUID OR AIR INTO THE BOWEL IN INTUSSUSCEPTION

The slow injection of bland fluids or air into the bowel may be employed for its mechanical effect in overcoming an obstruction due to intussusception. Success from either method, however, depends largely upon an early diagnosis of the condition, for disinvagination becomes more difficult in direct proportion to the length of time which has elapsed from the onset of the symptoms. *After the first twenty four hours of an attack, attempts at reduction by means of hydrostatic or gaseous pressure are not justifiable*, as tight adhesions, which render reduction impossible, or strangulation and partial necrosis of the gut with the added danger of rupture may be present. The greatest objection to this method of treatment lies in the fact that in many cases it is impossible to tell immediately whether the invagination has been reduced, and the success of the procedure can only be determined by allowing the patient to come out of the anesthetic and carefully observing the symptoms.

Not more than fifteen minutes to a half hour should be consumed in attempts at relief by these nonoperative measures. In all cases preparations for operation should be made beforehand so that, should reduction fail, an immediate laparotomy can be performed. Treatment by injections is, of course, only applicable when the intussusception occurs in the large bowel, on account of the obstruction by the ileo-cecal valve to the passage of fluid or gas into the small intestine.

Treatment by Injection of Fluid.—Apparatus.—A fountain syringe or a graduated glass irrigating jar as a reservoir and a rectal nozzle or a large catheter, attached to the reservoir by 6 feet (180 cm.) of rubber tubing 1/4 to 3/8 inch (6 to 9 mm.) in diameter, should be provided.

Solutions Employed.—Normal salt solution—salt dr. 1 (4 gm.) to a pint (500 c.c.) of water—thin gruel or milk and water may be used.

Temperature.—As the relaxing effect of heat is desirable, the solution should be at a temperature of about 105° F. (41° C.) as it enters the bowel.

Quantity.—The capacity of the colon varies from 10 ounces (300 c.c.) in a child of five months to a pint (500 c.c.) or more in a child a year old. Not more than 1 1/2 pints (750 c.c.) of solution should be injected into the bowel of a child under one year. In an adult, the rectum and colon hold as much as 9 pints (4.5 liters) without undue distention.

Rate of Flow.—The fluid should enter the bowel in a gradual, steady, continuous flow. From ten to fifteen minutes are consumed in injecting the given quantity of solution.

Amount of Pressure.—Starting with the reservoir elevated about 3 feet (90 cm.), which gives a pressure of less than 2 pounds, the height may be slowly increased to 4 or 5 feet (120 or 150 cm.) if necessary. A greater pressure than obtained at the latter elevation is not advisable for fear of rupturing the bowel. This danger should be constantly borne in mind.

Position of the Patient.—The patient should be in the dorsal position, with the hips elevated.

Anesthesia.—Anesthesia with ether to the full surgical extent to produce muscular relaxation is necessary.

Technic.—The nozzle or catheter is well lubricated with oil or vaselin, and any air is expelled from the tube. The nozzle is then inserted into the rectum for several inches, and the reservoir is elevated about 3 feet (90 cm.) and the solution is allowed to flow slowly into the bowel. Escape of the fluid along the side of the tube is prevented by tightly packed cotton about the anus and pressing the buttocks firmly together. While the solution is flowing, the abdomen may be *very gently* kneaded or the child may be inverted several times. Diminution of the pressure necessary to inject the fluid indicates that disinvagination or else a rupture of the bowel has occurred, and the injection should be immediately stopped.

After a thorough trial by injection, if in doubt as to the result, the solution is allowed to escape and the patient is examined. If there were present at the outset a distinct tumor, the success of the procedure will be denoted by its disappearance. A tumor still present and retaining its full size will, of course, signify a failure, and an immediate laparotomy should be performed while the patient is still under the anesthetic.

Treatment by Inflation with Air.—In employing air to distend the bowel the pressure cannot be so well regulated as with fluid, and, furthermore, the weight of the column of water, which in some cases seems to be an important factor, is lacking.

Apparatus.—A rectal tube or a catheter of appropriate size and an ordinary bellows or a Davidson syringe will be required. In order to permit the escape of air the moment it is desired, a T-tube of glass may be inserted between the rectal tube and the inflation apparatus. One limb of the T-tube is inserted into the rectal tube, the other into the tube leading from the inflator, while to the third limb a short piece of rubber tubing is attached which can be opened or shut by a clip.

Gases Used.—Ordinary air, oxygen, or carbonic acid gas may be employed.

Pressure.—The air should be injected very slowly. The best guide as to the amount to be introduced and the pressure is the distention produced along the colon and in the abdomen.

Anesthesia.—A general anesthetic should be employed to insure extreme relaxation.

Technic.—The tube or catheter is introduced well into the rectum and the inflating apparatus is connected. The air is very gently and slowly pumped in, while an assistant compresses the buttocks to prevent its escape. Gentle abdominal massage or inversion of the patient may be tried while the inflation is progressing. Reduction may be indicated by rumbling sounds or a gush of liquid fecal matter

DILATATION OF RECTAL STRICTURES BY THE BOUGIE

The surgical treatment of rectal strictures consists of: (1) Gradual dilatation; (2) proctotomy; (3) excision; (4) entero-anastomosis; and (5) colostomy. Treatment by dilatation, though not often curative, is a most valuable palliative measure. By means of gradual dilatation, the lumen of a stricture may be so much increased in size that the patient is relieved of his obstructive symptons and may be kept comfortable for years, provided the dilatation be maintained by the occasional passage of a bougie.

Exact information as to the site, caliber, length, and thickness of the constriction should be previously obtained by means of a digital examination, if within 4 inches (10 cm.) of the anus, or if seated higher up, by the use of the proctoscope and bougie, as already described, before any attempt at dilatation is made. The majority of strictures are situated within 3 inches (7.5 cm.) of the anus, though they may be located at any point higher up, or within the anus itself. The stricture may consist of a ring-like constriction, or a narrowing of the canal for a distance of 1 inch (2.5 cm.) or more, or it may be tortuous in shape. The bowel above the stricture is often markedly dilated and the rectal walls may be so thinned that rupture of the gut readily occurs upon the use of slight force. At the seat of stricture the mucous membrane is often ulcerated or replaced by dense scar tissue.

Instruments.—The instrument employed for dilatation should be a soft-rubber bougie with a conical tip, such as the Wales instrument

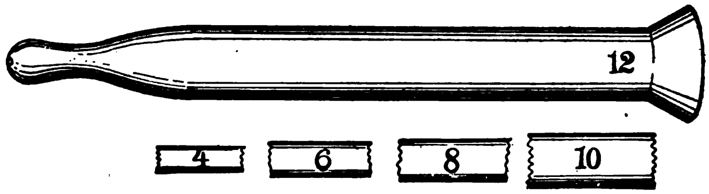


FIG. 612.—Wales' bougies.

(Fig. 612). Metal dilators and those of rigid material should be avoided as dangerous.

Asepsis.—The bougies are to be sterilized before using, and the bowels should be well cleaned out, the rectum being irrigated with normal salt solution both before and after each treatment.

Rapidity of Dilatation.—The stricture should be stretched gradually. Dilatation ought not to be performed rapidly or by divulsion. Such methods are extremely dangerous, as, apart from the shock, on account of the laceration of the tissues there is great risk of hemorrhage and septic infection.

Frequency.—This depends upon the amount of tenderness and irritation as the result of the manipulations. If the bougies are passed at too frequent intervals, irritation and inflammation are produced which induce the very condition it is intended to correct. As a rule, the stretching should not take place oftener than every other day. In some cases, the lapse of two or three days between

FIG. 613.—Method of inserting a bougie into a stricture through a proctoscope.

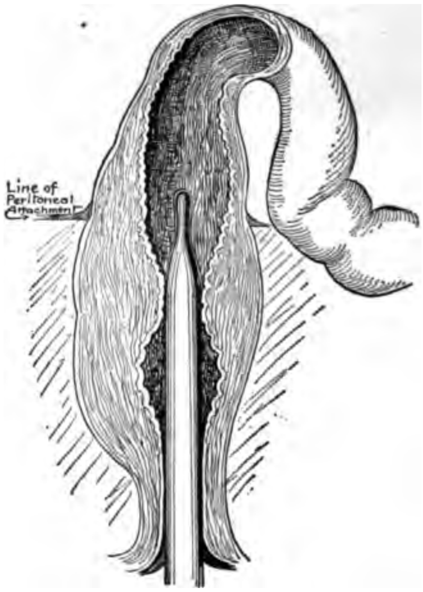


FIG. 614.—Showing a bougie passed through a stricture.

each treatment is necessary, for the bougie ought not to be reintroduced until all signs of the discomfort it has produced have entirely passed off. Later, when full dilatation has been reached, an interval up to a month may elapse between each treatment, if it is found that there is no tendency for the contraction to recur in the interval.

Position of the Patient.—The patient is to be in the Sims position, with the knee well drawn up, or in the knee-chest position if a proctoscope is to be used.

Technic.—The bougie is well lubricated and, guided by the right index-finger, is made to enter the orifice of the constriction; or, better still, it is inserted accurately into the stricture under the guidance of the eye through a proctoscope introduced to the seat of stricture (Fig. 613), as recommended by Tuttle. The advantages of this method are obvious. The greatest gentleness must be observed in inserting the bougies, and under no circumstances should the tissues be lacerated. The first instrument should be of such a size that it enters the stricture with ease. The next one, a size larger, is left in place for a few moments, and then a third instrument is inserted if it can be done without pain to the patient. The proctoscope is then withdrawn and the bougie is left *in situ* ten to fifteen minutes.

Following the treatment, an irrigation of hot normal salt solution is given, and the patient is kept quiet for a quarter to a half-hour. At the subsequent sittings, it is well to commence with an instrument a size smaller than the largest one used at the previous sitting. An increase in the dilatation is attempted at each sitting.

COLONIC MASSAGE

Abdominal massage is indicated for the relief of chronic constipation and its accompanying symptoms the result of atony of the intestines, in which class of cases, if properly carried out, it is a most valuable therapeutic measure, tending to strengthen the muscles of the abdomen and bowel and the tone of the nervous system, as well as to stimulate the secretory function of the colon and to increase the peristaltic action. To be of value, however, it should be performed by one trained for such work. Massage is contraindicated during menstruation and in pregnancy, and, of course, in the presence of such pathological conditions as gastric or intestinal ulcers, intestinal obstruction, appendicitis, hemorrhage from the bowel, inflammation of the peritoneum, etc.

Time for Massage.—The best time for massage is early in the morning before breakfast. In cases where this is not possible, care should be observed that it is not given until at least one hour has elapsed since the last meal.

FIG. 615.—Deep pressure colonic massage. (Bandler.)

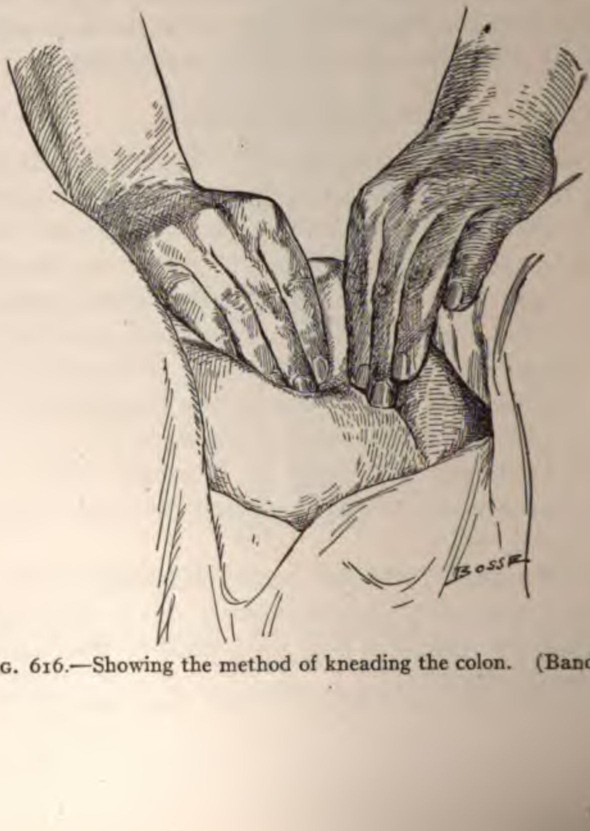


FIG. 616.—Showing the method of kneading the colon. (Bandler.)

ation.—Each treatment should consume from five to fifteen ı. The treatments should be persisted in until the regularity stools is re-established, to effect which may require several r months.

quency.—Treatments should be given daily.

arations.—The bladder and, if possible, the rectum should be

tion of the Patient.—The patient lies in the dorsal position e shoulders and knees slightly elevated, so as to secure as elaxation as possible.

nic.—The masseur stands upon the patient's left side and iis manipulations by making light circular movements (effleur- arting at the cecum and following the course of the ascending, rse, and descending colon. The small intestine and the rest bdomen are similarly manipulated. Then deep pressure and g movements (pétrissage) are substituted. In these move- he whole colon is manipulated in the first instance by per- zigzag movements while making deep pressure with one iperimposed upon the other (Fig. 615), and, in the second e, by raising up deep handgrasps of the abdominal muscles intestines and kneading them by alternately compressing xing the fingers (Fig. 616). In performing these deeper man- ns one will be governed as to the amount of force that may be ed by the sensitiveness of the patient. Care should be taken manipulations be not too vigorous, lest some injury to the result.

AUTO-MASSAGE

sage may be very effectually carried out by the patient him- rolling a ball over the abdomen, beignning at the cecum and

Fig. 617.—Cannon ball for auto-massage of the abdomen.

g the course of the colon up the right side, then across the n, and down the left side in the direction of the descending colon. A cannon ball or a wooden ball filled with shot weighing 3 to 5 pounds (1.4 to 2.2 K.), covered with chamois or flannel (Fig. 617), may be used for this purpose.

THE APPLICATION OF ELECTRICITY TO THE RECTUM AND COLON

Electricity is of value in conjunction with the abdominal massage in all form of constipation, but especially so in the atonic variety. Under the stimulating action of the electric current, the nerves, muscles, and glandular structures connected with the bowel are favorably influenced, so that the peristaltic action and the secretion of mucus are increased, at the same time, the contracting power of the voluntary muscles of the abdomen is strengthened.

FIG. 618.—Large flat sponge electrode.

Both the faradic and the galvanic currents are employed, the former being generally preferred for atonic constipation and intestinal paresis and the galvanic for spastic constipation and painful neuroses. They may be applied percutaneously or internally.

Apparatus.—For the percutaneous applications a large flat sponge electrode (Fig. 618) and a small sponge electrode (Fig. 619) will be required. When it is desired to make internal applications, a special irrigating rectal electrode, such as Boas' (Fig. 620) or Kemp's, and a flat abdominal sponge will be required.

Strength of Current.—As there is no means of estimating the strength of the faradic current, the sensations of the patient should be the guide, the current being strong enough to cause muscular contractions but no pain. For galvanism, from 10 to 15 ma. of current are ordinarily required.

Duration of Application.—Each treatment should consume from ten to fifteen minutes.

Frequency.—At first applications are made daily, then every other day, and, as the conditions improve, once or twice a week.

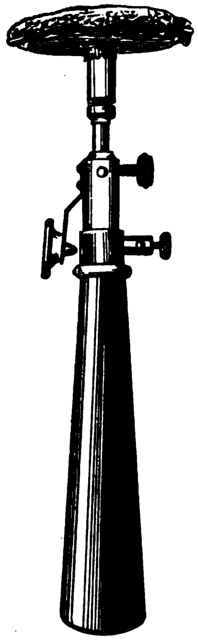


FIG. 619.—Small sponge electrode. (Bandler.)

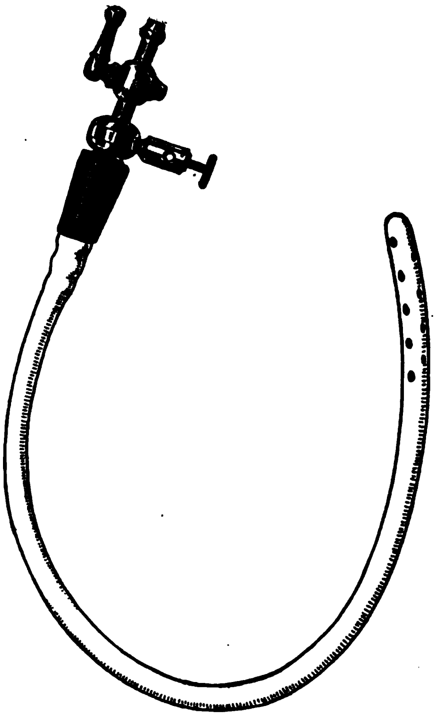


FIG. 620.—Boas' rectal electrode. (Bandler.)

Time of Application.—Treatments are given with best results at night, just before the patient retires.

Position of Patient.—The patient should be in the recumbent position, with the head slightly elevated and the legs flexed, so as to relax the abdominal muscles.

Technic.—1. *Percutaneous Application.*—The positive pole is attached to a large flat electrode, and the latter, well moistened, is placed over the spinal column. The negative electrode is then applied to the abdomen for a few minutes at a time, first over the cecum, then along the course of the transverse colon, and finally along the descending colon. This is supplemented by circular motions with the negative electrode over the same regions. Finally, the entire abdomen is similarly treated.

2. *Rectal Application.*—An irrgating electrode attached to the negative pole of the battery is inserted in the rectum and the positive electrode is placed over the spine or abdomen. When the current is turned on, saline solution is allowed to flow slowly through the rectal electrode, carrying the current to all portions of the colon.

CHAPTER XX

THE URETHRA AND PROSTATE

Anatomic Considerations

The Male Urethra.—The urethra is a closed canal, composed of erectile and muscular tissue, and lined by mucous membrane, extending from the bladder to the external urinary meatus. Its entire length is from 6½ to 9 inches (16 to 23 cm.), depending upon the

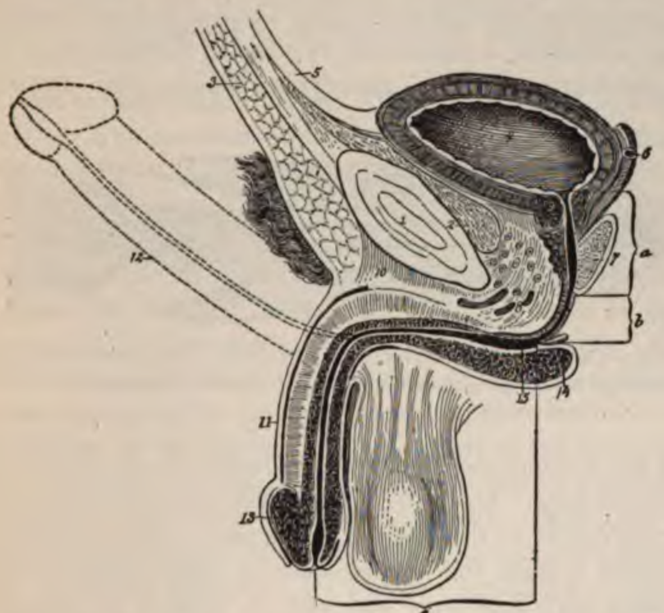


FIG. 621.—Section of penis, bladder, etc. (Testut.) 1, Symphysis pubis; 2, prevesical space; 3, abdominal wall; 4, bladder; 5, urachus; 6, seminal vesicle and vas deferens; 7, prostate; 8, plexus of Santorini; 9, sphincter vesicæ; 10, suspensory ligament of penis; 11, penis in flaccid condition; 12, penis in state of erection; 13, glans penis; 14, bulb of urethra; 15, cul-de-sac of bulb. *a*, Prostatic urethra; *b*, membranous urethra; *c*, spongy urethra.

length of the penis. For purposes of description it is divided into the following portions, corresponding to the parts through which it passes: (1) The spongy portion, or pars cavernosa, (2) the membranous portion, or pars membranosa, and (3) the prostatic portion, or pars prostatica (Fig. 621). Clinically and for all practical purposes, however, it may be divided into the anterior urethra, that portion lying in front of the anterior layer of the triangular ligament; and the posterior urethra, the portion lying behind the anterior layer of the triangular ligament.

The Spongy Urethra.—It extends the entire length of the corpus spongiosum opening externally upon the glans penis as a vertical slit, the meatus. The spongy urethra measures on the average about 6 inches (15 cm.). The lumen of this portion of the urethra is not of the same size throughout, but presents two fusiform dilatations, one at the bulb, the bulbous urethra, and the other within the glans, the fossa navicularis.

The mucous membrane is pale pink in color and has opening upon its surface a number of glands and crypts. In the floor of the bulbous portion the ducts of Cowper's glands open side by side. Scattered all

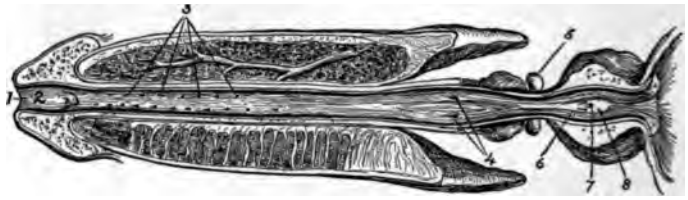


FIG. 622.—The interior of the urethra. 1, Meatus; 2, fossa navicularis; 3, urethral glands; 4, orifices of Cowper's glands; 5, Copwer's glands; 6, ejaculatory ducts; 7 sinus pocularis; 8, verumontanum.

through the mucous membrane of the urethra are the urethral glands or glands of Littré. Upon the roof, the mucous membrane is studded with small crypts or diverticula, the lacunæ. The orifices of these lacunæ open toward the meatus forming little pockets into which instruments may find their way and be arrested in their passage. One of these, the lacuna magna, is especially liable to interfere with the passage of instruments. It lies in the roof of the fossa navicularis about 1 inch (2.5 cm.) from the meatus. These mucous glands and lacunæ are liable to infection and may become the seat of small gonorrheal abscesses.

The Membranous Urethra.—It is that portion of the urethra lying between the two layers of the triangular ligament, and extends from the apex of the prostate gland to the bulb of the spongy portion. It measures about ½ inch (1 cm.) in length. The membranous urethra is the most fixed, as well as the least distensible of all segments of the urethra. In its course it pierces both layers of the triangular ligament and receives prolongations from these structures, and is also surrounded by the compressor urethræ muscle. Spasm of this muscle is a frequent hindrance to catheterization and the passage of sounds. Embedded in the fibers of the compressor urethræ and on either side of the membranous urethra lie the glands of Cowper, the ducts from which open in the anterior portion of the bulbous urethra.

The mucous membrane lining this portion of the canal is darker in color and much more sensitive than that in the spongy portion.

Prostatic Urethra.—It measures 3/4 to 1 1/4 inches (2 to 3 cm.) in length and extends from the internal urethral orifice to the posterior layer of the triangular ligament, traversing the prostate gland from base to apex. In the presence of hypertrophy of the prostate, the caliber of this portion of the canal may become obstructed or deformed.

The floor of the prostatic urethra is encroached upon by a fusiform swelling, the verumontanum or caput gallinaginis. At the front and most prominent part of the verumontanum is seen the slit-like opening of the sinus pocularis, a blind pouch or diverticulum, usually 1/4 to 1/3 inch (6 to 8 mm.) in length, which runs up in the substance of the prostate beneath the middle lobe. It is regarded as homologous with the uterus in the female. Within the sinus pocularis or upon its margins are the slit-like openings of the ejaculatory ducts. On each side of the verumontanum is a depression, the prostatic sinus into which the openings of the prostatic ducts empty.

The Caliber of the Urethra..—The caliber of the urethra varies greatly. While the average diameter is 0.3 inch (7.5 mm.) or 27 French scale, the individual urethra is not of the same uniform caliber from end to end, there being a number of constricted and dilated portions. The wide parts are: (1) The pars prostatica, (2) the bulbous urethra, and (3) the fossa navicularis. The narrow portions are: (1) The meatus, (2) the penoscrotal junction, (3) the membranous urethra, and (4) the internal prostatic opening Of these the meatus is the narrowest, and in a normal individual an instrument that will pass the meatus should pass the other narrow points.

Normally, the walls of the urethra are in contact and on cross section the canal appears as a mere slit. In the prostatic portion, from the projection of the verumontanum, it has the appearance of a half moon, in the membranous portion it is star-shaped; in the cavernous portion, it appears as a transverse slit; in the glans, as a vertical slit.

Curves of the Urethra.—The anterior urethra is freely movable and may be made to assume any curve. The posterior urethra is fixed, however, between the suspensory ligament of the penis and the internal vesical opening, and its natural curves are important to bear in mind in the passage of instruments. In the prostatic portion the direction of the urethra is downward; in the membranous, downward and forward; and in the spongy portion, forward and slightly upward for 2 inches (5 cm.), and then sharply downward. Thus two curves are formed: (1) concave forward, and (2) concave downward. The latter may be straightened or obliterated by lifting up the penis, but the first is fixed and can only be straightened by using some force. In children and in thin individuals, the fixed curve is much sharper, while in large, stout men it becomes flattened. A distended bladder or an enlarged prostate lengthens it.

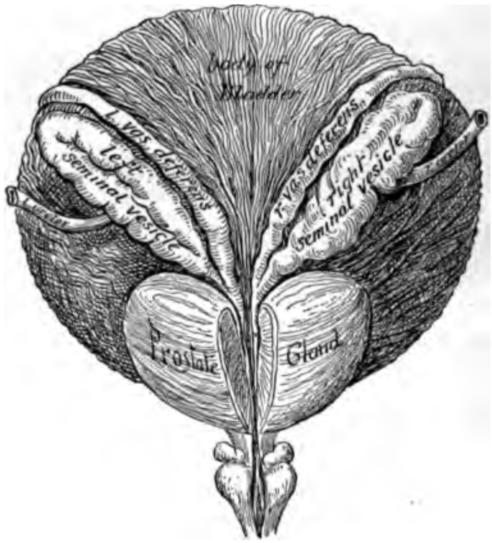


FIG. 623.—The prostate gland and seminal vesicles.

The Prostate Gland.—The prostate is a sexual organ composed of glandular, muscular, and fibrous tissue, lying in front of the neck of the bladder. It is pierced above by the urethra and below by the ejaculatory ducts. In shape it resembles an irregular truncated cone, the apex of which rests against the posterior layer of the triangular ligament while the base is directed toward the bladder. In size it measures about 1½ inches (4 cm.) transversely, 1¼ inches (3 cm.) vertically, and ¾ inch (2 cm.) longitudinally. It weighs 4 to 6 drams (16 to 24 gm.). The size of the prostate is not constant, however, varying greatly in different individuals and depending upon the age of the patient. In a child, the gland is only rudimentary, not reaching the full size until about the twenty-fifth year. During the later years of life, it often becomes hypertrophied, not infrequently enlarging to over twice its original size.

The prostate consists of two lateral lobes which bulge posteriorly and a so-called middle lobe. The latter is that portion of the gland which lies between the two ejaculatory ducts directly posterior to the beginning of the urethra. If enlarged, as occurs when the gland is the seat of senile hypertrophy, the median lobe forms a projection which may cause urinary obstruction and interfere with the passage of instruments. The two lateral lobes meet and become continuous in front and behind the urethra. The tissue forming this union in front is spoken of as the anterior commissure and the portion behind as the posterior commissure or isthmus (pars intermedia).

The Female Urethra.—It extends from the neck of the bladder to the external urinary meatus, curving downward and a little forward. The female urethra measures 1¼ to 1½ inches (3 to 4 cm.) in length and ¼ inch (6 mm.) in diameter, but, as it is not surrounded by resisting structures, it is possible to so dilate it as to admit the finger. It lies in front of, and is very closely associated with, the anterior wall of the vagina through which it may be readily palpated.

Its walls, composed of muscular, erectile, and mucous tissue, are normally in contact, presenting a stellate appearance on cross section. The mucous membrane is pale in color and is thrown into a series of longitudinal folds, one of which, on the upper half of the posterior wall, is quite marked and corresponds to the verumontanum in the male. The compressor urethræ muscle surrounds it, between the layers of the triangular ligament.

Close to the posterior margin of the external urethral orifice on either side of the mid-line are the tubes of Skene. As in the male, the external meatus is the narrowest portion. It appears as a vertical slit, ⅕ to ¼ inch (5 to 6 mm.) in length, about 1 inch (2.5 cm.) posterior to the base of the clitoris.

Diagnostic Methods

In the examination of the urethra some definite system should be followed. The first step consists in taking a careful history of the case. This should embrace the family history, a history of past ailments, and the patient's description of the present trouble, its onset, duration, etc. While in some cases of urethral disease exhaustive questioning of the patient is superfluous, it will be found that an exact history will often be of the greatest aid in arriving at a correct diagnosis.

The examiner should then take up more in detail the symptoms complained of by the patient. It should be ascertained whether the patient has or has had a urethral discharge, and, if so, its character; whether it is sufficient to stain or stiffen the linen, or whether it simply glues the lips of the meatus together; whether it occurs only with the first urine passed, or in the intervals as well; whether there is any discharge with defecation; also whether defecation is accompanied by pain about the prostate or rectum. It is important to inquire into the act of urination, ascertaining whether the passage of urine causes any pain, and, if so, its character, and whether the pain is present at the beginning or end of the act; also whether there is an increased frequency in urination. The patient should be questioned as to the character of the stream of urine, its force and caliber; whether there is any dribbling; whether the stream is interrupted or suddenly stopped, such as would be the case with enlargement of the prostate or in the presence of a vesical calculus. The character of the urine passed should also be inquired into; whether the presence of blood has been noted, and whether shreds are present, and their character. More exact information upon these latter points, however, will be obtained after a complete examination of the urine.

Having questioned the patient along the lines above indicated, secretions and discharges, if present, should be collected for examination (see pages 283, 295), and then the actual examination of the urethra and prostate may be taken up. The methods available for this include: (1) glass tests and injection tests for the purpose of locating the seat of the discharge, (2) inspection, (3) palpation, and (4) instrumental examination. *The use of instruments, however, should not be undertaken if there is an active discharge from the urethra* for fear of aggravating the inflammation and producing such complications as abscess, stricture, etc. It is far better to postpone such exploration until the severity of the inflammation and the discharge have been reduced by the use of injections or irrigations.

GLASS TESTS

A number of tests have been employed for the purpose of determining whether the seat of the pus has its origin in the anterior or posterior urethra. The simplest of these are known as the two-glass test and the five-glass test.

The Two-glass Test.—It is performed as follows: The patient is instructed to hold his urine for three or four hours, and upon presenting himself for examination he is told to urinate into two glasses or graduates. He should pass about 2 ounces (60 c.c.) into the first glass and the remainder into the second. If the contents of the first glass, in which are collected the washings from both the anterior and posterior urethra, contains pus or shreds revealed by holding the glass before a strong light and the contents of the second glass is clear, it may be inferred that the anterior urethra is involved, but the posterior urethra, if at all, only slightly so. If, on the other hand, the contents of both glasses are cloudy or contains shreds, it shows that there is sufficient secretion from the posterior urethra to have escaped into the bladder and discolored its contents, or that the secretion come from the bladder itself, the ureters, or kidneys. In the former case, the contents of the first glass is more turbid than that in the second glass; while in the latter conditions there is but little difference between the two specimens.

Another method and one that is more certain in differentiating between an anterior and posterior urethritis, consists in first thoroughly irrigating the anterior urethra with a warm boric acid or normal salt solution by means of a catheter introduced as far as the bulb, and then having the patient urinate into two glasses. If the contents of both glasses are clear, we may be sure the posterior urethra is free. Pus or shreds appearing in the second glass indicate a posterior urethritis, or that they come from the bladder or beyond.

The Wolbarst Five-glass Test.—This is more reliable than the the two-glass test in determining the source of shreds or pus. The technic is as follows: The patient presents himself with a full bladder, having held his urine for 4 or 5 hours. The meatus is thoroughly washed off to remove any adherent secretion, and the anterior urethra is irrigated by means of a hand syringe with sterile water. These washings are collected in the first glass and represent the contents of the anterior urethra. Further irrigation of the anterior urethra is performed until it is certain that the urethra is clean as far back as the cut-off muscle, and these washings are collected in glass two, or the control anterior urethral glass. A soft sterile catheter is next introduced into the bladder and a sample of its contents is drawn off into a third glass. This represents the bladder urine. If this specimen proves to be clear and free from shreds, the catheter is removed and the patient is instructed to void an ounce or two (30 to 60 c.c.) of urine into a fourth glass. This glass represents the contents of the posterior urethra and, if it contains shreds or pus, it is evident they originate in the posterior urethra as the anterior urethra and bladder are clean. If it should be found, however, that the contents of the second glass is not clear, that is, if the bladder urine is cloudy, the catheter is left in place and the bladder is emptied and is then washed out with sterile water, allowing from 4 to 6 ounces (120 to 180 c.c.) of clear solution to remain. The catheter is then removed and the test is carried out as before for the fourth glass. The prostate is next thoroughly massaged and the patient then voids the urine or solution containing pus expressed from the prostate and seminal vesicles into a fifth glass. If desired, the right and left seminal vesicles may be massaged and their contents collected in similar manner in a sixth and seventh glass as is done in the seven glass test of Pedersen.

INJECTION TEST

For the purpose of differentiating between an anterior and a posterior urethritis, the anterior urethra may be injected with a solution that will color the shreds in that portion of the canal. A 1 per cent. solution of methylene blue is employed. By means of a blunt-pointed urethral syringe the anterior urethra is filled with the methylene blue and the patient is instructed to hold the solution in the urethra for about a minute. The solution is then allowed to escape. If upon urination the shreds appear blue, they come from the anterior urethra; unstained shreds from the posterior urethra. A microscopical examination may be necessary, however, to determine whether the shreds remain unstained. In making this test it is essential that the patient should not have urinated for some time previously.

INSPECTION

In the Male.—In the male, inspection of the urethra without the aid of instruments is limited to the meatus and the exterior of the canal as far as the peno-scrotal junction. Swelling, signs of inflammation, new growths, etc., which present externally may thus be recognized. While comparatively limited in scope, inspection should never be neglected, but should form part of the routine examination.

Position of Patient.—The patient may stand or lie flat upon a table.

Technic.—The penis is elevated so as to bring its under surface to view and any abnormalities are noted. The presence or absence of a discharge should also be determined. By stripping the urethra from the scrotum forward by means of the index-finger applied externally, the presence of any discharge may be demonstrated. If present, some should be deposited upon a slide, and later should be stained and examined for gonococci.

In the Female.—In the female, the mouth and the vaginal surface of the canal in its entire course may be inspected.

Position of Patient.—The patient should be placed in the dorsal position.

Technic.—The operator, sitting in front, separates the labia and notes the condition of the meatus and searches for signs of inflamma-

FIG. 624.—Method of stripping a discharge from the urethra. (Ashton.)

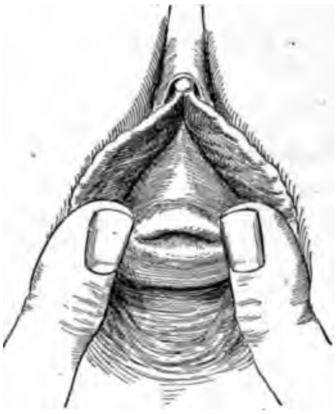


FIG. 625.—Method of inspecting the urethral orifice in the female. (Ashton.)

tion, the presence of new growths, eversion of the mucous membrane, discharges, etc. The presence of the latter may be more readily demonstrated by stripping the canal from the bladder forward by means of a finger passed into the vagina (Fig. 624). The mouth of the urethra may be exposed by drawing the lips apart by means of the fingers, one placed on each side as shown in Fig. 625. In this manner the orifices of Skene's glands may be exposed. Finally, the index-finger or a speculum is passed into the vagina and its posterior wall is depressed, so that the whole extent of the vaginal surface of the urethra is exposed. In this manner tumors, dilatations, cysts, sacculations, etc., will be noted.

PALPATION

In the Male.—Like inspection, palpation of the urethra is of limited value, especially in the male. By it, however, changes in the consistency, sensitiveness, and form of the canal may be recognized.

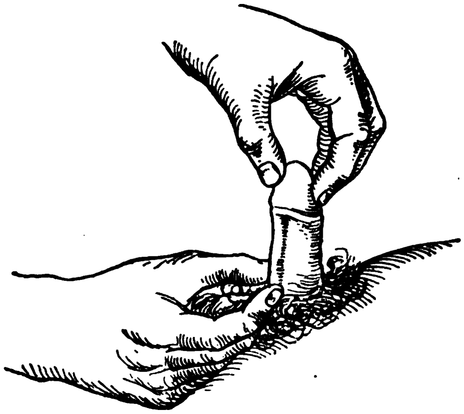


FIG. 626.—External palpation of the urethra.

Position of Patient.—The urethra may be palpated with the patient standing or in the dorsal position. To palpate the prostate

FIG. 627.—Showing the method of palpating the prostate gland.

the patient should be placed in the knee-chest position, or should bend over with the hands resting upon a chair and the thighs separated.

Technic.—In palpating the urethra the penis should be grasped just behind the glans between the thumb and the forefinger of the left hand, and, while putting the organ on the stretch, the penile portion of the urethra is palpated between the thumb and the forefinger of the right hand (Fg 626). It should be noted whether the urethra is elastic, as it normally is, or whether it is hard, indurated, or nodular. An inflamed urethra will be painful to the touch and will feel tense and swollen. A urethral abscess appears as a painful swelling bulging the wall of the canal. A cancerous growth will be hard, nodular, and adherent. By inserting a sound and then palpating the urethra

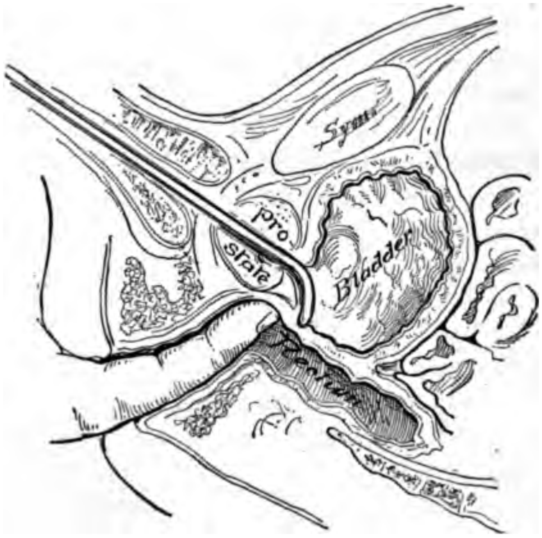


FIG. 628.—Combined rectal and instrumental examination of the prostate gland.

upon it more valuable information may be obtained, as changes in the consistency of the canal will be accentuated.

To palpate the membranous urethra and prostate a rectal examination will be necessary. For this the bladder should preferably contain a little urine. The operator, standing upon the patient's left, inserts his right forefinger, protected by a finger cot and well lubricated, into the bowel (see Palpation of the Rectum, page 579). After passing the sphincter, the examining finger comes in contact with the membranous urethra for a space of ½ inch (1 cm.), and then the prostate gland is reached. Normally, the latter is not very distinctly felt, but in the presence of hypertrophy it readily is, and sometimes it is so enlarged that it may be palpated bimanually. Points of tenderness, softening, painful swellings, or a general enlargement should be looked for and any difference between the two lobes, should be noted. The condition of the seminal vesicles should likewise be investigated. They lie above each lobe of the prostate extending upward and outward, but are not palpable, unless enlarged or thickened by disease.

If desired, the seminal vesicles and prostate may at this time be massaged for the purpose of obtaining their secretions for examination. This is done by carrying the finger up over each seminal vesicle in turn and, while making firm pressure, carrying the finger downward over the lobe of the prostate toward its base. The massage will force the discharge into the urethra and it may then be collected upon a clean slide by stripping the urethra from behind forward.

At times a combined examination with the finger in the rectum and an instrument in the urethra will be of assistance in exploring the prostate. A bladder sound or other metallic instrument is introduced into the bladder, and; by engaging the prostate between it and the examining finger (Fig. 628), the extent of hypertrophy as well as the amount of induration may be ascertained.

In the Female.—In the female, the entire canal may be explored by palpation through the vagina and valuable information is thus often obtained

Position of Patient.—The patient is placed in the dorsal position.

Technic.—The examiner, sitting in front, separates the labia with the fingers of his left hand, while he palpates with his right index-finger. The meatus is first examined by pressing with the examining finger, placed just outside the vaginal outlet, up against the symphysis. Then by means of the index-finger in the vagina the whole length of the urethra may be explored by tracing the course of the canal back as far as the bladder. By rolling the urethra with the index-finger from side to side and exerting pressure upward upon the canal with the inferior and posterior surfaces of the symphysis as points of counter-pressure, changes as to sensitiveness, consistency, or form of the canal may be readily recognized.

EXAMINATION BY SOUNDS AND BOUGIES

Having obtained all the informaton possible by the means already detailed, an instrumental exploration of the urethra, *provided the latter is not the seat of an acute inflammation*, for the purpose of determining the presence or absence of strictures is, the next step. While such symptoms as a gleety discharge, dribbling at the end of urination, malformation in the shape of the stream, difficulty in starting the stream, retention of urine, etc., may point strongly to the presence of a stricture, they are by no means infallible, and it is only by a careful local examination of the urethra that the diagnosis of

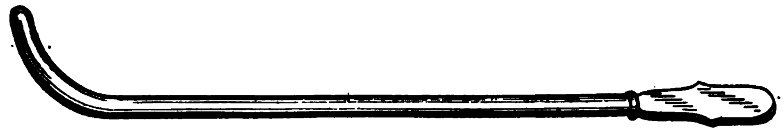


FIG. 629.—Blunt steel sound.

stricture can be absolutely made. For the purpose of simply locating a stricture and determining its size, sounds and bougies are employed, while for determining the length of the contracture the bulbous bougie or bougie à boule is necessary.

FIG. 630.—Flexible urethral bougie.

In inserting an instrument into the urethra, the utmost gentleness is required. The instrument should be passed slowly so that, if an obstruction is suddenly encountered, there will be no danger of producing injury to the canal; even *the slightest force should always be*

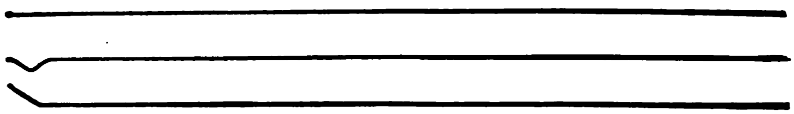


FIG. 631.—Filiform bougies.

avoided. It is only by cultivating a delicate touch and keeping in mind the anatomical variations in the urethra that painless manipulation of urethral instruments is possible. In making such an exam-

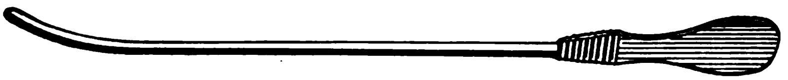


FIG. 632.—Female sound. (Ashton.)

ination it should be remembered that the passage of an instrument for the first time may result in a severe chill, and a rise of temperature. To prevent this, it is well to terminate the examination with an instillation of 1 to 1500 nitrate of silver to lessen the urethral congestion. After one exploration the urethra should be given a rest for a few days, as not infrequently the irritation produced aggravates a chronic urethral discharge.

Instruments.—Blunt steel sounds of the proper curve (Fig. 629) are preferable for the exploration of strictures of large caliber. There is considerable risk of injuring the urethra when a rigid steel instrument of a size smaller than 15 French is used, and it is safer for those not especially skilled in the manipulation of urethral instruments to employ woven-silk olivary bougies (Fig. 630) in examining small strictures. A set of these instruments from the smallest size made up to No. 20 French should, therefore, be at hand. The best are made in France. For finding the channel through very tight strictures whale-bone filiform bougies (Fig. 631) are necessary. They are provided with small bulbous points from which they taper for an inch (2.5 cm.) or so until the full size of the shaft is reached. To facilitate the entrance of these instruments into tortuous canals the tips may be softened in hot water and then bent into various shapes, as curves, spirals, angles, etc. For diagnostic purposes the filiforms should be about 12 inches long (30 cm.). For exploring the female urethra a slightly curved steel sound is employed (Fig. 632).

FIG. 633.—Formalin sterilizer for urethral instruments.

a, Top; *b*, rack for catheters; *c*, container for formalin.

Asepsis.—Metal instruments are boiled for five minutes in a 1 per cent. soda solution. The best makes of the silk-elastic instruments may also be boiled, but some of the others will not last long if so treated, and it is safer to sterilize them in formalin vapor for twenty-four hours and then rinse well in sterile water before using. A special apparatus (Fig. 633) is required for this, however. It consists of a glass cylinder about 16 inches (40 cm.) long with a perforated plate near the top for holding the catheters and in the base a receptacle for formalin tablets. In its absence the instrument may be soaked in a 1 to 20 carbolic acid solution followed by immersion in a saturated boric acid solution and rinsing in sterile water. Whale-bone bougies may be boiled, though they will not stand prolonged boiling. The examiner's hands should be as carefully cleansed as for any operation.'

The glans penis should be first washed with soap and water, then with a 1 to 5000 bichlorid solution followed by sterile water. The urethra is irrigated with a warm saturated solution of boric acid or with a 1 to 5000 solution of potassium permanganate both before and after the examination.

Position of the Patient.—The patient should lie in the dorsal position with his shoulders slightly raised and thighs flexed and rotated somewhat outward, and near that side of the table upon which the operator stands. The operator takes his place just above the patient's hips, facing the patient's body, upon whichever side of the table is most convenient for him—generally the left side is chosen.

Technic.—In beginning the examination *the largest instrument that will pass the meatus* should be introduced. As the meatus is the

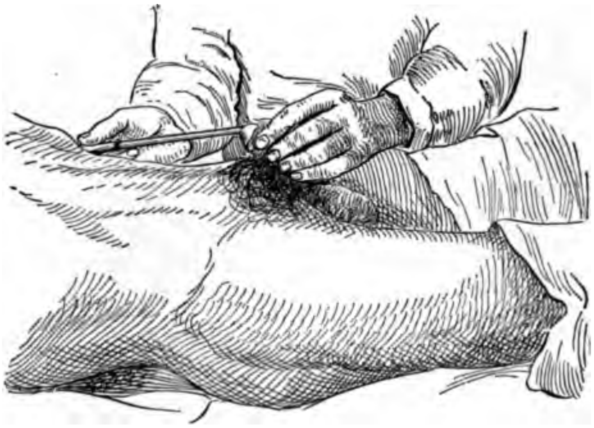


FIG. 634.—First step in inserting a urethral sound.

narrowest portion of the urethra, any instrument that can be introduced through it will pass along the entire canal, unless some contraction is present. Should the meatus be abnormally small, it may be enlarged by an incision (see page 679). The operator grasps the penis behind the corona between the ring and the middle fingers of the left hand and with the thumb and index-fingers of the same hand he retracts the foreskin and separates the lips of the meatus. The sound, warmed and well lubricated with one of the Irish-moss preparations, is grasped lightly between the fingers of the right hand, and is *gently* introduced into the meatus. As the point of the instrument is inserted in the meatus the handle should lie parallel to the abdominal wall and in line with the fold of the groin (Fig. 634). From this position the handle is gradually swept to the center line (Fig. 635), and the

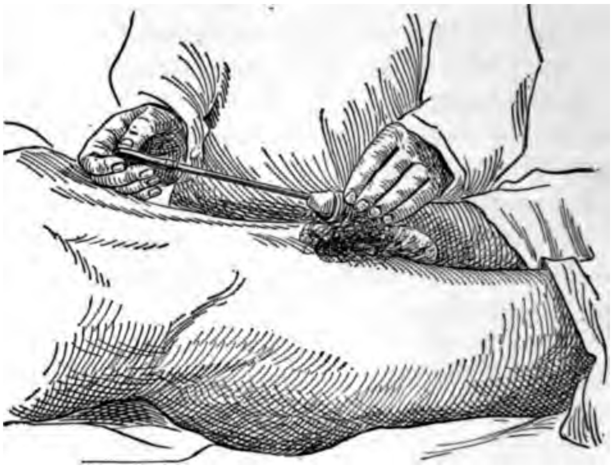
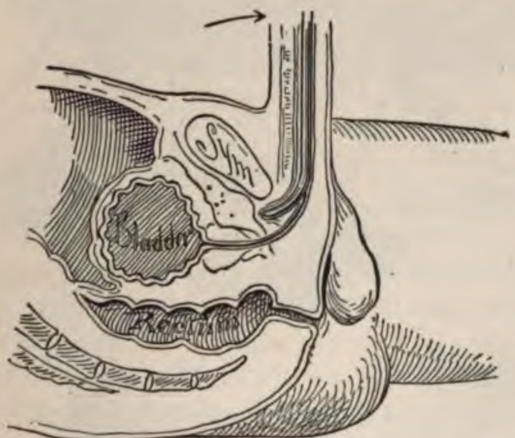


FIG. 635.—Second step in inserting a urethral sound.

FIG. 636.—Third step in inserting a urethral sound.

instrument is further introduced with its point first hugging the floor of the urethra and then *gently* following the roof of the canal through the rest of its course into the bladder. The instrument is then ished onward and downward, the penis being drawn over it until the int of the sound is deep in the bulbous urethra (Fig. 636). The ndle is next gradually raised to a perpendicular and is then de-

FIG. 637.—Fourth step in inserting a urethral sound.



. 638.—Showing false passage of sound from depressing the handle of the instrument too soon.

essed, thus permitting the point of the instrument to follow the ed curve of the urethra beneath the pubic arch (Fig. 637).

Care must be taken, however, not to raise the handle of the instrument too soon, that is before the beak has entered well into the bulbous uretha, as otherwise its point will be made to lodge against the upper part of the anterior layer of the triangular ligament instead of entering the membranous portion (Fig. 638). Again, the sound may

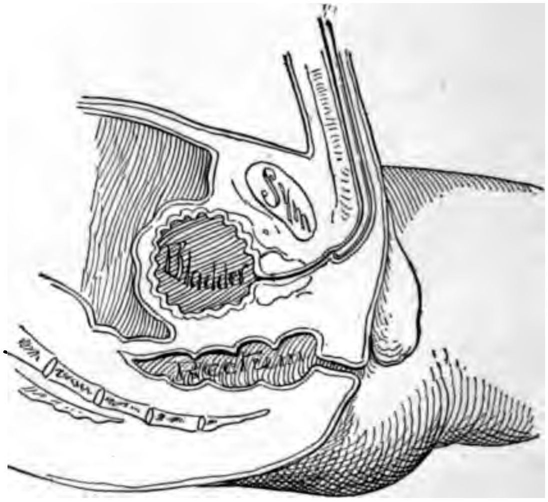


FIG. 639.—Showing the tip of the sound caught in the bulb at the anterior layer of the triangular ligament.

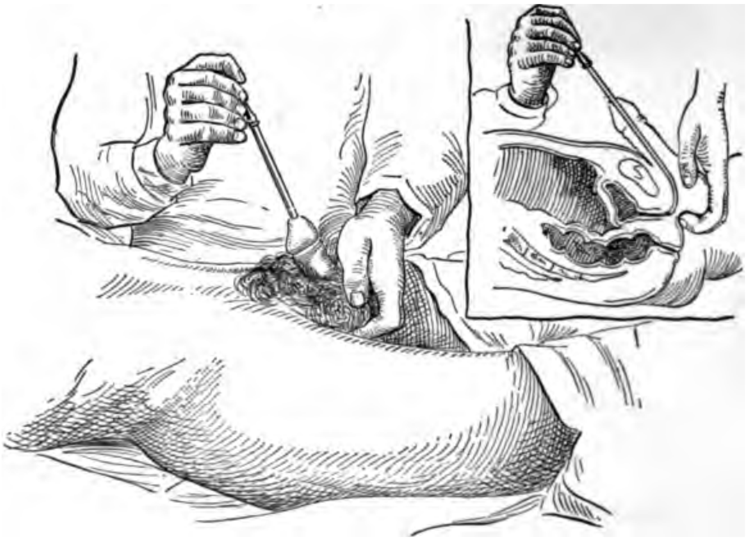


FIG. 640.—Method of lifting up the tip of the sound obstructed by the lower portion of the triangular ligament.

fail to enter the membranous uretha from the point lodging in the bulbous urethra against the lower portion of the triangular ligament

(Fig. 639). This may be avoided by depressing the handle and at the same time by lifting up on the point of the instrument with the fingers inserted behind the scrotum so as to press against the perineum (Fig. 640).

Having passed the beak of the sound into the membranous urethra it is then made to traverse the remainder of the canal and to enter the bladder by sweeping the handle forward and downward between the thighs (Fig. 641), provided, of course, that no obstruction has been encountered. While this is being done the free hand should make pressure over the pubes in order to relax the suspensory ligament of the penis.

By rotating the sound about its own axis it can readily be ascertained whether the beak has entered the bladder or is still in the

FIG. 641.—Final step in inserting a urethral sound.

prostatic urethra. Furthermore, by sweeping the beak of the instrument about the vesical neck any irregularity or disproportion between the two lobes of the prostate will be noticed.

If an obstruction is met in any portion of the canal, the instrument should be slightly withdrawn, and the penis put on the stretch, so as to straighten out any folds of mucous membrane in which the point of the instrument may have caught. If it then fails to pass, the obstruction is due either to spasm or to an organic stricture. When the seat of obstruction is in front of the bulbous urethra, spasm may be ruled out, but an obstruction at the bulbo-membranous junction or in the membranous urethra, on the other hand, is often caused by spasm. To determine this, the instrument is not withdrawn, but should be kept firmly and gently pressed against the face of the obstruction for a few moments, when, if spasm were the cause, it will in time subside so that the instrument can be readily passed into the bladder. Furthermore, upon attempting to withdraw the instrument, that characteristic grasping of the instrument such as is found in the presence of a tight organic stricture will be absent. When an obstruction is met deeper than 6½ inches (16 cm.) from the meatus, or in the prostatic urethra, stricture may be ruled out; such an obstruction may be due to an enlarged prostate, a stone, or spasm of the internal sphincter.

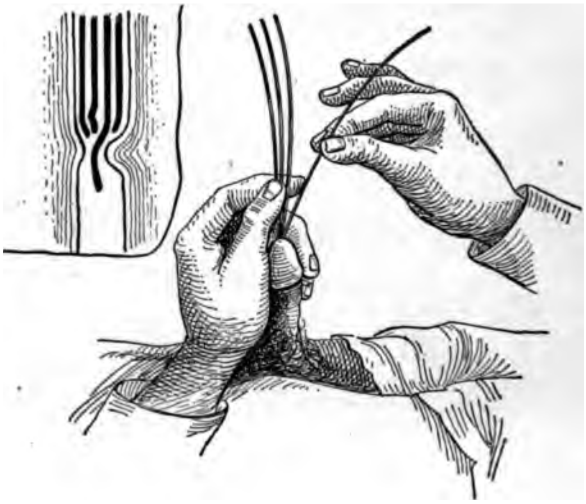


FIG. 642.—Showing the method of passing a filiform bougie through a small stricture by first filling the canal with filiforms.

In this way the presence of a stricture is determined and its distance from the meatus is readily estimated. To ascertain its caliber is the next thing. When the examining instrument encounters the stricture no force should be used in attempting to make it pass; instead, that particular instrument is withdrawn, and smaller sizes inserted in succession, substituting flexible bougies for steel instruments below a No. 15 French, until an instrument is found that will readily pass. If even the smallest-size bougies will not pass, filiforms should be used. As a general rule, *no attempt should be made to pass a filiform on the same day that other exploration has been attempted*, for after repeated attempts have been made to pass an instrument, the opening in the stricture becomes distorted from pressure of the sounds or bougies, and for a time is impassable even to a filiform. In using filiforms it should be remembered that, owing to their small size, they are liable to be obstructed from being caught in folds of mucous membrane or in the orifices of the glands and ducts so abundant throughout the urethra, and it is very easy to make a false passage with one of these instruments if undue force is used. If a filiform catches in a pocket or fold of mucous membrane, it should be withdrawn slightly, and then gently advanced, or it may be gently rotated as it is advanced. Sometimes the passage of a filiform will be greatly facilitated by injecting sufficent sterile oil through the meatus alongside the filiform to thoroughly distend the canal, and then, while keeping the lips of the meatus closed, the instrument is gently advanced.

When once an instrument has entered the stricture there can be no doubt of this fact from the tightness with which it is grasped by the stricture, a sensation, which, once recognized, will not be forgotten. Should the operator be unable to find the opening with a single filiform, the canal may be filled with them and, by first advancing one and then another, it will usually be possible to make one engage in the stricture (Fig. 642). Failing by this maneuver, a urethroscope may be introduced down to the face of the stricture and through it the instrument may be passed under direct vision.

After such exploration the urethra should be irrigated with warm normal salt solution or with a warm saturated solution of boric acid.

EXAMINATION BY THE BOUGIE À BOULE

The bougie à boule or bulbous bougie is employed for the purpose of determining the size and length of a stricture. The usefulness of this instrument is limited to the anterior urethra, as, if passed into the membranous portion, the compressor urethræ muscle is liable to contract about the bulb of the instrument and give a sensation of stricture. Furthermore, when the canal is the seat of more than one stricture, it is frqeuently impossible with the bougie à boule to detect the deeper ones, as those in the anterior portion of the canal may be so tight that the passage of an instrument sufficiently large to detect the deeper ones is out of the question.

Instruments.—The bulbous bougie consists of a flexible shaft, upon the end of which is mounted an acorn-shaped tip. The head of the instrument should be short and should join the shaft at rather an abrupt angle. They are made of metal or of woven material with a rubber head (Fig. 643). The latter are preferable as being less rigid. These instruments are made in sizes from 5 to 40.

Asepsis.—The proper sterilization of these instruments has already been described in detail (page 640). The hands of the operator are to be thoroughly cleaned. The glans penis should be washed off with soap and water, and then wiped with a swab wet with a 1 to 5000 bichlorid of mercury solution, followed by sterile water. The

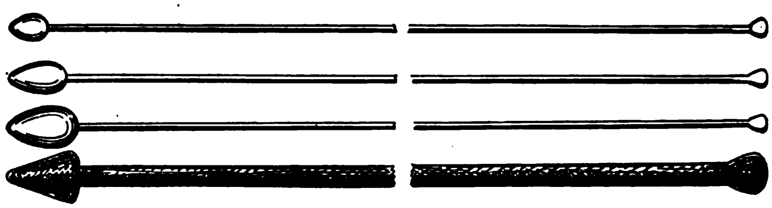


FIG. 643.—Urethral bougies à boule.

urethra should be irrigated with a 1 to 5000 potassium permanganate solution, or a saturated solution of boric acid both before and after examination.

FIG. 644.—Method of estimating the length of a urethral stricture. The bougie à boule arrested at the face of the stricture.

Position of Patient.—The patient lies upon a firm table in the dorsal position. The operator stands upon the side most convenient for him, facing the patient's body and just above his hips.

Technic.—As large an instrument as will pass the meatus is chosen. The operator grasps the penis behind the corona between the middle and ring fingers of the left hand, and with the thumb and forefinger of the same hand retracts the foreskin and opens the meatus. The bougie, well lubricated and held lightly between the thumb and first two fingers of the right hand, is introduced until an obstruction is met (Fig. 644). The distance of the obstruction from the meatus is measured upon the shaft and the instrument is withdrawn. Successively smaller sizes are introduced until a size that will pass the stricture is reached. From this the size of the stricture is determined. The instrument is passed entirely through the stricture, and is then withdrawn until resistance caused by the shoulder of the instrument striking the distal face of the stricture is felt (Fig. 645).

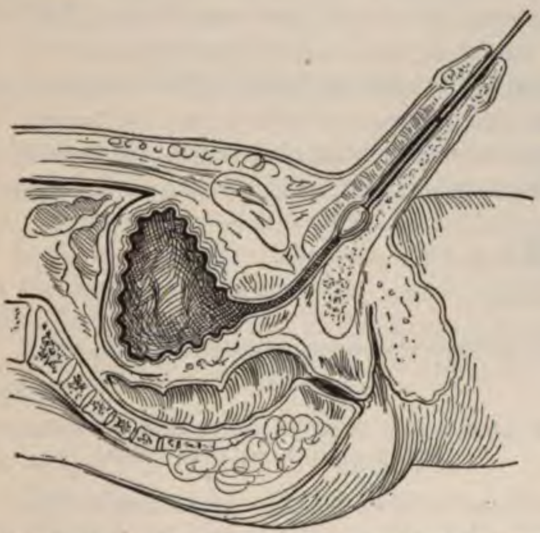


FIG. 645.—Method of estimating the length of a urethral stricture. The base of the bougie à boule withdrawn until in contact with the distal end of the stricture.

The shaft is then grasped at the meatus as a guide, and the instrument is removed. The distance from the meatus to the shoulder is then measured, and subtracting the previous measurement from this gives the length of the stricture. In this way the entire anterior urethra to the bulbo-membranous junction may be explored and strictures, if present, calibrated.

In exploring the deep urethra the shaft of the instrument, if of wire, should be bent to correspond to the normal curve of the canal. It is then introduced in the same manner as a sound (see page 641). As already mentioned, spasmodic contraction of the compressor urethræ muscle may simulate stricture. After removal of the bougie the urethra should be irrigated with boric acid solution.

URETHROMETRY

It is a method of measuring the caliber of the anterior urethra by means of a special instrument, the urethrometer. This instrument has an advantage over a sound or bougie in that it can be introduced through a narrow meatus and strictures of large caliber can be detected and measured. At the same time, several strictures may be examined by one insertion of the instrument. The method is, however, more irritating to the urethral mucous membrane than the use of a sound or bougie, and is it only applicable to the anterior urethra. In inexperienced hands it is often an unreliable method of examination, as strictures that do not exist may be imagined to be present, which turn out to be the normal constrictions of the canal.

Instruments.—The urethrometer of Otis (Fig. 646) consists of a small straight cannula marked off in inches and half-inches, ending in a series of short metallic arms hinged upon themselves, and upon the shaft of the instrument, which may be enlarged into a bulb-like shape

FIG. 646.—Otis' urethrometer. *a*, Instrument open; *b*, instrument closed; *c*, rubber stall to cover the end of instrument.

of any size—from 16 to 45 French—by turning a thumb-screw at the proximal end of the instrument. A dial and indicator show the extent of expansion. A thin rubber stall is drawn over the end of the instrument when closed, for the purpose of protecting the urethra.

Asepsis.—The urethrometer is boiled in a 1 per cent. solution of carbonate of soda. The external genitals are thoroughly cleansed, and the urethra is irrigated with a mild antiseptic solution. The operator's hands are sterilized in the usual way.

Position of Patient.—The patient is placed in the dorsal recumbent posture.

Technic.—The closed instrument, warmed and lubricated, introduced through the meatus and is passed as far as the bulb membranous junction. The bulb is then expanded by turning the thumb-screw upon the proximal end of the instrument until the patient feels a fulness in the perineum. This indicates the normal size of that portion of the urethra. The instrument is then slowly with drawn until an obstruction is met, when the instrument is screwed down until it is of sufficiently small size to pass and is then again enlarged and drawn forward. In this way the entire anterior urethra may be measured, and strictures located and calibrated. It should be remembered when employing this instrument that the urethra is not of uniform caliber, but normally is the seat of dilatations and constrictions. Thus, the bulbous urethra is the widest and most distensible portion, and the meatus the most contracted. More or less constriction of the canal is also encountered at the peno-scrotal junction.

At the completion of the operation the canal is irrigated with an antiseptic solution.

ESTIMATION OF THE LENGTH OF THE URETHRA

This procedure is of value in determining whether the prostate is enlarged. For practical purposes the length of the urethra is the distance it is necessary to pass a catheter from the meatus before urine begins to flow. This may vary from 6½ to 9 inches (16 to 22 cm.), but on the average it is 7½ to 8¼ inches (19 to 21 cm.). A marked increase beyond the normal in the urethral length indicates that the prostatic urethra is lengthened and that the prostate is therefore enlarged.

Instruments.—An ordinary silk gum-elastic catheter or a catheter marked off in inches (Fig. 647) may be employed.

Asepsis.—The catheter is boiled or immersed in a 1 to 20 carbolic acid solution followed by rinsing in sterile water. The external

Fig. 647.—Cathether marked off in inches.

genitals are thoroughly cleansed and the urethra is irrigated with a mild antiseptic solution. The operator's hands are also thoroughly cleansed.

Position of Patient.—The dorsal position is employed.

Technic.—The catheter, well lubricated, is introduced into the bladder until urine begins to flow. It is then withdrawn until the flow just stops and the point where the catheter protrudes from the meatus is noted. The distance from this mark to the eye of the catheter represents the length of the urethra. If the catheter passes without obstruction and urine begins to flow when the eye of the catheter is a distance of from 7½ to 8¼ inches (19 to 21 cm.) from the meatus, we may conclude that the prostate is not enlarged. On the other hand, a marked increase in the distance the catheter has to travel indicates an increase in the length of the prostatic urethra.

URETHROSCOPY

It consists in direct inspection of the interior of the urethra through a metal tube by the aid of suitable illumination. While in the routine examination of the urethra direct inspection is not always necessary, the urethroscope becomes a valuable instrument for

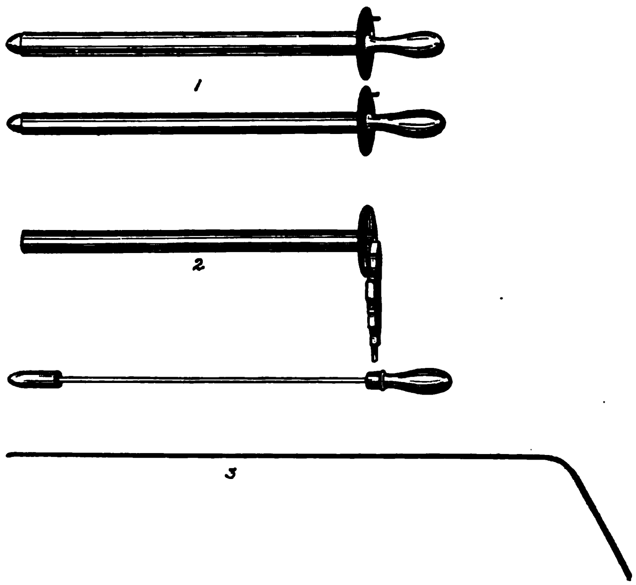


FIG. 648.—Instruments for urethroscopy. 1, Chetwood's tubes; 2, tube with light in place; 3, applicator.

the diagnosis of conditions in which the pathological changes are slight and of such a character as not to be detected by means of the sound or bougie. Lesions of the mucous membrane may be thus accurately located and their character definitely determined. Furthermore, by means of the urethroscope, it is possible to make local applications directly to diseased areas or to remove calculi, foreign bodies, polypi, etc. (see page 673). The instrument is also sometimes of value in the treatment of strictures, as by its aid it is possible to discover the opening of a very tight or eccentrically placed stricture and insert a filiform under direct vision.

To successfully employ the urethroscope care and gentleness in manipulation are absolutely essential and the operator must have had considerable experience in its use and must be familiar with the normal appearance of the different portions of the urethra in order to properly interpret the findings. If strictures exist or the caliber of the canal is below 22 French, preliminary dilatation by means of sounds should be carried out. In acute gonorrhea the use of the urethroscope is contraindicated.

Apparatus.—The urethroscope consists of a metal tube supplied with an obturator to aid in its introduction and an electric light for illuminating its interior. The tubes for use in the anterior urethra are straight and are 4 to 5 inches (10 to 12 cm.) long, while those for the posterior urethra are 5 to 6 inches (12 to 15 cm.) long; a

FIG. 649.—Swinburne's urethroscope for examining the posterior urethra.

straight tube may be used in the posterior urethra or the tube may be obtained with the distal end slightly curved to facilitate its introduction, as the Swinburne urethroscope (Fig. 649) or the Goldschmidt instrument. The caliber of the tubes is from 22 to 32 French. The illumination is furnished through a two- or four-volt lamp from a four- to six-dry-cell battery. In the Chetwood instrument, the illumination is supplied by means of a delicate cold lamp at the distal end of the instrument, while in the Otis urethroscope the light is placed at the proximal end of the instrument. In their stead, a head light and Klotz tube (Fig. 650) may be employed.

In addition to the urethroscope long slender applicators wrapped with cotton are necessary.

Asepsis.—The tube and applicators should be boiled for five minutes in a 1 per cent. soda solution, while the lamp may be immersed in a 1 to 20 carbolic acid solution and then in alcohol. The operator's hands should, of course, be sterile. The glans penis is washed with soap and water, and is then wiped with a 1 to 5000 bichlorid of mercury solution. The urethra is to be irrigated with a warm saturated solution of boric acid or 1 to 5000 potassium permanganate solution.

Position of Patient.—The patient should be upon a flat table in the recumbent position for anterior urethroscopy and in the lithotomy position for examination of the posterior urethra.

Fig. 650.—Klotz's urethral tube.

Anesthesia.—Cocain is not to be used if it can be avoided, as it alters the appearance of the mucous membrane somewhat and by deadening sensibility it conceals valuable information as to the condition of the canal. Hyperesthesia of the urethra, if present, may be lessened to a considerable degree by the passage of a full-sized sound once or twice before the intended examination.

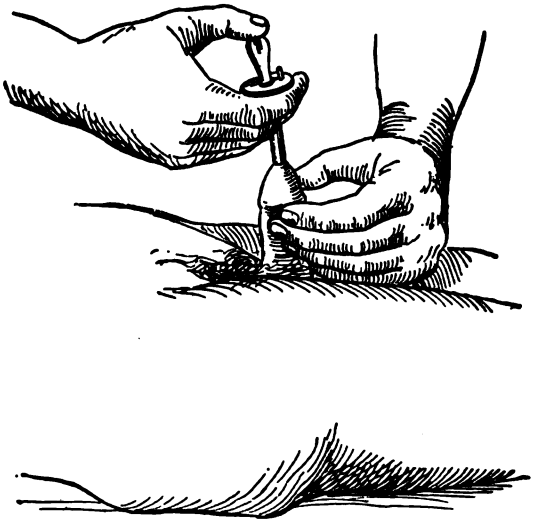


Fig. 651.—Method of inserting the urethroscope.

Technic.—A tube as large as will pass through the meatus should be used, as very little information is obtained by inspection through a small tube. If the meatus is abnormally small, it should be cut (see page 679). The patient voids his urine just before the examination is begun. Before proceeding with the examination, the patient is instructed to tell the operator if any particular sensitive spot is encountered while the instrument is being passed. The penis is held vertically upward in the fingers of the left hand, and the tube, well warmed and lubricated, and with the obturator in place, is inserted through the meatus (Fig. 651), and thence onward until it meets an obstruction or reaches the bulbous urethra, provided the anterior portion of the canal only is to be examined. If the prostatic urethra is to be inspected, the tube is inserted all the way into the bladder. This is accomplished by turning the

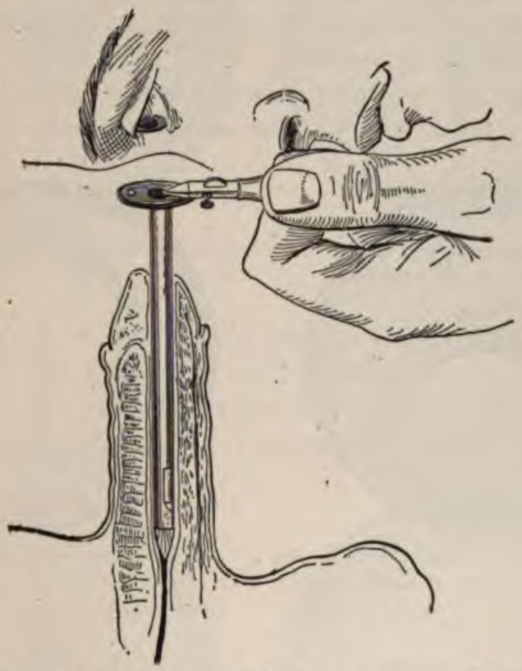


FIG. 652.—Showing the method of examining the anterior urethra through the urethroscope.

instrument down between the thighs to an almost horizontal position as soon as its point reaches the bulbous urethra and, at the same time, making gentle upward pressure upon the point of the instrument by means of the fingers on the perineum. In this way the point of the instrument is made to pass through the opening in the triangular ligament. The tube is then gently pushed on into the bladder. Inserting a straight tube into the posterior urethra is generally painful and it may not be possible without employing local anesthesia; introduction of the curved urethroscope is much less disagreeable for the patient.

As soon as the instrument is inserted to the desired depth, the obturator is removed, the light is turned on, and, as the tube is slowly withdrawn, the different portions of the mucous membrane are inspected as they appear in the end of the urethroscope (Fig. 652). If a clear view of the mucous membrane is interfered with by blood or secretion collecting in the end of the tube, long applicators covered with cotton should be inserted through the instrument and the mucous membrane mopped dry; care should be taken not to push the tube back in the canal after the examination has once begun without inserting the obturator, as the edges of the tube might cause damage to the parts.

Before one can become competent in recognizing pathological conditions it is necessary that the examiner should be acquainted

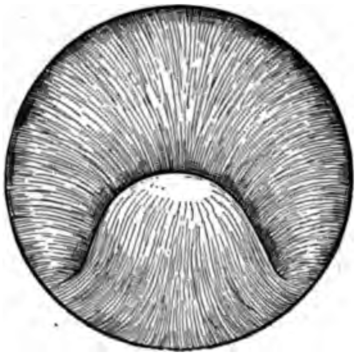


FIG. 653.—The appearance of the upper portion of the prostatic urethra. (After Stern.)

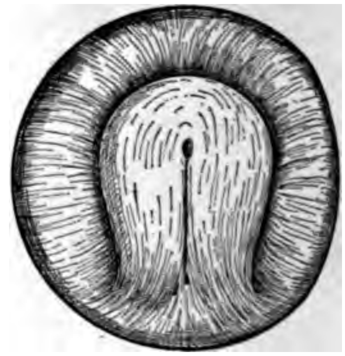


FIG. 654.—The appearance of the middle portion of the prostatic urethra. (After Stern.)

with the normal appearance and color of the urethral mucous membrane. Beginning at the posterior urethra in a normal case the central figure appears as a cone, the mucous membrane, which is of a dark red color, being thrown into longitudinal folds. As the instrument is withdrawn, the verumontanum comes to view in the form of a semilunar curve with the convexity upward (Fig. 653) and the mucous membrane appears of a bright red color. By slightly changing the position of the instrument, it is possible to obtain a view of the sinus pocularis and openings of the ejaculatory ducts (Fig. 654). Upon the further withdrawal of the instrument, the ridge of the verumontanum becomes gradually less marked and the mucous membrane takes on a paler hue. In the membranous urethra the central figure appears as a cone with a central dot.

the mucous membrane extending out in radiating folds (Fig. 655). In the bulbous urethra the central figure changes to a vertical slit with the mucous membrane bulging on each side (Fig. 656). In this portion of the canal the mucous membrane is still paler in color.

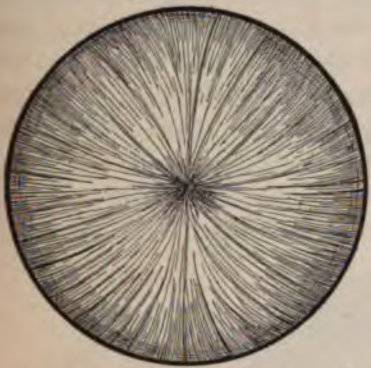


FIG 655.—The appearance of the membranous urethra. (After Stern.)

FIG 656.—The appearance of the bulbous urethra. (After Stern.)

The central figure then gradually changes from a vertical slit to a triangular opening (Fig. 657), and at the penoscrotal junction it takes the form of a transverse slit with radiating folds extending to the periphery (Fig. 658). In the pendulous urethra the central

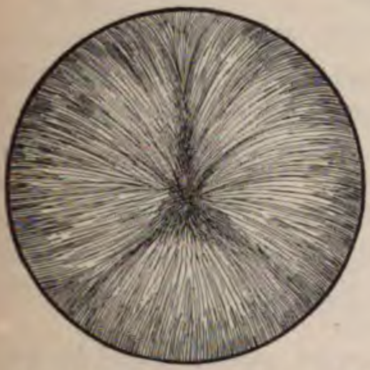


FIG. 657.—The appearance of the perineal portion of the spongy urethra. (After Stern.)

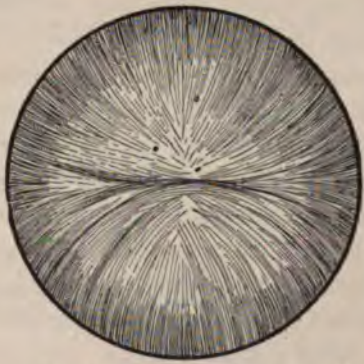


FIG. 658.—The appearance of the urethra at the penoscrotal junction. (After Stern.)

figure again becomes cone-shaped (Fig. 659) and, finally, at the meatus it appears as a vertical slit, the color of the mucous membrane changing from a pale pink to a purplish hue.

In examining the urethra through the urethroscope it should be first ascertained whether the normal elasticity of the canal is impaired or not. This is accomplished by noting the central figure as the tube is withdrawn. In chronic inflammatory conditions the urethra becomes more or less rigid and does not immediately collapse over the end of the urethroscope as it is withdrawn; instead, the cone-like central figure often becomes elongated or else distorted from being contracted at certain points, if the inflammation is a localized one, and, in addition, the whole mucous membrane in such cases not infrequently becomes of a paler hue than normal. Changes in the appearance of the mucous membrane should also be noted. In chronic urethritis there will at times be found localized congested areas, granular patches which frequently bleed, and superficial

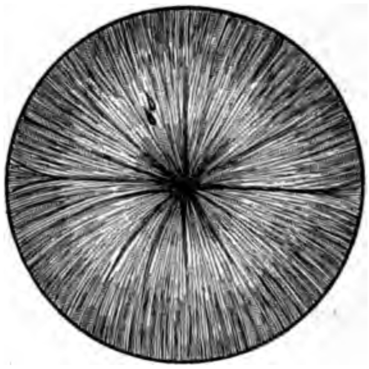


FIG. 659.—The appearance of the pendulous urethra. (After Stern.)

ulcerations covered with secretion. Inflamed lacunæ appear as red openings upon the surface of the mucous membrane from which will frequently be seen exuding drops of pus. Retention cysts, polypi, etc., are readily diagnosed by this means. If, during the examination, it is desired to more closely study the condition of the mucous membrane at any particular spot this may be accomplished by pushing that part into the field by digital compression upon the urethra below the end of the urethroscope.

After removal of the tube the anterior urethra should be irrigated with a warm saturated boric acid or normal salt solution, and. if the instrument has been passed into the deep urethra, the bladder should also be irrigated.

URETHROSCOPY IN THE FEMALE

The female urethra being shorter and capable of greater distention than that of the male lends itself more readily to examination by the urethroscope.

Instruments.—Short male endoscopic tudes or a regular female urethroscope may be employed. They may be obtained with the light at the distal end or, as in the Kelly tubes (Fig. 660), with the light reflected from a head mirror. The female urethroscope should be about 3 inches (7.5 cm.) long. The tubes vary in size anywhere from 24 to 36 French

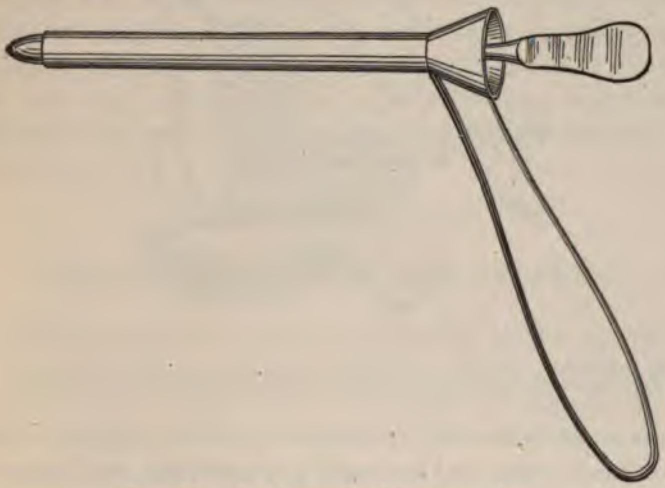


FIG. 660.—Kelly's urethral tube-speculum.

A Kelly cone-shaped urethral dilator (Fig. 661) should be provided for dilating the meatus. Applicators or alligator-jawed forceps and absorbent cotton will also be required.

Asepsis.—The tubes, applicators, etc., may be boiled for five minutes in a 1 per cent. soda solution. The lamp is sterilized by immersion in a 1 to 20 carbolic acid solution and then rinsed off in

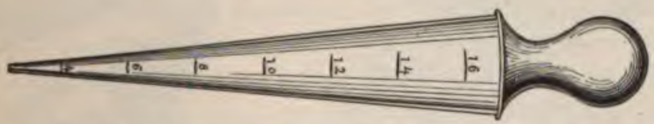


FIG. 661.—Kelly's cone-shaped urethral dilator. (Ashton.)

alcohol. The vulva and the external urethral orifice are sterilized by washing with tincture of green soap and water, next with a 1 to 5000 bichlorid of mercury solution, and finally with sterile water.

Position of Patient.—The dorsal posture is employed.

Anesthesia.—If the urethra is hyperesthetic, a small pledget of cotton saturated with a 2 per cent, solution of cocain is placed in the mouth of the urethra for a short time before the operation.

Technic.—The urine is voided before the examination begins. If necessary, the meatus is dilated sufficiently to admit a good-sized tube by means of a Kelly dilator (Fig. 662). The instrument, with

FIG. 662.—Showing the method of dilating the urethra. (Ashton.)

the obturator in place and well lubricated, is then inserted into the mouth of the urethra and is carefully passed into the bladder (Fig. 663). The obturator is next removed and the lighting apparatus is

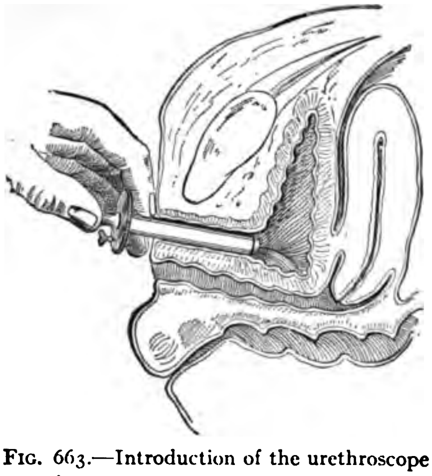


FIG. 663.—Introduction of the urethroscope into the female urethra. (Ashton.)

FIG. 664.—Showing the method of inspecting the female urethra through the urethroscope. (Ashton.)

properly adjusted. The instrument is then gradually withdrawn while the examiner notes the condition of the mucous membrane as it falls over the end of the tube (Fig. 664).

At the internal urethral orifice there appears through the urethroscope a large opening surrounded by a narrow ring of mucous membrane. As the instrument is withdrawn the central figure becomes first more oval and then lower down appears as a transverse slit with the mucous membrane thrown into folds that radiate to the periphery. Finally, at the external orifice the central figure appears as a vertical slit, while the mucous membrane appears thrown into a number of radiating folds. A posterior fold is especially marked in the upper portion of the canal; it is a continuation of the trigone.

The points to be noted in the examination have been sufficiently dealt with under the technic of male urethroscopy and will not be repeated here.

Therapeutic Measures

HAND INJECTIONS FOR THE URETHRA

The injection of solutions into the anterior urethra by means of a small hand syringe is employed either for simple cleansing purposes in preparation for the passage of urethral instruments or for the purpose of treating anterior urethritis. The efficiency of injections in limiting acute gonorrhea is a question and it is doubtful if they have much effect outside of removing the irritating discharges and cleansing the mucous membrane. They may, however, be prescribed in the acute stages in the form of mild antiseptic solutions to be used by the patient himself as an adjunct to irrigations carried out by the physician. In the declining stages of the disease or when the condition becomes chronic, astringent injections are of undoubted value in reducing the congestion and thus drying up the thin discharge that remains.

When injections are employed, certain precautions should be observed. In the first place, mild solutions are preferable to very strong ones, as being less irritating to the mucous membrane. They should not be strong enough to cause more than temporary pain or stinging, otherwise they are likely to do more harm than good. In the second place, the greatest gentleness in making the injection is necessary to avoid injuring the urethral mucous membrane. Furthermore, while it is desirable that the solution should be brought into contact with all the folds and depressions of the mucous membrane, it is important that the fluid should not be injected into the bladder, which, however, rarely happens, as the cut-off muscle interposes a barrier. If it should occur, infective material will necessarily be carried back into the deep urethra with a good chance of starting up a posterior urethritis and epididymitis. For this reason, only a small quantity of fluid should be injected at a time and that without force. Used with these precautions, injections may be safely employed by the patient himself when desired.

The Syringe.—The best form of instrument for injections is a hand syringe with a capacity of about 2 ½ drams (10 c. c.). It should be preferably of glass so that it can be sterilized by boiling. The nozzle should be cone-shaped (Fig. 665) that it may fit into the meatus, and it should be seen that it is perfectly smooth. Before using, the syringe should be tested to see that the piston moves easily and without any jerks. A basin should also be provided to receive the solution that flows back from the urethra.

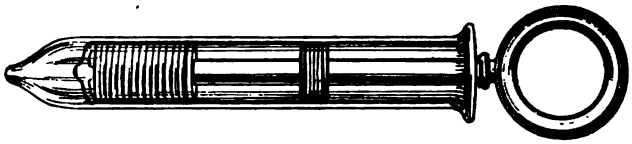


Fig. 665.—Urethral syringe.

Solutions Employed.—Many solutions with soothing, astringent, or antiseptic properties are employed, a few of which are given:

Sedative Injections

℞. Fl. ext. hydrastis,		♏xx–xxx (1.2–2 c.c.)
Aquæ destil.,		℥i (30 c.c.)
℞ Morph. sulph.,		gr. viii (0.5 gm.)
Cocainæ,		gr. iv (0.26 gm.)
Muc. acaciae,		℥i (30 c.c.)
Aquæ destil.	q.s.ad	℥ii (60 c.c.)

Astringent Injections

℞. Zinci sulphatis,	gr. iv-viii (0.26-0.5 gm.)
Aquæ destil.	℥iv (120 c.c.)
℞ Zinci sulphocarbolatis	gr. vi–xii (0.4–0.8 gm.)
Aquæ destil.,	℥iv (120 c.c.)
℞. Plumbi acetatis,	gr. iv–xii (0.26–0.8 gm.)
Aquæ destil.,	℥iv (120 c.c.)
℞. Zinci acetatis,	gr. i–xv (0.065–1 gm.)
Aquæ rosæ,	℥i (30 c.c.)

Antiseptic Injections

℞. Sol. protargol,	0.25 to 1 per cent.
℞. Sol. argyrol,	5 to 10%
℞. Sol. potass. permanganat.,	1–5000 to 3000
℞. Sol. bichlorid of mercury,	1–30,000

Temperature.—The solution should be used at about the temperature of the body.

Quantity.—Only sufficient quantity of the solution to distend the anterior urethra should be injected at a time. At first about ʒi (4 c.c.) should be used; later this may be increased to ʒiii (12 c.c.).

Frequency.—The injections may be employed three to six times daily, depending upon the severity of the case. As the symptoms improve they may be given less frequently. It should be remembered, however, that in some cases after a time the continued use of injections may prevent a discharge from entirely disappearing, and it is necessary to stop them entirely for a week or more before a cure is obtained.

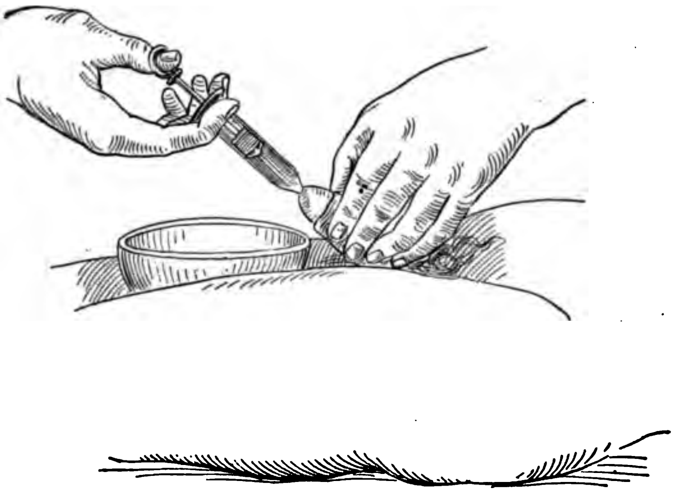


FIG. 666.—Method of giving a urethral injection.

Position of Patient.—Injections may be given with the patient lying recumbent or sitting upon the edge of a chair.

Preparation.—The glans penis and the lips of the meatus should be washed off with a 1 to 5000 solution of bichlorid of mercury.

Technic.—The patient urinates immediately before the injection is given so as to wash out as much of the discharge as possible and also that he may not have to urinate soon afterward, thus allowing the solution to remain in contact with the urethra the maximum length of time. The syringe is then filled with from 1 to 20 drams (4 to 8 c.c.) of solution, and any air is expelled by depressing the piston while the tip is elevated. The penis is held back of the corona between the thumb and forefinger of the left hand, while with the right hand the nozzle of the syringe is inserted into the meatus, far enough to completely occlude the meatus and prevent leakage, and the solution is gently injected into the urethra and immediately allowed to escape. A second syringeful of solution is then injected into the urethra until the latter is well distended (Fig. 666). The syringe is then removed and the meatus is held together for from three to five minutes so as to keep the solution in contact with the mucous membrane (Fig. 667). The solution is then allowed to run out into the receptacle provided for the purpose.

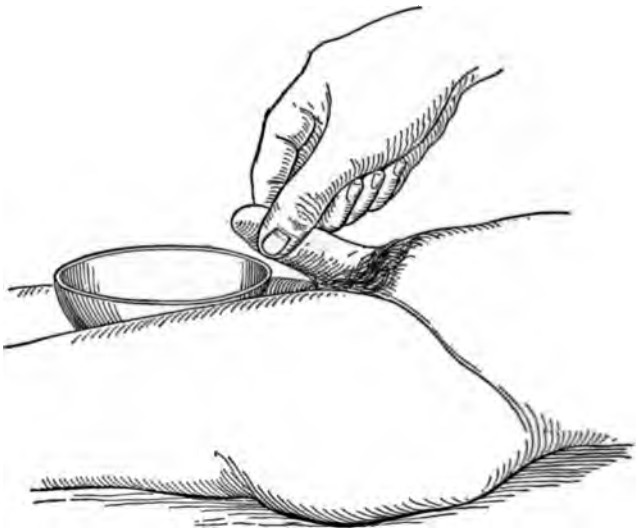


FIG. 667.—Second step in injection of the urethra, holding the solution in the urethra.

IRRIGATIONS OF THE URETHRA

Irrigation of the urethra is accompllshed by flushing out the canal with copious quantities of mild antiseptic solutions. It is a method employed extensively in the treatment of acute gonorrhea. To be effective large quantities of fluid must be used, and the urethra must be so distended that the solution comes in contact with all recesses and folds in the mucous membrane.

It is claimed that under the irrigation method of treatment, properly employed, the intensity of the symptoms is much lessened and the duration of the attack shortened. On the other hand, many authorities oppose this form of treatment on the ground that it increases the dangers of prostatic infection and that the virulence of the infection is increased. If gentleness is observed and the precaution is taken not to give the anterior injection under too great pressure, that is, not to force the solution into the bladder, as is so frequently done, the danger of complications is slight. It is not a

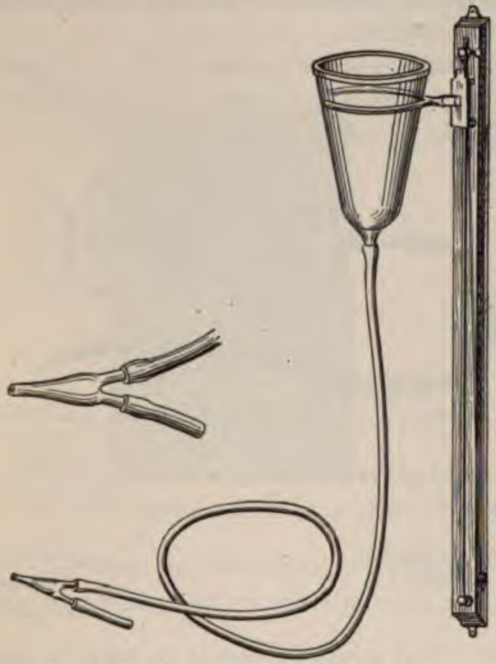


FIG. 668.—Valentine irrigator and Chetwood's urethral irrigating nozzle.

method of treatment, however, that can be placed in the hands of the patient, but it should always be carried out by the physician. Both the anterior and the posterior urethra may be irrigated.

FIG. 669.—Chetwood's alternating cut-off.

Apparatus.—An irrigating reservoir that can be raised or lowered to any desired height at will, such as Valentine's, a Chetwood two-way blunt glass urethral nozzle, a waste-pail, and two pieces of rubber tubing, one about 8 feet (240 cm.) long for connecting the inflow with the irrigator and another, a short piece, leading from the outflow tube to the waste-pail, are required for anterior irrigations. While not absolutely necessary, an alternating irrigating clamp (Fig. 669) is a convenience.

For irrigating the posterior urethra a No. 12 to 18 French soft-rubber catheter with a smooth beveled eye, and a large glass syringe (Fig. 670) should be provided.

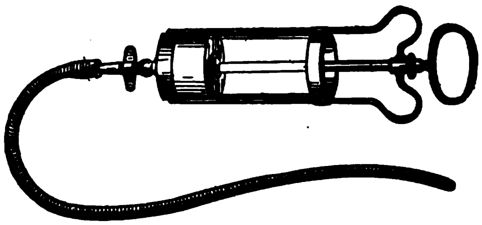


FIG. 670.—Syringe and catheter for irrigating the posterior urethra.

Solutions.—Mild antiseptic solutions are employed. Those most frequently used are:

Permanganate of potash,	1–6000 to 1–1000
Bichlorid of mercury,	1–30,000 to 1–10,000
Silver nitrate,	1–15,000 to 1–2000

Temperature.—The solutions should be used at about the body temperature.

Quantity.—About a quart (1 liter) of solution should be used in an anterior irrigation.

For posterior irrigations from 4 to 12 ounces (120 to 360 c.c.) of solution are employed.

Frequency.—Early in the disease, when the discharge is free, two daily irrigations give the best results. Later, one irrigation a day is sufficient.

Height of Reservoir.—The reservoir should not be raised above 4 feet (120 cm.). Such an elevation will give all the necessary distention of the urethra without forcing the solution beyond the anterior urethra. If it produces pain, the pressure should be reduced by lowering the reservoir or partially pinching off the inflow tube.

Position of Patient.—For anterior irrigations the patient may stand or be seated upon the edge of a chair, while for a posterior irrigation the patient should be in the dorsal position.

Preparation of Patient.—For protecting the clothes the patient may wear a rubber apron in which is provided an opening for the

(Fig. 671). The glans penis and lips of the meatus should be ed off with a 1 to 5000 bichlorid of mercury solution.

echnic. 1. *Anterior Irrigations.*—The patient should empty ladder before each treatment. The operator holds the penis

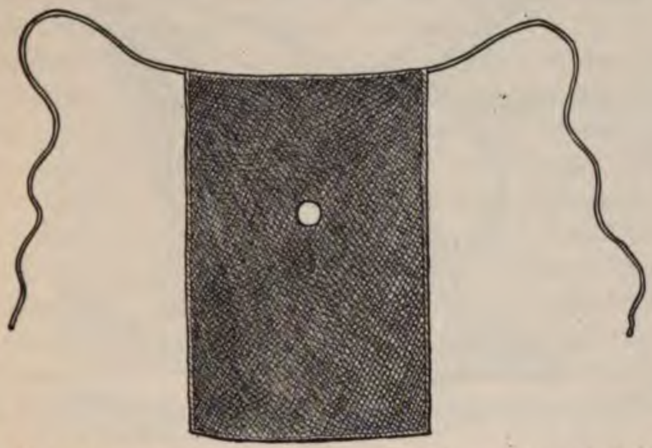


FIG. 671.—Apron for protecting the patient during a urethral irrigation.

id the glans between the thumb and forefinger of the left hand compressing the rubber inflow tube between the thumb and in-

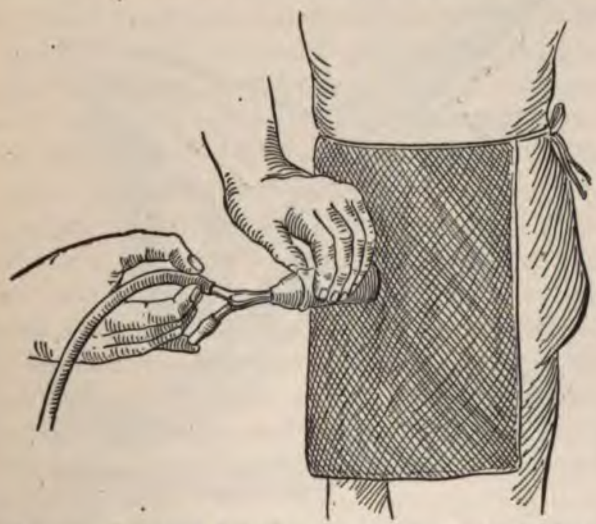
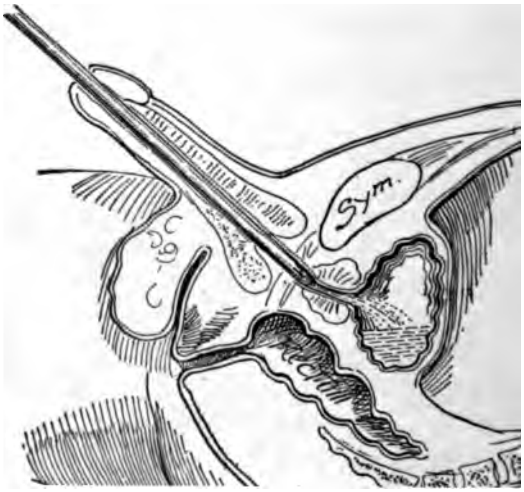


FIG. 672.—Method of giving an anterior urethral irrigation.

inger of the right hand, inserts the glass nozzle into the meatus. hen releases the inflow tube, at the same time closing the out-

Fig. 673.—First step in irrigating the posterior urethra. Cathe the bladder until urine begins to flow.



same time shutting or opening the outflow, the urethra is alternately distended with solution and emptied without the necessity of removing the nozzle. This alternate filling and emptying of the urethra is much easier to perform with the scissor-like clamp of Chetwood than with the fingers. It takes about five minutes to thus irrigate the urethra with 1 quart (1 liter) of solution.

2. *Posterior Irrigations.*—The anterior urethra is first irrigated as just described. A No. 12 to 18 French catheter, well lubricated with one of the Irish-moss preparations, is then inserted into the urethra with the eye upward until urine just escapes (Fig. 673). After the bladder is emptied, the catheter is withdrawn 1 inch (2.5 cm.) until its point lies in the prostatic urethra and from 4 to 12 ounces (120 to 360 c.c.) of the antisepic solution are gently injected (Fig. 674). The posterior urethra is thus washed backward toward the bladder. The catheter is then removed and the patient is instructed to void the contents of his bladder, thus giving a final washing from behind forward to both posterior and anterior urethræ.

INSTILLATIONS

Instillations are employed when it is desired to medicate the urethra with small quantities of strong solutions. They are lindicated in chronic gonorrhea, but should not be used in acute cases; they are specially useful in chronic post erior urethritis. Instilations are also valuable in the treatment of sexual neurasthenia when inflammatory lesions are present in the posterior urethra. The object of such injections is to induce a hyperemia of the tissues with the hope that it will be followed by absorption of the old as well as the new products of inflammation and by a return to normal. It is a method that may be applied to the anterior or posterior urethra. Instillations should not be employed in cases where injections or irrigations of weak solutions are followed by irritation, and they should likewise be avoided in posterior urethritis when the prostate and seminal vesicles are the seat of an acute inflammation.

The Syringe.—While the instillation may be given by means of a flexible catheter and small syringe, a special instrument, such as Keyes' modification of the Ultzmann syringe (Fig. 675), will be found more satisfactory. The latter consists of a long curved nozzle of German silver, provided with a central opening, to the proximal end of which is attached a large hypodermic syringe with the piston graduated in minims.

Asepsis.—The syringe should be sterilized by boiling for five minutes in a 1 per cent. solution of sodium carbonate. The glans penis and meatus are then washed with warm water and soap, followed by a 1 to 5000 bichlorid of mercury solution.

Solutions Employed.—In using instillations it is well to start with a weak solution, employing it till the urethra becomes tolerant, and then to gradually increase the strength. The solutions most frequently made use of are:

Silver nitrate	0.5 to 2 per cent.
Thallin sulphate,	3 to 10 per cent.
Copper sulphate,	1 to 4 per cent.
Argyrol,	10 to 20 per cent.
Protargol,	0.25 to 10 per cent.
Ichthyol,	2 to 10 per cent.

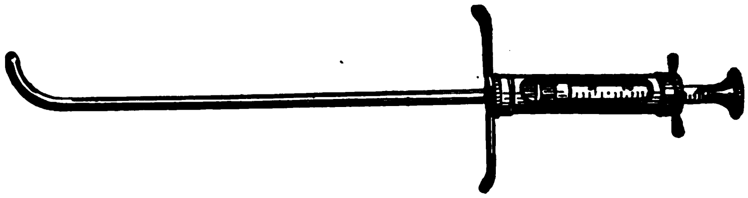


Fig. 675.—Keyes-Ultzmann instillation syringe.

Temperature.—The solution should be given at about the temperature of the body—say 100° F. (38° C.).

Quantity.—Ten or twenty minims (0.6 to 1.25 c.c.) of solution are injected at a time.

Frequency.—Instillations may be given at from forty-eight- to seventy-two-hour intervals. As a general rule, a second injection is not to be given until all irritation from the first has subsided.

Position of the Patient.—The patient should be lying down upon a bed or table.

Technic. 1. *Posterior Instillations.*—The patient should void his urine previous to the instillation, and the anterior urethra is first cleansed by an injection of weak antiseptic solution. The syringe, filled with the desired amount of solution, and with the nozzle well lubricated with some nonoily lubricant, as one of the Irish-moss preparations, is carefully introduced in the same manner as one would pass a sound (page 641) until its point lies behind the compressor urethræ muscle in the membranous urethra (Fig. 676). This will be at a distance of about 5½ to 6 inches (14 to 15 cm.) from the meatus or roughly when the shaft of the instrument is at an angle of 45 degrees with the horizon. From 5 to 20 drops (0.3 to 1.25 c.c.) of solution are then slowly injected. Care must be taken in withdrawing the nozzle of the instrument not to permit any solution to drip from the point along the anterior urethra. To avoid this, the piston of the syringe should be withdrawn slightly before the nozzle is removed.

Generally there is considerable burning upon urination following a posterior instillation and at times there may be pain and tenesmus and some discharge during the first twenty-four hours. As a rule, these symptoms subside within six to twenty-four hours. If the

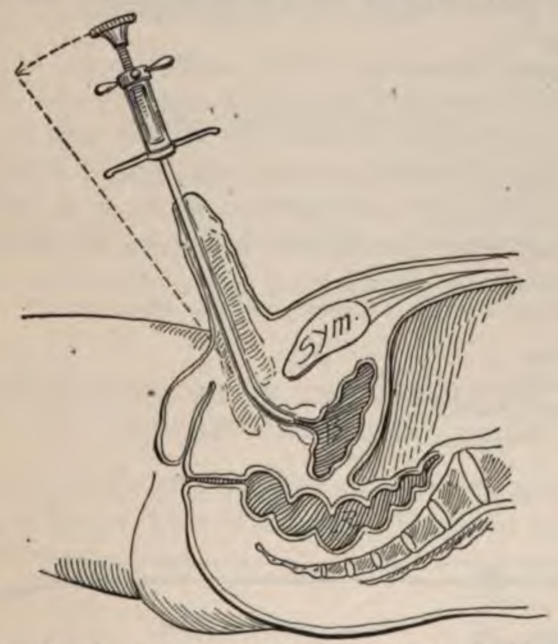


FIG. 676.—Showing the syringe in position for deep urethral instillation.

reaction is severe, however, the patient should remain quietly in bed and an opium suppository should be introduced into the rectum and heat applied to the perineum.

2. *Anterior Instillations.*—In giving an anterior instillation the same preparations are followed as for a posterior instillation. The nozzle of the instrument, well lubricated, is then carefully introduced as far as the bulb of the urethra and about 20 drops (1.25 c.c.) of solution are injected. The solution follows the instrument as it is withdrawn, medicating the whole anterior urethra. A piece of cotton should be placed over the glans and worn for a few hours

to prevent any excess of solution escaping from the meatus and soiling the patient's clothing. The cotton may be readily secured in place by means of a *loose-fitting* elastic band placed behind the corona.

APPLICATION OF OINTMENTS TO THE URETHRA

Astringent and stimulating ointments are at times employed in the treatment of chronic urethritis instead of instillations. They are considered by some authorities more efficient than the use of drugs in solution, as being more penetrating and more lasting in effect.

Instruments.—Ointments may be applied to the whole urethra, in which case an ordinary sound or a cupped sound (Fig. 677) is employed or they may be brought into contact with any particular area by means of Tomasoli's or some other form of ointment syringe (Fig. 678). This latter instrument consists of a hollow curved catheter-like nozzle and a plunger for forcing the ointment out at the end.

Formulary.—Unna's ointment for use with sounds consists of:

℞. Ol. cocæ,	℥iii (90 c.c.)
Ceræ flav.,	ʒss (2 gm.)
Argent. nitratis,	gr. xv (1 gm.)
Bals. peruviani,	ʒss (2 c.c.) M.

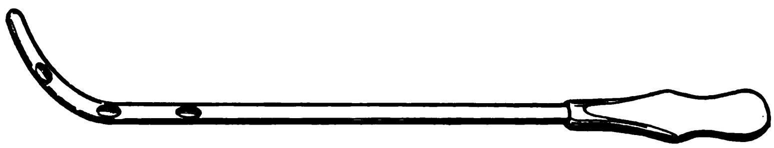


FIG. 677.—Cupped sound.

The mixture is melted over a hot-water bath and the sound is then dipped into it and the ointment is permitted to solidify by cooling.

Finger's Ointment consists of:

℞. Argent. nitratis or cu. sulphatis,	gr. xv (1 gm.)
Ol. olivæ,	ʒiss (5.6 c.c.)
Lanolin,	℥iii (90 c.c.) M.

Another consists of:

℞. Pot. iodidi.,	ʒss (2 gm.)
Iodi. pur.,	gr. v (0.3 gm.)
Ol. olivæ,	ʒss (2 c.c.)
Lanolin,	℥i (30 c.c.) M.

Preparations.—The patient's bladder should be empty. The glans penis and meatus are washed with soap and water, followed by a 1 to 5000 bichlorid of mercury solution.

Technic.—When a sound is employed, as large a one as will comfortably pass the meatus is coated with the ointment, or if a cupped sound is used, the depressions are filled with the ointment, and it is passed through the urethra and is left in place about five minutes. The ointment melts and thus medicates the entire urethral mucous membrane.

FIG. 678.—Urethral ointment syringe.

In employing a special ointment carrier the instrument is partly filled with the ointment and, after being well lubricated, it is passed as far as the diseased area. The piston is then inserted and is pushed through the instrument forcing the ointment out the end into the urethra.

THE URETHROSCOPE IN THE TREATMENT OF URETHRAL DISEASES

By means of the urethroscope or an open wire speculum (Fig. 679) lesions in the urethra may be accurately located and efforts at

FIG. 679.—Open wire urethral speculum.

treatment can be thus focused on the exact seat of the disease. Endoscopic treatment is thus of great value in the presence of localized lesions of the urethra which, resisting the ordinary methods of treatment by irrigations, instillations, etc., are often the cause of a persistent gleety discharge. For example, through the urethroscope and by the aid of suitable instruments, strong applications may be made to granular patches, erosions, and ulcerations; suppurating glands or follicles may be incised and small growths may be removed from the canal under direct vision.

The technic of using the urethroscope has previously been fully described (page 652) so that the application of the instrument to

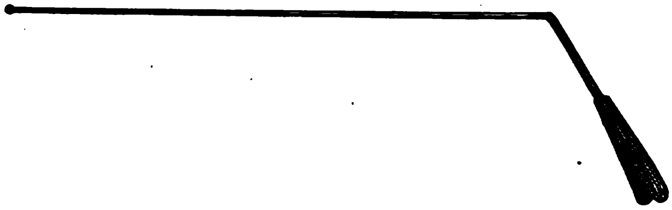


FIG. 680.—Urethral probe.

the treatment of various urethral conditions will simply be outlined in a general way. As has been already emphasized in previous pages, it is essential that one should be familiar with the normal ap-

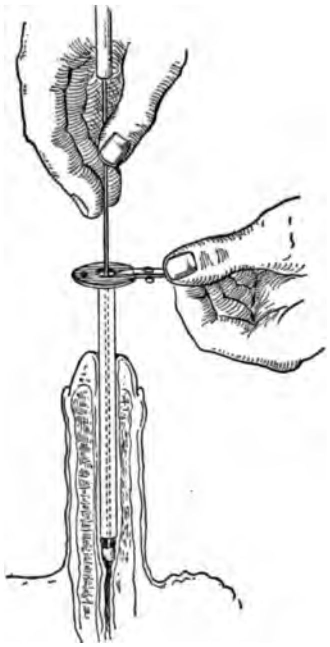


FIG. 681.—Method of making applications to the urethra through the urethroscope.

pearance of the urethra before attempts to employ the instrument for treatment are made. Furthermore, the greatest gentleness in manipulation is necessary to avoid injury to parts already diseased.

In the treatment of congested and granular patches, erosions, l ulcerations, local applications of silver nitrate or copper sulphate y be used by means of cotton-wrapped probes through the throscope previously passed to the seat of the disease (Fig. 681). this way strong solutions of these drugs—30 to 60 gr. (2 to 4 .) to the ounce (30 c.c.)—which would be extremely irritating if

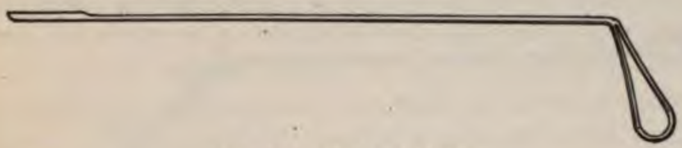


Fig. 682—Urethral knife.

lied to the whole mucous membrane, may be applied. If the eased areas are numerous and extensive the strength of the appli- ions should be somewhat weaker—say 5 to 10 gr. (0.3 to 0.6 gm.) the ounce (30 c.c.). When using the stronger solutions, care uld be taken to make the application exactly to the diseased area

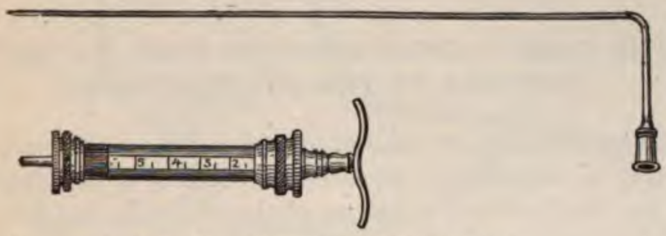


Fig. 683.—Kollmann's urethral syringe.

d not to leave any excess of solution to run over the healthy mucous mbrane. Such applications should not be made too frequently— t oftener than once a week—as usually an acute urethritis, often companied by a bloody discharge, is set up. This, as a rule, bsides in twenty-four to forty-eight hours.

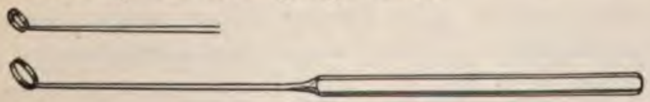


Fig. 684.—Urethral curet.

Areas of induration may be incised through the urethroscope by eans of a urethral knife (Fig. 682). Two or 3 drops of a 4 per cent. lution of cocain with adrenalin chlorid should be applied to the eased area by means of a cotton-wrapped probe, and the incision y then be made without pain. In the same manner abscesses of Littré's glands or inflamed follicles may be opened. A discharging crypt or follicle may be injected every few days with a few drops of a peroxid of hydrogen solution by means of Kollmann's syringe and cannula (Fig. 683). Polyps and papillomata may be removed by a urethral curet (Fig. 684) or by caustics. If pedunculated, a wire snare (Fig. 685) or the galvanocautery snare may be employed. In

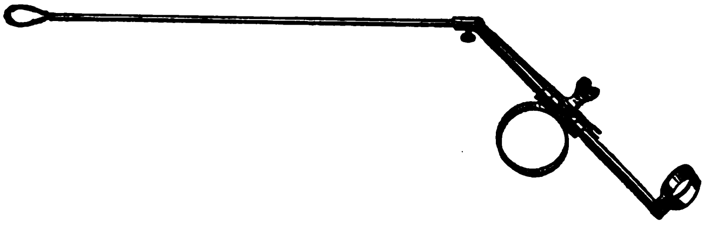


FIG. 685.—Urethral snare.

any case the area of operation should be first cocainized in the manner above described.

THE DIRECT APPLICATION OF COLD TO THE URETHRA BY THE PSYCHROPHORE

In the treatment of spermatorrhea and sexual neurasthenia where the urethra is congested or hyperesthetic the direct application of cold to the deep urethra by means of the cold-water sound or psychrophore is often of value. An ordinary cold sound is also employed in treating such conditions, but is not so effective, as the instrument soon becomes warm from contact with the urethra. With the psychrophore it is possible to keep a continuous cold application in the urethra as long as is desired.

Apparatus.—The psychrophore is a double-current closed sound within the outer sheath of which are two canals, one for the inflow of cold water and the other for the outflow, which communicate near the terminal end of the instrument, thus permitting that portion of the instrument to be kept cold. The inflow canal is connected with a rubber tube leading from a douche bag or irrigating jar (Fig. 686).

Temperature.—The temperature of the water should be about 50° to 40° F. (10° to 5° C.) to start with. As the urethra grows more tolerant the temperature may be lowered.

Duration of Treatments.—The sound should be left in place for from five to ten minutes at a sitting.

Frequency.—Treatments may be given daily or on alternate days.

Technic.—An instrument as large as the normal caliber of the urethra should be used. It is well lubricated and gently inserted in the same manner as a sound (page 641) until the curved portion lies in the membranous and prostatic portions of the urethra. The tubing from the reservoir is then connected with the inflow canal and a current of cold water is allowed to pass through the instrument, escaping from the outflow canal into a basin provided for the purpose. In this way the hyperesthetic urethra is exposed to the mechanical effect of the sound and the sedative action of cold.

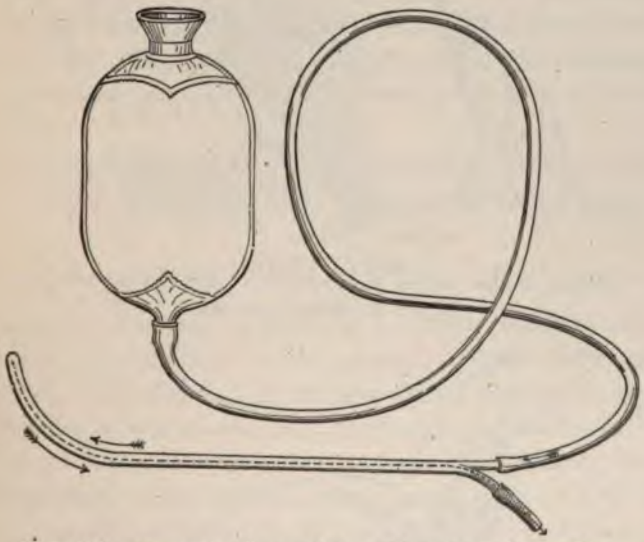


FIG. 686.—Apparatus for applying cold water to the urethra.

PROSTATIC MASSAGE

Massage of the prostate gland by means of the finger in the rectum is frequently employed, and with good results, in the treatment of chronic prostatitis in which the inflammation extends deep in the gland tissue. The object is to express from the prostate into the posterior urethra as much as possible of the purulent contents of the gland and to cause absorption of the products of inflammation from indurated areas. It is also used for the purpose of emptying the distended seminal vesicles and hastening resolution. It should not be employed in acute prostatitis or acute vesiculitis, and care should be taken not to perform the massage too vigorously, otherwise the tissues will be bruised and the inflammation will be aggra vated.

FIG. 687.—Position of the patient and method of introducing the finger into the rectum in prostatic massage.

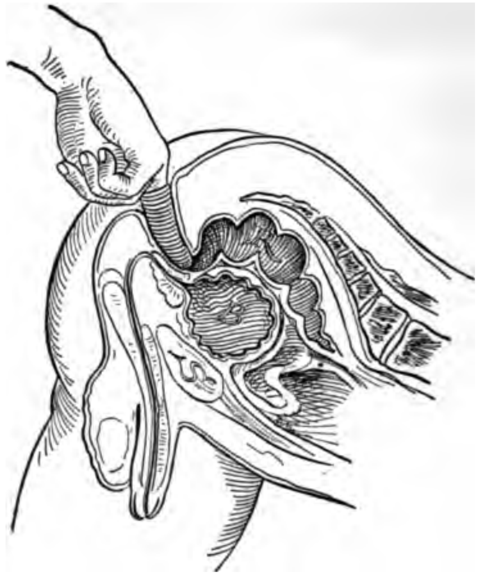


FIG. 688.—Showing the method of massaging the prostate.

Duration of Treatment.—The massage should be carried out fo two or three minutes at a sitting.

Frequency.—Unless followed by irritation, treatments may be given once every four or five days.

Position of Patient.—The operation may be performed with the patient bending forward over a chair or in the knee-chest position.

Technic.—If possible, the patient's bladder should be full. The operator wears a rubber glove on the right hand or a finger cot on his right index-finger and, after lubricating the index-finger, introduces it into the rectum (Fig. 687), carrying the finger high up on one side over the seminal vesicle. Firm but gentle pressure is then made with the finger over the seminal vesicle and the finger is slowly drawn down over the vesicle toward its duct and also over the corresponding lobe of the prostate (Fig. 688). This procedure is then repeated upon the opposite side, and finally over the central portion of the gland. All portions of the gland are thus massaged, but special attention should be paid to those portions that are enlarged or diseased.

After completing the massage the patient urinates, thus emptying the bladder of pus and débris expressed by the massage.

MEATOTOMY

Meatotomy consists in dividing a narrow meatus. It may be required as a preliminary to the passage of large instruments into the urethra or bladder and in the presence of urethral inflammation, when the size of the meatus is such that free drainage is interfered with. If properly performed, it is an operation without danger.

Instruments.—The incision is best made with an Otis meatome (Fig. 689) or with an ordinary blunt-pointed straight bistoury.

Location of Incision.—The meatus should be cut exactly in the median line upon the *floor* of the urethra.

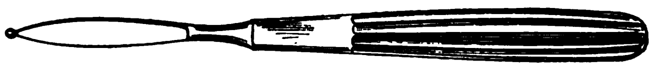


FIG. 689.—Otis' meatome.

Preparations.—The glans penis and meatus should be washed with soap and water followed by a 1 to 5000 solution of bichlorid of mercury. The anterior urethra should be irrigated with a saturated boric acid solution.

Anesthesia.—To render the operation painless the line of proposed incision is infiltrated with a 0.1 per cent. solution of cocain or a 0.5 per cent. procain solution introduced through the frenum or, if desired, by the topical application of a weak cocain solution (see page 87).

Technic.—The operator retracts the foreskin and, steadying the penis between the thumb and forefinger of his left hand, inserts the knife, with the cutting-edge down, into the urethra for a distance of 1 ½ inches (4 cm.). The meatus is then incised exactly in the mid-line by drawing the knife out. To allow for subsequent contraction it is well to incise the canal to a size larger than is desired to permanently maintain it—a meatus that will give passage to a No. 30 F. sound is sufficiently enlarged. If it is found upon inserting an instrument that the constriction has not been entirely cut, any remaining bands should be divided.

At first there may be some hemorrhage from the incision, but this can usually be controlled by inserting a plug of gauze for an inch (2.5 cm.) or so within the meatus. Should the bleeding be severe, the incision should be grasped between the thumb and forefinger placed on either side of the frenum and should be compressed until the hemorrhage stops.

The After-Treatment.—This consists in passing a full-sized straight sound through the meatus, at first daily and then every second day for a week or ten days, otherwise the narrowing is apt to reform. When meatotomy is performed as a preliminary to instrumental examination, the exploration may be performed at the same sitting.

THE TREATMENT OF STRICTURES BY INSTRUMENTAL DILATATION

The methods of treatment applicable to organic stricture of the urethra include gradual dilatation, continuous dilatation, and cutting the stricture either from within —internal urethrotomy—or from without—external urethrotomy. Two other methods, namely, divulsion and electrolysis, which are sometimes described in text-books, are now practically obsolete. Divulsion is so dangerous that it has been abandoned, while electrolysis is an operation that is of doubtful benefit and has never found much favor.

Intermittent dilatation of strictures by the passage of instruments of increasing size should be the method of choice when possible, as, if properly performed, it is without danger. It is, of course, only applicable to strictures which are permeable, but a large proportion of such may be successfully treated by this method. It is especially suited to those strictures which are fairly recent, soft, and dilatable. For old strictures with considerable scar tissue formation, which are rigid and unyielding, attempts at dilatation are apt to fail, so, if after a fair trial of the method in these cases it does not give results, more radical means of treatment should be substituted. Again, intermittent dilatation is not apt to be successful when applied to the so-called resilient strictures; these, while dilatable, are so elastic that they recontract between treatments, and little, if any, advance is made beyond a certain point. Strictures which are irritable, that is, those in which attempts at dilatation are followed by pain and spasm resulting in retention of urine, those in which the passage of instruments is followed by chills and fever, those complicated by numerous false passages and suppurating fistulous tracts, and all strictures near the meatus should be cut. For strictures complicated by cystitis, intermittent dilatation is, likewise, undesirable on account of the dangers of pyelonephritis, these require cutting of the stricture and free drainage of the bladder.

Before making any attempt to treat strictures, the number of strictures, their exact location, their size, and their extent should be determined by instrumental exploration of the urethra, and sufficient time for the tissues to react—at least seventy-two hours—should elapse after such an examination before the dilatation is begun. Strictures may occur at any point in the canal except in the prostatic urethra, but the most frequent sites are: (1) in the region of the bulbomembranous junction, (2) within 2½ inches (6 cm.) of the meatus, and (3) near the penoscrotal junction. They may be single or multiple, and in shape annular or tortuous. The opening is seldom situated in the center of the stricture, but generally lies to one side of the median line of the urethra.

All strictures have a tendency to contract and in time cause more or less impediment to the urinary flow with serious results to the whole urinary tract. The urethra immediately behind the stricture is the first to feel the effects of this obstruction and the canal at this point becomes more or less dilated and the mucous membrane is thinned out. Urine collects in this dilated portion and decomposes, with the result that an inflammation is set up accompanied by a gleety discharge. This may in time go on to ulceration and extravasation of urine with the formation of false passages and fistulæ. The effect of the urinary obstruction is also felt upon the bladder. It first hypertrophies and may later become thinned and dilated, and it is not uncommonly the seat of cystitis. In time inflammation and dilatation of the ureters and kidney follow, resulting in pyelitis and pyelonephritis.

Mention is made of these complications because their presence, or absence, and severity, if present, are of direct practical importance in determining the method of treatment to pursue. If should further be borne in mind that the stricture itself is usually congested and the mucous membrane is softened and inflamed, so that *in performing dilatation the greatest care and gentleness are necessary to avoid lacerating and contusing the already irritated tissues.* Roughness or carelessness in introducing the instrument can do only harm. The beneficial effects of dilatation depend not only upon the mechanical distention to which the urethra is subjected, but also upon the simple presence of the instrument which stimulates the tissues to a mild reactionary hyperemia, which is accompanied by softening and absorption of the scar tissue. If more than this is done, that is, if the tissues are so irritated that an inflammation is induced, the value of the treatment is lost and the original trouble is simply aggravated.

Instruments.—For strictures above No. 15 French conical steel sounds of proper curve are employed. These may be of the style

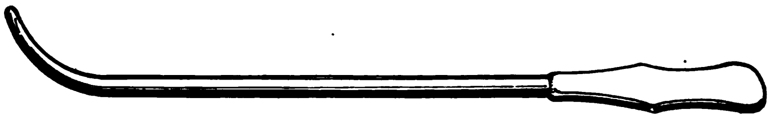


FIG. 690.—Conical steel sound.

shown in Fig. 690, or those with a double taper (Fig. 691) may be used. The latter instrument has a slight advantage in that, the shaft being smaller than the shoulder, dilatation of the deeper parts is effected without unduly stretching the meatus. For strictures

FIG. 691.—Double-taper steel sound.

in the pendulous urethra in front of the bulb a straight conical sound (Fig. 692) may be employed; such an instrument should not be used, however, in the deep urethra.

Kollmann dilators are used in preferance to sounds by some operators. They are made on the principle of the Otis urethrometer with four blades regulated by a thumb-screw at the proximal end

FIG. 692.—Straight steel sound.

of the instrument. A dial and indicator show the extent to which the blades are separated. Two styles of dilators are generally em-

FIG. 693.—Kollmann's straight dilator.

FIG. 694.—Kollmann's curved dilator for the posterior urethra with irrigating attachment.

ployed—a straight one for the anterior urethra (Fig. 693) and a curved instrument (Fig. 694) for the posterior urethra. Some are supplied with attachments for irrigating the urethra. A rubber sheath is provided with these instruments to be drawn over the blades (Fig. 695) and so avoid injuring the urethral mucous membrane when the instrument is being closed. This is not used, however, with the irrigating dilators. When closed the instrument measures 20 French and may be expanded to 45 French. On account

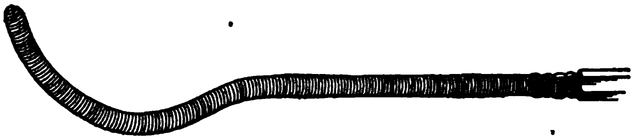


FIG. 695.—Rubber sheath in position.

of their small size, they may be used for dilating strictures in the presence of a narrow meatus without first cutting the latter.

With small steel instruments there is a considerable chance of making a false passage and always the danger of inflicting traumatism, so that for strictures of a smaller size than No. 15 French, soft

FIG. 696.—Flexible urethral bougie.

instruments should be employed. Flexible olivary bougies (Fig. 696) are the best in this class of cases, as they find their way through the stricture with greater ease and there is less danger of making a false passage. They are made of woven material covered with rubber and the best are of French make.

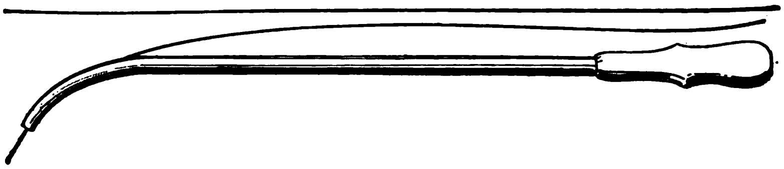


FIG. 697.—Gouley tunneled sound and filiform.

For dilating tight strictures whalebone filiform bougies and tunneled sounds (Fig. 697) should be provided. The filiforms should be at least 18 inches (45 cm.) long and of such size that the tunneled sounds will slip easily over them. Care should be taken not to use rough or split filiforms. In fact, any instrument, no matter what the variety, must be perfectly smooth and sound; imperfect instruments should be discarded as unsafe.

Asepsis.—The strictest asepsis should be observed in regard to the instruments used. Metal instruments should be boiled for five minutes in a 1 per cent. solution of sodium carbonate. Filiforms and the newer gum-elastic instruments will stand moderate boiling. They may also be sterilized by formaldehyd vapor, after which they should be well rinsed in sterile water; or they can be immersed first in a 1 to 20 carbolic solution and then in a saturated solution of boric acid.

The glans and meatus should be washed with soap and water followed by a 1 to 5000 bichlorid of mercury solution. The urethra is irrigated both before and after each treatment with a saturated solution of boric acid or a 1 to 5000 permanganate of potash solution, and, if the bladder is infected, it should likewise be irrigated, provided the stricture is sufficiently large to admit a catheter.

The same regard to cleanliness should also apply to the operator's hands.

Rapidity of Dilatation.—This can only be determined by a study of the individual case. It is important, however, not to do too much dilating at a time. It should not be carried to a point where discomfort or pain is caused. If the stretching is too rapid, it practically amounts to divulsion with its attendant risks of inflammation and sepsis. Furthermore, tearing of the stricture results in new formation of tissue which in turn contracts. In the case of tight strictures the introduction of a second instrument after the first is sufficient. In other cases the dilatation may be carried further, using three or four instruments in all.

Frequency of Treatment.—After the passage of an instrument a reactionary hyperemia sets in and this should be given time to subside before instruments are reintroduced. A lapse of three to seven days should, therefore, occur between treatments—on an average an interval of about five days. One will be guided, however, partly by the amount of contraction that takes place between treatments and also by the toleration of the urethra. Instruments should never be passed so frequently as to produce irritation. Very contractile strictures require the frequent passage of sounds, while for those that are easily dilated and do not readily reform longer intervals may be allowed. After the stricture has been stretched to 28 or 30 French, the intervals between the treatments may be increased, at first to once a week, then once or twice a month, and finally to several times a year.

Extent of Dilatation.—There is no fixed rule to be followed as to the extent to which a stricture is to be dilated. Various scales have been devised for determining the approximate size of the urethra from comparison with the circumference of the penis, but they are not accurate. As a general rule, dilatation of the stricture to the size of the meatus, provided it is of normal caliber, is sufficient.

Position of Patient.—The patient should be in the dorsal position with his shoulders slightly raised and thighs a little flexed and rotated outward. The operator takes his place just above the patient's hips and facing toward the patient's body, upon whichever side is most convenient for him.

Anesthesia.—Local anesthesia is only necessary where the patient is nervous and the urethra hyperesthetic, or upon the first passage of a sound after urethrotomy, as properly introduced instruments should cause little or no pain. In such cases the urethra is well

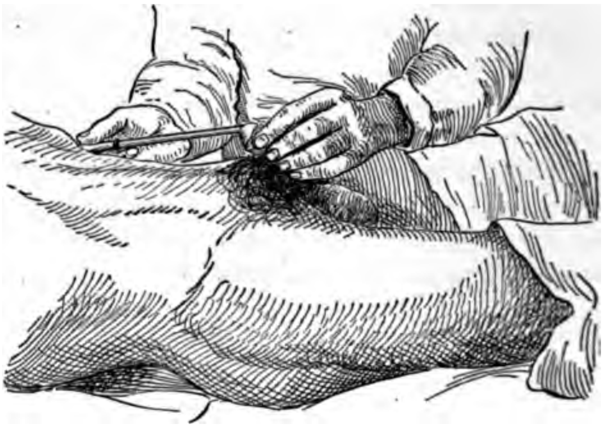


FIG. 698.—First step in passing a sound.

distended with a 0.2 per cent. solution of cocain and adrenalin solution and the solution is confined in the urethra for fifteen minutes by holding the meatus closed.

Technic. 1. *Large Strictures.*—Under this heading will be considered strictures above 15 French in size.

With Sounds.—A sound of a size that will easily pass through the stricture—determined by previous exploration—is warmed, well lubricated with lubrichondrin or other Irish-moss preparation, and is *very gently* introduced in the following manner: The operator grasps the penis behind the corona between the ring- and middle fingers of the left hand and with the thumb and index-fingers of the same hand he retracts the foreskin and separates the lips of the meatus. The sound is grasped lightly between the thumb and first two fingers of the right hand and is carefully inserted into the urethra. At this stage the handle of the instrument should be parallel to the abdominal wall and in line with the folds of the groin (Fig. 698). As

FIG. 699.—Second step in passing a sound.

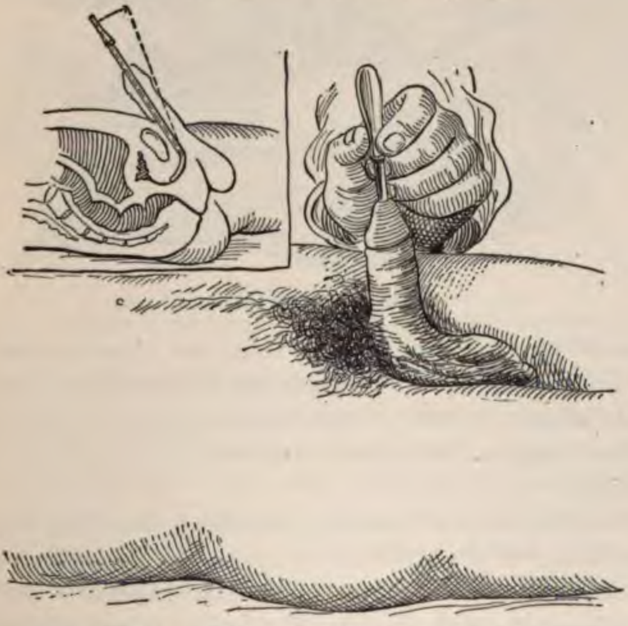


FIG. 700.—Third step in passing a sound.

the sound is pushed onward and downward, the handle of the instrument is gradually swept to the center line (Fig. 699) and is then slowly raised to a perpendicular so that its beak passes beneath the pubic arch (Fig. 700) into the membranous urethra. Unless the stricture be in the deep urethra, it is not necessary to insert the sound into the bladder—the instrument should simply be passed through the stricture. To insert the instrument the full distance, the handle is brought forward and downward between the thighs (Fig. 701). When the point of the sound reaches the stricture, the utmost gentleness in manipulation should be used in engaging it in the stricture, and no attempt to enforce the instrument along should be made, until it is certain that its point has entered the opening in the stricture. Having passed the sound entirely through the stricture,

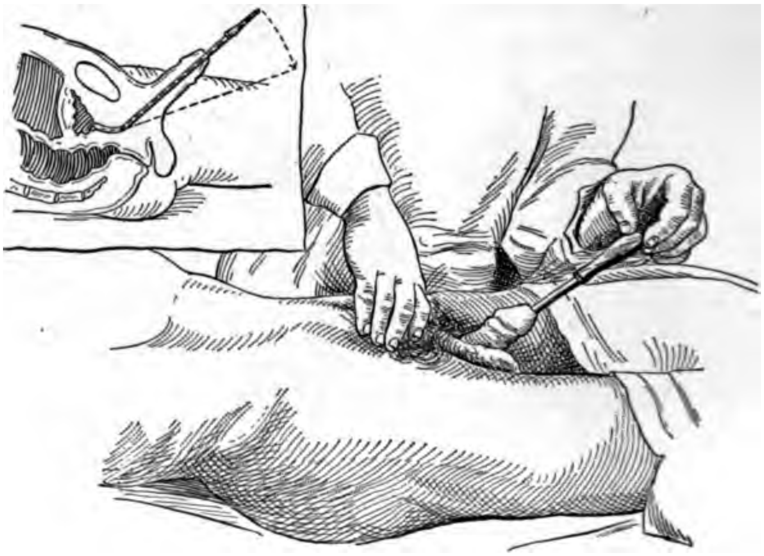


FIG. 701.—Fourth step in passing a sound.

it is removed by a reversal of these steps and a second one is introduced. If this causes pain or spasm, it is immediately withdrawn, and no immediate further attempt to dilate is made. If, however, the urethra tolerates the second instrument, a third one may be introduced.

At the next sitting the dilatation is begun by inserting a sound one size larger than the first instrument used at the previous treatment, and the dilatation is increased one or two sizes as before. In this way the treatments are continued until the desired degree of dilatation is obtained.

The passage of the sound will cause more or less smarting, but it is only transitory. At times a few drops of blood may follow the removal of the instrument. The next act of urination is apt to be painful, and not infrequently the gleety discharge is increased for twenty-four or forty-eight hours. The patient should be warned of these symptoms beforehand.

With the Kollmann Dilator.—The rubber sheath is drawn over the instrument. The dilator, closed and well lubricated, is then introduced to the seat of constriction and dilatation of the canal is then produced to any desired extent by turning the thumb-screw at the end of the instrument. The stretching must be performed *very gradually* and with great care, as these instruments are so powerful that severe trauma may be caused by a too rapid dilatation. If the patient complains of pain, or if an undue amount of resistance is felt, the dilatation should be stopped. Having effected the desired amount of dilatation, the instrument is left in place for several

FIG. 702.—Method of inserting a flexible bougie through a urethral stricture.

moments before it is closed and removed. At subsequent treatments the dilatation is increased one or two numbers each time.

2. *Small Strictures.*—For small strictures, that is, below 15 French, soft bougies are employed. A bougie of a size that will readily enter the stricture is selected. The penis is held straight up and upon the stretch in the fingers of the left hand after the manner described above, and the bougie, well lubricated, is carefully passed straight down to the seat of obstruction (Fig. 702), provided the latter is in the anterior urethra. An instrument can thus be readily passed straight as far as the bulbomembranous junction, but here it is apt to be obstructed. To pass this point and enter the deep urethra, the bougie should be introduced bent as much as possible to

the shape of a curved sound, and, when the point reaches the bulb, slight pressure should be made with the fingers on the perineum (see Fig. 640). When the instrument strikes the face of the obstruction, gentle attempts are made to engage its point in the stricture. This accomplished, the instrument is pushed on entirely through the stricture, and the dilatation is proceeded with in the same manner as when using sounds. Steel instruments may be substituted for the bougies when the dilatation has been carried as high as 15 French.

3. *Filiform Strictures.*—In the beginning of the treatment of a filiform stricture it often requires the greatest perseverance and skill to enter the bladder, as frequently the stricture is of such small caliber

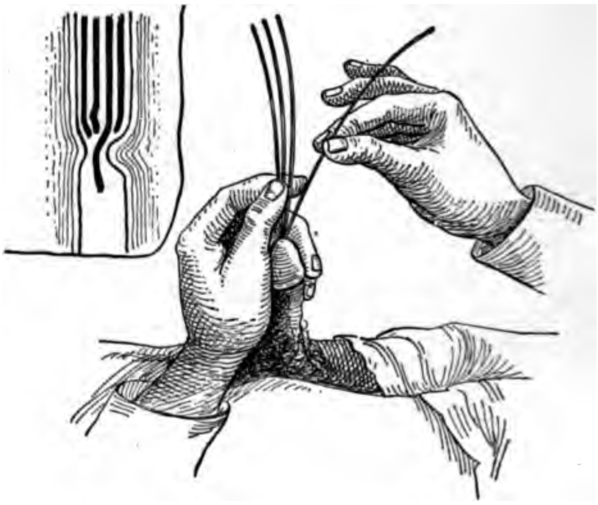


FIG. 703.—Method of passing a filiform bougie through a stricture by first filling the canal with filiforms.

or the opening is so situated that it is extremely difficult to engage even a fine filiform. Once, however, the filiform is inserted, the main difficulty is surmounted. In introducing filiforms the same method is employed as for straight bougies. The penis, grasped in the fingers of the operator's left hand, is put upon the stretch and the filiform, well lubricated, is inserted along the floor of the canal. If the point of the instrument is obstructed by a fold of mucous membrane or the opening of some lacuna, it should be withdrawn slightly and then slowly reinserted. When the face of the stricture—the location of which has been previously determined—obstructs the further advance of the filiform the instrument should be slowly rotated making attempts to engage its point in the stricture, the while, but without using any force. Sometimes by distending the canal with warm sterile oil it is possible to enter the filiform in the opening of the stricture. Failing with one filiform, a second may be inserted beside the first one and the same manipulation is carried out as with the first. If still unsuccessful, additional filiforms are inserted until the urethra contains six or seven of them. Then gentle attempts are made to pass each in turn, and usually one will finally slip into the opening (Fig. 703), whence it can be readily passed into the bladder. If, after a fair trial, it is impossible to insert an instrument, it is better to give up the attempt for the time being, and try again a few days later. Sometimes upon a second or third trial the opening will be readily located. Gentle manipulation combined with perseverance will result in success in the great majority of cases, but, if it is impossible to pass the instrument by these means, a urethroscope may be introduced as far as the obstruction and the filiform inserted by direct sight.

FIG. 704.—Method of passing a tunneled sound over a filiform.

Having finally passed a filiform, the smallest size tunneled sound should be inserted over it as a guide (Fig. 704). If there has been much manipulation in passing the filiform, the operator's efforts had best stop at this, or, at the most, a second sound is introduced. At the next sitting the filiform is again inserted and the dilatation increased by inserting larger instruments over it as a guide. After some dilatation has been thus obtained, soft bougies may be substituted for the filiforms and tunneled sounds, and the treatments may be carried out as outlined above.

Accidents and Complications Attending Dilatation.—There are several troublesome as well as serious complications that may follow the passage of urethral instruments.

Shock.—In some cases, in spite of the utmost gentleness in manipulation, the passage of a sound produces sufficient shock to cause the patient to faint or collapse. It is more likely to occur in patients upon whom an instrument is passed for the first time, especially if they are of a distinctly nervous type and look upon the operation with fear and apprehension.

Much may be done in preventing such a complication when the nervous element is in evidence by avoiding pain through the use of local anesthesia. Should fainting occur, the patient's head is to be immediately lowered and stimulants administered if necessary.

Urethral Chill and Fever.—A form of urinary septicemia spoken of as urethral chill and fever is liable to follow urethral instrumentation. It may be the result of absorption of toxic elements which are present in the urine, in the urethra, or are introduced from without with the instrument, or it may be the result of shock to the kidneys. The condition may be of a mild type—in which case a few hours after the passage of the instrument the patient is seized with a chill followed by fever, more or less prostration, and within twenty-four hours recovery—or it may be severe and progressive and eventually result in the death of the patient.

Preventive treatment, which is of the greatest importance, should consist in rigid asepsis, gentle manipulation of urethral instruments, and antiseptic irrigations or instillations after any instrument has been used. Actual treatment comprises rest in bed, quinin in 5- or 10-grain (0.3 to 0.6 gm.) doses, and the administration of genito-urinary antiseptics. In the presence of urinary suppression, hot baths or hot packs and stimulants are indicated.

Inflammation of the Urethra, Prostate, or Bladder.—Inflammation of the stricture, prostatitis, or cystitis may follow as a result of injury to the urethra or vesical neck from rough or careless introduction of instruments or from failure to pay due regard to cleanliness. The inflammation may extend, in addition, from the urethra down the ejaculatory ducts and set up an epididymitis. In the presence of such complications, attempts at dilatation should cease until the acute period is passed and appropriate treatment should be directed to the cure of the complication.

Hemorrhage.—At times considerable hemorrhage may result from the passage of instruments. This, as a rule, indicates a false passage or an attempt at too great a degree of dilatation at one sitting. Bleeding may occur, however, in some cases where the urethra is markedly congested with scarcely any injury to the tissues. The bleeding usually stops of its own accord. If excessive, the patient should be kept quietly in bed and cold applications should be applied to the perineum.

False Passage.—Another accident that may result from the use of urethral instruments is the formation of a false passage by forcing the instrument through the urethral wall into the surrounding tissues. It is more liable to happen when using rigid instruments of small size and probably occurs more frequently than is recognized. When a false passage is made, there will generally be free hemorrhage at the time or upon withdrawal of the instrument, and the patient will complain of severe pain and may show signs of shock. At the same time, the operator, while conscious that the instrument has passed the obstruction, will recognize that the point is not in the urethra from the direction of the handle. In such a case, if an examination is made by the rectum, the point of the instrument will be found in the perineum near the rectal wall. Furthermore, the instrument, if it be a rigid curved one, cannot be rotated about its own axis as would be the case were its point in the bladder.

Following such an accident, if the patient can urinate, the treatment should be expectant in the main; that is, he should be put to bed and given urinary antiseptics and carefully watched. Should extravasation of urine occur or an abscess develop, prompt and free drainage should be established and perineal urethrotomy should be performed.

CONTINUOUS DILATATION

Continuous dilatation consists in inserting a filiform or small bougie through a stricture and leaving it in place for twenty-four or forty-eight hours. By the end of this period more or less absorption of the stricture has taken place, so that there is some dilatation, and a larger instrument may then be inserted. It is a method that may be sometimes employed for securing dilatation of tight strictures not amenable to gradual dilatation, and is worthy of trial in such cases before resorting to a radical cutting operation. The method has its objections, however, in that it is necessary to keep the patient under constant observation and in bed; furthermore, irritation from the instrument in the urethra is apt to cause urethritis which may in turn lead to cystitis. The method is contraindicated in the presence of cystitis or if renal complications exist.

Instruments.—Filiform (see Fig. 631) or soft bougies (see Fig. 630) may be employed.

Asepsis.—Rigid asepsis is, of course, imperative. The instruments are to be sterilized as already described (page 640). The penis and meatus are washed with soap and water, followed by a 1 to 5000 bichlorid of mercury solution. The urethra should be irrigated with a 1 to 5000 permanganate of potash or saturated boric acid solution, and the bladder should be likewise irrigated with boric acid solution, if possible, upon changing the instruments.

Technic.—The instrument is passed through the stricture after the method already described for intermittent dilatation (page 689),

Fig. 705.—Showing the method of securing a bougie or catheter in the urethra. (After Sinclair, *Polyclinic Journal*, July, 1908.)

and is then securely fastened in place. There are several methods of doing this, but the following is the simplest and most effective. Four pieces of adhesive, each about 4 inches (12 cm.) long and 1/4 inch (6 mm.) wide are secured to the bougie (which for a space of an inch (2.5 cm.) in front of the meatus has been thoroughly dried and from which all grease has been removed) in such a way that one strip lies upon the dorsum, one on the ventral surface, and one on either lateral surface of the penis. When a foreskin is present, it is drawn down over the glans and each strip is carried over it and caused to adhere to the penis. An additional strip of adhesive 1 inch (2.5 cm.) wide is placed horizontally about the penis just behind the corona covering the four small strips (Fig. 705) This strip should not entirely encircle the penis, thus avoiding any danger of constricting it. Where there is no foreskin, a piece of gauze should be interposed between the glans and the small strips. A liberal sterile gauze dressing is then wrapped about the penis and the protruding instrument, and the whole is supported by means of a T-bandage. The urine escapes along the side of the bougie into the gauze, which should be changed when saturated. Within twenty-four or forty-eight hours the bougie is removed, and the stricture will be found sufficiently stretched to permit the easy introduction of a larger instrument. This is left in for the same length of time, and upon its removal gradual dilatation may be begun.

When there is retention of urine, the filiform is passed as before, a tunneled catheter is passed over it as a guide into the bladder (page 690), and the urine is drawn off. The bladder is then irrigated and the catheter removed, but the filiform is secured in place as described above. Usually urine will begin to pass along the bougie in a short while, but if not it may be withdrawn as often as necessary by means of a tunneled catheter.

CHAPTER XXI

THE BLADDER

Anatomic Considerations

The bladder is a musculomembranous reservoir for the reception of urine, lying behind the pubes and in front of the rectum in the male and the uterus in the female. The bladder may be described as having (1) a summit, or apex; (2) a base, or fundus, which rests upon the rectum and into which open the ureters; (3) a body, or middle portion; and (4) a neck, or constricted portion, opening into the urethra. It has an average physiological capacity of from 6 to

FIG. 706.—Showing the space above the pubes through which it is possible to enter the bladder without opening into the peritoneum.

9 ounces (180 to 270 c.c.), and a normal maximum capacity of 24 ounces (720 c.c.), but, under certain pathological conditions, it may become enormously distended without rupture. Its shape and position depend to a certain extent upon whether it is empty or full. When empty, it lies well behind the pubes, and upon median section appears triangular in outline; when partially filled, it becomes rounded in outline; and, when completely distended, it becomes oval and rises partly from the pelvis into the abdominal cavity.

The peritoneum partially covers the anterior surface and sides of the bladder, and entirely covers the superior surface, extending posteriorly as far as the level of a transverse line passed between the upper limits of the seminal vesicles, whence it is reflected to the rectum in the male, while in the female it is reflected to the uterus. When the bladder becomes distended, the peritoneum is carried from the anterior abdominal wall with it, so that in retention of urine with distention it becomes possible to empty the viscus by passing an aspirator into it above the pubes without fear of entering the peritoneal cavity (Fig. 706).

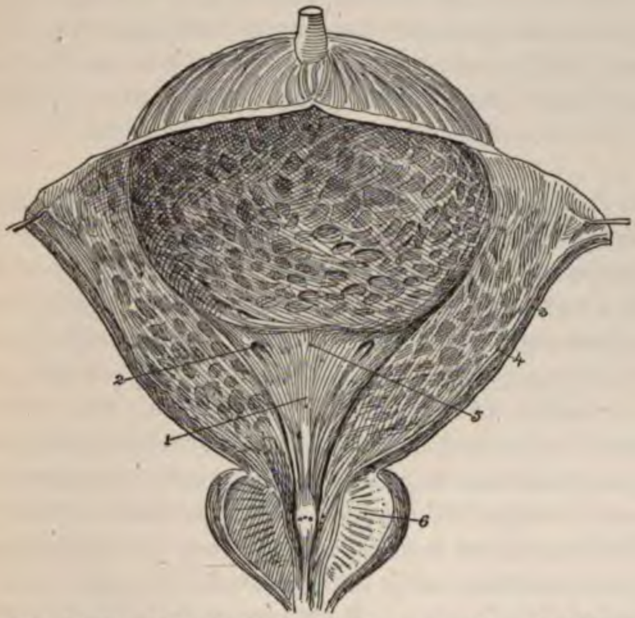


FIG. 707.—The interior of the bladder. 1, Trigone; 2, orifice of ureter; 3, muscular layer; 4, mucous membrane; 5, interureteric line; 6, prostate gland.

Beneath the peritoneal coat lies the muscular layer. It consists of three coats: external, middle, and internal. The external is composed of fibers arranged longitudinally and in thick bundles over the anterior and posterior surfaces, but forming a comparatively thin layer at the sides. The fibers of the middle coat have a circular arrangement. They are thickest at the neck where they form the internal vesical sphincter. The internal layer is thinner than either of the others. Some of its fibers are arranged longitudinally and others circularly.

The mucous coat is composed of stratified pavement epithelium.

It is of a pale salmon color. When the bladder is distended, the mucous membrane forms a smooth lining for the interior, but is thrown up into thick folds when the viscus is empty, except over the portion known as the trigone where it is always smooth. The mucous membrane of the bladder is comparatively insensitive to touch when in a normal condition, as it has a scant nerve supply, the most sensitive portion being over the trigone. The trigone is a smooth triangular space at the base of the bladder, the apex of which corresponds to the opening of the urethra and the base to a line passing between the orifices of the two ureters (Fig. 707).

The ureters pierce the bladder wall obliquely and appear upon the mucous membrane as round openings or oval slits directed forward and inward. These orifices are from 1 to 1½ inches (2.5 to 4 cm.) apart and about 1 inch (2.5 cm.) from the beginning of the urethra.

Diagnostic Methods

When examining a case of suspected bladder disease the symptoms complained of should first receive careful attention. In addition to the usual questions, information bearing upon the act of urination should be sought, ascertaining whether there is frequency of urination, whether there is urgency, whether the act is difficult, whether pain is present and, if so, its relation to the passage of urine, whether the force or caliber of the stream is changed, etc., etc.

Frequency of urination is common in all bladder affections where the mucous membrane is inflamed. It is also a symptom of vesical stone, tumor, foreign body, or an enlarged prostate. In the presence of stone this symptom is more marked when the patient is up and about or after exertion, while in the case of an enlarged prostate it is more pronounced at night. Frequent micturition may, however, occur when the bladder is healthy, as in diabetes, in hysteria, in those who drink large quantities of water, in those whose urine contains excessive amounts of uric acid or oxalates, etc.

Urgency of micturition, or the feeling of being compelled to pass urine the instant the desire is felt, points strongly to inflammation of the bladder or the prostate. Inflammation or irritation of the urethra may also cause it. It is, however, sometimes observed as the result of certain mental emotions, as fright or apprehension, or mental suggestions, such as the sound of running water. Irritating urine and diseases of the nervous system are also causes.

With a history of painful micturition, it is important to determine the seat of the pain and the exact relation it bears to the act of urination. Pain from prostatitis is generally felt in the perineum or rectum, pain in bladder disease is felt over the pubes, in kidney disease in the loins. A vesical calculus, however, will frequently cause pain in the head of the penis. Pain at the beginning of urination, as a rule, points to some obstruction to the outflow of urine or to inflammation of the urethra, or it may be the result of very irritating urine. If it occurs during micturition, it may be caused by inflammation of the urethra, prostate, or bladder wall. Pain at the end of urination occurs when a vesical calculus is present or when there is inflammation involving the neck of the bladder or the prostate. In acute prostatitis pain is also present upon defecation. When pain is present in the intervals between the acts of urination, it may be caused by a vesical calculus, tumors, or prostatic abscess. When such pain is increased upon exertion and entirely relieved by rest in the dorsal position, it is believed by some writers to be pathognomonic of vesical calculus.

Difficuty of urination, as a rule, indicates stricture of the urethra or an enlarged prostate. Changes in the caliber of the stream generally point to stricture. In the presence of enlarged prostate, disease of the bladder wall, and in some nervous affections, the force of the stream may be greatly diminished, so much so as to amount to a mere dribbling. A vesical calculus may at times cause a sudden stoppage of the stream, and this is frequently accompanied by sharp pain.

While a complete history should always be obtained, at the same time too much importance should not be placed upon symptomatology in the diagnosis of vesical affections. The symptoms are often deceptive, as they may be common to diseases involving the bladder, kidneys, or urethra. Even when they clearly point to the bladder as their seat of origin, they are sometimes of but little value in differentiating between the various morbid conditions that may affect this organ. An accurate diagnosis can only be arrived at by a physical examination along the lines detailed below.

The methods available for examination of the bladder include urinalysis, inspection, percussion, palpation, sounding, cystoscopy, tests of the capacity, the sufficiency, and the absorption power of the bladder, and the X-rays.

EXAMINATION OF THE URINE

A complete chemical, microscopical, and bacteriological examination of the urine should be made in all cases of suspected disease of the bladder or kidneys. The proper method of collecting the specimen for such examination has been previously described (page 305), but it is outside the province of this work to describe urinalysis; for this the reader is referred to some of the numerous works devoted to the subject. The diagnostic significance of modifications in the normal condition of the urine as far as applies to vesical and renal disease will, however, be briefly considered.

The quantity of urine passed normally by a healthy adult amounts on an average to 50 ounces (1500 c.c.) in twenty-four hours, but this may be greatly modified even in health, depending upon the season of the year, the quantity of water imbibed, the amount of exercise taken, the condition of the nervous system, etc., etc. In certain diseases, as fevers, in affections accompanied by night-sweats or diarrhea, chronic parenchymatous and acute nephritis, in blockage of a ureter by an impacted stone or by a twist, in shock, hemorrhage, etc., the output of urine may be greatly decreased (oliguria). On the other hand, an increased quantity of urine (polyuria) will be found in hysteria, in the presence of interstitial changes in the kidney, from the use of diuretics, in diabetes, in renal tuberculosis, in pyelitis, etc.

In bladder affections the daily output of urine generally remains unchanged and, in the presence of marked changes in this respect, involvement of the kidneys or some constitutional disease may be implied.

The specific gravity of the urine for a normal individual is fixed at 1.018 to 1.025 at 60° F. (16° C.). The specific gravity is closely related to the amount of solids excreted, so to be of value the test should be applied to a mixture of the urine voided during twenty-four hours.

In diseases of the bladder the specific gravity is unaffected, but in renal disease it may be markedly changed. A low specific gravity and an increased output of urine, when the bladder is diseased, points strongly to pyelitis or pyelonephritis.

The odor of urine is faintly aromatic, the more marked the greater the proportion of solids. The taking of such drugs as copaiba, cubebs, turpentine, and sandalwood modify this characteristic odor. In diabetic coma the odor of the urine resembles that of chloroform from the presence of acetone and diacetic acid. Urine that has undergone ammoniacal decomposition, as is frequently the case in chronic cystitis, has the characteristic and offensive odor of stale urine. Urine coming from a bladder which communicates with the rectum by a rectovesical fistula has an odor of skatol. In the presence of ulcerations within the bladder, especially ulcerating tumors, the urine will be foul-smelling and may even have a distinct odor of putrefaction.

The color of the urine is a light or dark amber depending upon the concentration. The presence of blood gives the urine a bright red or reddish black hue, depending upon whether the hemorrhage is recent or old. Bile gives a dark yellow or brownish color with a greenish tinge. In chyluria the urine appears milky. Fevers render the urine darker than normal. Various drugs may also modify the color, thus senna, rhubarb, and santonin may color the urine a golden-yellow or deep red hue, methylene blue gives a greenish-blue color, and poisoning from carbolic acid, chlorate of potash, or creosote makes the urine smoky or black.

Transparency.—Normal urine should be clear and transparent when voided. In bladder diseases the urine is, as a rule, turbid. Turbidity may be caused by urates, phosphates, blood, pus, epithelium, chyle, or bacteria. The turbidity caused by urates disappears upon heating the urine, that due to phosphates clears up upon the addition of one or two drops of acetic acid.

In bacteriuria, as is seen after the passage of unclean instruments, the turbidity is slight and remains unchanged upon standing, upon the application of heat, or in the presence of acetic acid. The condition is recognized by the aid of the microscope.

The turbidity produced by pus is increased upon heating the urine, and does not disappear upon the addition of an acid. Furthermore, upon allowing such a specimen to stand a few hours, it will be found that the pus settles to the bottom leaving the rest of the fluid clear. A simple test for the presence of pus is to add a little solution of potassium hydrate to the suspected specimen; in the presence of pus a gelatinous precipitate is formed.

The reaction of urine is normally slightly acid. The acidity is increased in fevers, gout, lithemia, rheumatism, chronic Brights disease, etc., and upon a diet composed chiefly of proteids. A vegetable diet and large quantities of fluids render the urine neutral or alkaline.

In diseases of the bladder the urine may be acid or alkaline, thus in acute cystitis the urine is usually acid. In chronic cystitis it may be either acid or alkaline, always the latter in the presence of ammoniacal fermenation, but when due to the gonococcus, tubercle bacillus, or colon bacillus it is acid. In uncomplicated cases of pyelitis and pyelonephritis the urine also has an acid reaction.

Albuminuria.—Albumin in the urine is not to be considered an invariable sign of kidney disease. It may result from a number of local causes, such as blood, pus, prostatic secretion, etc., due to an inflammation involving the kidney pelvis, ureter, bladder, prostate, or urethra, without the existence of organic disease of the kidney. Furthermore, a transient albuminuria is not infrequently the result of the diet, the amount of excercise taken, nervous shocks, toxins in the blood, etc. So that it becomes of the greatest importance to decide whether an albuminuria is of renal origin or is the result of other pathological conditions, and sometimes this is a difficult matter. The two may exist together.

Hematuria.—Blood in the urine may have its source in any part of the genitourinary tract, as the urethra, prostate, bladder, ureters, or kidneys. While it is not always possible to determine the source of the hemorrhage from an examination of the urine, there are certain characteristic differences in hemorrhages from these different regions.

Urethral hemorrhage may arise from acute urethritis or inflamed strictures, or may follow traumatism to the canal, the passage of instruments, etc. In urethral hemorrhage, if the source is from in front of the compressor urethræ muscle, the blood appears independently of urination, and may escape from the meatus freely, in drops, or in the form of long clots. If from the posterior urethra, the blood finds its way backward into the bladder and when of considerable quantity, uniformly discolors the urine. If, however, the posterior hemorrhage is slight, the first and last portions of the urine passed may be blood-tinged while the intermediary portion will be clear.

Vesical hemorrhage may follow the sudden and complete emptying of the bladder in retention, or it may be due to trauma, the passage of instruments, varicosities, stone, inflammation, ulcer, tuberculosis, tumors, etc. The urine in a recent vesical hemorrhage may be comparatively clear at first, or only slightly discolored, becoming more so as the bladder is emptied, until it finally has a bright red color or consists of almost pure blood. It may contain large clots which have no definite shape, and, if long retained, they appear black and tarry. The reaction of the urine is generally alkaline.

Renal hematuria may be due to inflammation, congestion, trauma, stone, tuberculosis, tumors, the use of strong diuretics, etc., etc. The blood will be thoroughly mixed with the urine, imparting to the latter a smoky tint or deep red-brown color. It will be found that the corpuscles are greatly changed and without coloring matter, often appearing as mere shadows, but in cases of ruptured kidney or in severe renal hemorrhage from other cause, they may remain unaltered and the urine will be much lighter in color. The urine during renal hemorrhage and just after is generally acid in reaction unless the bleeding has been severe or pus is present. Large clots are seldom formed unless the blood coagulates after reaching the bladder, but there may be found casts of the kidney tubules or cylindrical-shaped clots from the ureters.

A more positive diagnosis between hematuria of renal origin and that of the bladder may be made by introducing a catheter and thoroughly washing out the bladder with a warm normal salt solution, being careful to wash out all the clots. If the blood is of renal origin, the last washings will consist of clear fluid and will remain clear until more blood flows from the ureters. If, on the other hand, the bleeding arises from the bladder, it will be found impossible to completely free the fluid from blood.

By means of a cystoscopic examination (page 713) the bladder may be excluded as the source of the blood if it is found free from disease, or it may be possible to see blood escaping from one or other ureter. (See also the absorption test, page 713.)

Pyuria.—Pus in the urine is a common accompaniment of bladder diseases and also those affecting the urethra and kidneys. Pyuria is a symptom of suppuration or catarrh in the genitourinary tract, thus it will be found in pyonephritis, pyelitis, tuberculosis, cystitis, urethritis, etc. It is characterized by cloudy urine in which a thick yellow sediment settles upon standing.

A differential diagnosis between urethral pus and bladder pus may be made by having the patient void his urine in two glasses (page 633). If the urethra is the source, the first glass of urine will be found cloudy and the contents of the second glass clear or nearly so. When the bladder is affected the contents of both glasses will be equally cloudy.

In deciding between vesical and renal pyuria, it should be borne in mind that in the former condition the amount of albumin will be slight and there will be no renal casts, but bladder epithelium will be found, while in urine containing pus from the kidney albumin will be found in a greater proportion than can be accounted for by the amount of pus, and casts may be present. The use of the catheter or cystoscope will, however, furnish more exact evidence as to the source of the pyuria.

To apply the first test, the bladder is thoroughly washed with a warm normal salt or boric acid solution through a catheter until the fluid returns clear. The catheter is then clamped and allowed to remain in place ten or fifteen minutes, and what urine has entered the bladder in the meantime is drawn off. If this last specimen is again turbid we may conclude that the pus comes from the kidneys.

On cystoscopic examination, if the bladder be found free from disease, this evidence points to the kidney as the source of pus. The diagnosis may be made absolute if pus is seen exuding from the ureters or a sample of urine obtained by ureteral catheterization contains pus.

INSPECTION

Inspection of the bladder without the aid of instruments is extremely limited in value. By inspection of the abdomen, it is possi-

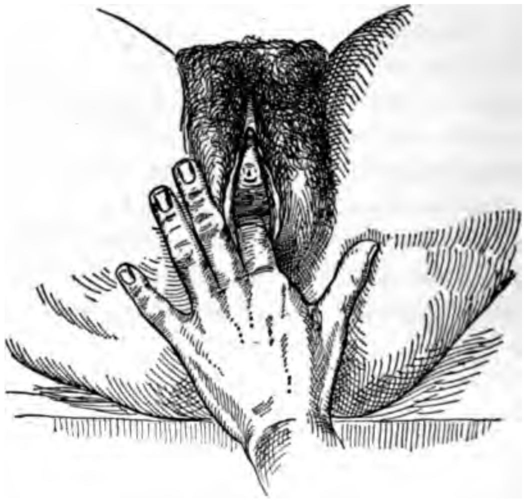


FIG. 708.—Vaginal inspection of the bladder. (Ashton.)

ble to recognize a distention of the bladder, and, in the female, by means of a vaginal inspection, some information as to the condition of the floor of the bladder may be gained.

Position of Patient.—For ordinary abdominal inspection the patient lies flat on the back with the body uncovered from the umbilicus to the knees, and with the legs extended in the same plane as the body.

For inspection through the vagina the patient should be in the dorsal posture.

Technic. 1. *Abdominal Inspection.*—The examiner takes his position upon one side of the patient and carefully notes any change in the size or shape of the hypogastrium. A distended bladder appears as an ovoid tumor with the narrow end down, situated above the symphysis generally in the median line.

2. *Vaginal Inspection.*—The examiner sits facing the vulva, and, by retracting the perineum with the index-finger of the left hand introduced within the vagina (Fig. 708), the anterior vaginal wall is exposed for inspection. In this way a displacement of the bladder, protrusion from distention, or a vesicovaginal fistula may be recognized.

PERCUSSION

Percussion of the bladder is chiefly of use in determining the presence or absence of distention. The percussion note over the hypogastrium is normally tympanitic. When the bladder becomes distended with fluid, there will be a fluctuating tumor above the symphysis which gives a flat percussion note and tympany at the sides. If, however, coils of intestine fill the space between the bladder and the abdominal wall, as is sometimes the case where the intestines become adherent as the result of pelvic peritonitis, percusion will furnish but imperfect information, as a tympanitic note may be obtained and yet the bladder be distended. Any doubt as to the presence of distention should be immediately settled by passing a catheter into the bladder.

PALPATION

In the case of thin individuals with relaxed abdominal walls palpation will often give valuable information, but in fat or very muscular patients it is of limited use. The palpation may be performed abdominally or bimanually. The latter method yields the most valuable information. Distention, large foreign bodies, calculi, or tumors, and tender areas may be thus recognized, and an idea as to the thickness and sensibility of the bladder walls may be obtained. It is an especially useful method to employ in examining the bladders of children.

Digital palpation of the bladder by means of a finger introduced through a perineal or suprapubic wound or through the urethra in the female are methods now rarely employed for diagnosis alone, as we have other equally efficient and more simple means of examination.

Position of Patient.—For abdominal palpation the patient should be in the dorsal posture with the thighs flexed and the body uncovered from the umbilicus down. This or the knee-chest posture may be employed for bimanual examination.

Anesthesia.—In stout individuals or those with rigid abdominal walls, it may be impossible to make a satisfactory bimanual examination without the aid of general anesthesia.

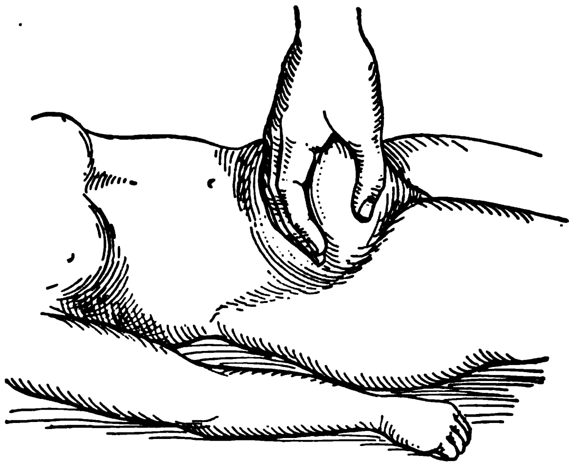


FIG. 709.—Abdominal palpation of a distended bladder.

Technic. 1. *Abdominal Palpation.*—The examiner stands upon the left side of the patient, and, placing his right hand flat upon the

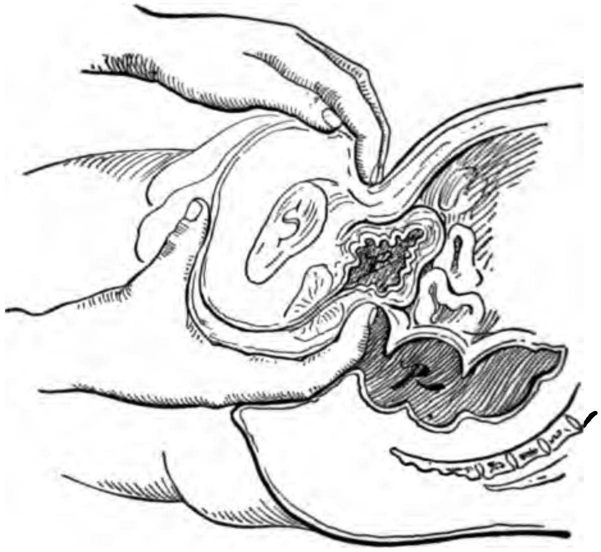


FIG. 710.—Bimanual palpation of the bladder.

abdomen just above the pubes, gently palpates the hypogastric region by means of his finger tips. In thin individuals, if distention is present, a fluctuating tumor will be recognized. By requesting the patient to breathe deeply with the mouth open and at the same time pressing the ulnar border of the hand deeply toward the pelvis, it is often possible to outline the swelling of a distended bladder more distinctly (Fig. 709). Such manipulation will frequently cause the patient to evince a desire to urinate.

2. *Bimanual Palpation.*—The bladder should be first emptied. The index-finger of the right hand or the index and middle fingers, if possible, are introduced into the rectum in the male or the vagina in the female, after first being well lubricated. The four fingers of the left hand are then placed above the symphysis, and, while they make counter pressure toward the base of the bladder, the entire viscus is palpated bimanually (Fig. 710).

SOUNDING

Palpation of the interior of the bladder by means of a suitable sound is a method of exploration employed in cases of suspected stone, foreign bodies, or tumors. The sound is also of value in testing the sensitiveness of the bladder walls and in estimating the

FIG. 711.—Thompson stone searcher.

amount of intravesical enlargement of the prostate (page 637) and in the diagnosis of cystocele in the female.

While sounding is a fairly reliable method in searching for a stone, there are certain difficulties and sources of error that should be borne in mind. A stone may be encrusted with blood and mucus and so be missed entirely, or it may be encysted with only such a small portion exposed that it may be difficult to reach it, or it may lie behind an enlarged middle lobe of the prostate. Very small stones may likewise be missed or they may be so light that slight shock imparted by contact of the instrument is unnoticed. A tumor, or a contracted thick bladder wall encrusted with lime salts or phosphates may give a sensation that is confused with the click of a stone.

Instruments.—For sounding the male bladder a Thompson metallic searcher (Fig. 711) is employed. This instrument has a fairly large beak, flattened from side to side, which joins the shaft at an angle of 120 degrees. The shaft should be slender—12 to 15 French scale—so it can be readily moved back and forth or rotated from side to side within the urethra. The handle of the instrument is supplied with a guide which indicates the direction of the beak.

Asepsis.—The sound is boiled for five minutes in a 1 per cent. sodium carbonate solution. The external genitals are cleansed with soap and water followed by a 1 to 5000 bichlorid of mercury solution. The hands of the operator should be sterilized in the usual way. The urethra should be irrigated with a saturated solution of boric acid or a 1 to 5000 permanganate of potassium solution. The bladder is emptied and irrigated with boric acid solution.

Position of Patient.—The patient should be in a recumbent position with the hips raised several inches higher than the head and the thighs extended flat.

Preparations of the Patient.—The rectum should be empty. About 4 ounces (120 c.c.) in an adult and 2 ounces (60 c.c.) in a child of a saturated boric acid solution or a normal salt solution should be introduced into the bladder so as to permit easy movement of the searcher and to prevent the stone from being concealed in the folds of mucous membrane.

Anesthesia.—As a rule, no anesthesia is necessary. In sensitive cases the instillation of a few drops of a 2 per cent. solution of cocain into the posterior urethra will suffice, or the bladder may be filled with 5 ounces (150 c.c.) of a warm 0.1 per cent. solution of cocain to which is added 20 drops (1.25 c.c.) of adrenalin chlorid. This is to be retained fifteen to twenty minutes. If the bladder is extremely irritable and the patient nervous, a general anesthetic may be administered. In children a general anesthetic is usually necessary.

Technic.—The instrument is well lubricated with lubrichondrin or one of the other Irish-moss preparations and is introduced in the same manner as a sound (page 641). When the beak of the instrument reaches the triangular ligament, the fingers of the left hand are applied to the perineum and assist in guiding the point into the opening. The handle of the sound is then brought down between the thighs and the instrument is at the same time gently pushed into the bladder. As the instrument traverses the fixed curve of the urethra, pressure should be made over the region of the pubes to relax the suspensory ligament of the penis (see Fig. 637). To be sure the point is within the bladder, the instrument should be introduced a distance of about 8 inches (20 cm.).

A systematic examination of the entire bladder is then performed. The instrument, being held lightly between the thumb and the forefinger of the right hand, is first inserted to the full length, and is then slowly withdrawn, rotating the beak from side to side, so that the point of the sound is brought into contact with every portion of the bladder wall. In this way any thickness or rigidity of the bladder wall, as is found in hypertrophy, chronic inflammatory conditions, and in the presence of firm growths, may be recognized. In the same manner the sensitiveness of the organ may be tested. Normally, the bladder has but little sensation to touch except in the region of the trigone. In cases of posterior urethritis this region may

FIG. 712.—Palpation of a stone lodged above the vesical openings.

be markedly hyperesthetic. Local areas of increased sensitiveness point to ulceration or new growths, while in cases of cystitis the entire bladder will be sensitive.

In examining for suspected stone the search should be carried out in the same systematic manner, carrying the instrument to the fundus first and then tapping each lateral wall in succession as the instrument is withdrawn to the vesical neck. The upper wall of the bladder is then palpated by depressing the handle of the instrument well down between the thighs, and as an aid the bladder wall may be depressed toward the instrument by means of the free hand placed above the pubes. In this way a stone located above the vesical opening may be located (Fig. 712). The beak of the sound is then rotated and turned downward. In doing this, if the point catches in the mucous membrane, the handle should be depressed so as to lift the beak clear of the floor. The posterior prostatic region is then explored. Should the prostate be enlarged, the handle of the instrument should be raised, somewhat, and, with a finger in the rectum, it will be possible to bring a stone, if one is present, within reach of the instrument (Fig. 713).

When the sound strikes a stone, the examiner will recognize the fact by a distinct click that may sometimes be heard as well as felt. Some idea as to the consistency of the stone may be gained from the sharpness of the ring; a high-pitched metallic click generally indicates a hard stone (oxalate), while a dull low-pitched sound would indicate a soft stone (urate). It is also possible to determine whether

FIG. 713.—Palpation of a stone lodged behind the prostate with the aid of a finger in the rectum.

a stone is rough or smooth from the sensation imparted as the beak of the instrument is drawn over its surface. If possible it should be ascertained whether a stone is movable or fixed by attempting to dislodge it with the beak of the instrument or by changing the position of the patient, that is, after the stone is located, the sound is withdrawn and the patient is put in the knee-chest posture, on resuming the dorsal position, the instrument is again inserted and any change in the position of the stone is noted.

To determine the size of the stone, the beak of the instrument is carried to the posterior surface and the position of the meatus is marked on the shaft. The instrument is then slowly withdrawn, tapping the stone the while, until the anterior border is reached and the relation of the meatus to the shaft is again noted. Subtracting the latter measurement from the first one gives approximately the length of the stone in its antero-posterior diameter. The transverse diameter may be likewise estimated by tapping the stone from side to side.

At the completion of the operation the instrument is removed by a reversal of the steps taken in its insertion, and the bladder is irrigated with a warm saturated solution of boric acid, followed by a deep urethral instillation of 1 to 1500 silver nitrate solution.

TEST OF THE BLADDER CAPACITY

By distending the bladder with fluid its capacity is readily estimated, and from this it may be determined whether the bladder is

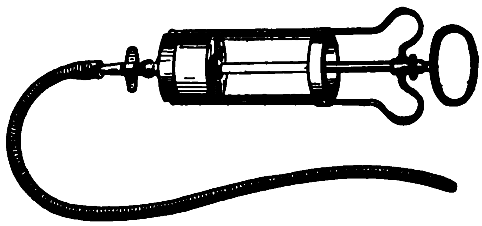


FIG. 714.—Catheter and syringe for estimating the bladder capacity.

normal, atonic, or contracted. If large quantities of solution can be injected without inducing contractions, it may be inferred that atony or paralysis exists, but if, on the other hand, the bladder is in an inflamed condition or is contracted, it will often not be possible to inject more than an ounce (30 c.c.) or so without the patient complaining of distention.

This test is also useful in the diagnosis of a ruptured bladder. By injecting a definite amount of solution into the bladder and noting the quantity that returns, the presence or absence of rupture may be readily recognized. In performing this test, however, it is necessary to inject 6 to 8 ounces (180 to 250 .c.) of fluid, as small amounts may give misleading results.

Apparatus.—An ordinary soft-rubber catheter for the male or a glass catheter for the female and a large syringe, such as a Janet or Record (Fig. 714), are required.

Asepsis.—The apparatus is sterilized by boiling and the examiner's hands are to be thoroughly cleansed. The external genitals are washed with soap and water, followed by a 1 to 5000 solution of bichlorid of mercury, and the urethra is irrigated with a saturated solution of boric acid or a 1 to 5000 solution of potassium permanganate.

Position of Patient.—The patient should be in the dorsal position upon a flat table.

Technic.—The catheter, well lubricated, is introduced into the bladder and all the urine is drawn off. The syringe is then filled with a warm (100° F. (38° C.)) saturated solution of boric acid or normal salt solution, and the solution is slowly injected into the bladder (Fig. 715). As soon as the patient complains of distention, the injection is stopped and the quantity of fluid that has entered the bladder is estimated. The syringe is then disconnected from

FIG. 715.—Method of distending the bladder with fluid when estimating its capacity.

the catheter and the fluid is allowed to escape from the bladder through the catheter.

ESTIMATION OF RESIDUAL URINE

Normally, with micturition the bladder empties itself almost completely, but, if the evacuation of urine is interfered with by obstruction from a stricture or an enlarged prostate or from the condition of the bladder itself, as, for example, in atony, cystocele, etc., the evacuation will be incomplete and more or less residual urine will remain. The amount of residual urine often has a bearing upon the prognosis as well as the treatment to be pursued in a given case, and its estimation is thus of some importance.

Apparatus.—All that is required is a Mercier catheter with a coudé curve and a glass graduate.

Asepsis.—The catheter is sterilized by formalin vapor or by immersion in a 1 to 20 carbolic acid solution followed by rinsing in sterile water. The external genitals are cleansed in the usual way, and the urethra is irrigated with a mild antiseptic solution. The hands of the operator should likewise be sterile.

Technic.—The patient is instructed to empty his bladder as completely as possible while in the upright position. He is then placed in the dorsal position. The catheter, well lubricated, is introduced into the bladder, and any urine that remains is drawn off into the graduate and is measured. This may amount to from 1 dram (4 c.c.) to several ounces. If there is more than 2 ounces (60 c.c.) of residual urine, it is certain that some interference with the voluntary evacuation of the bladder exists. Observation of the flow of urine from the catheter may also furnish valuable information. If the urine is expelled in a strong gush, it indicates that the muscular structure of the bladder is competent, while, if it simply escapes by gravity, an atonic condition is probably present.

THE ABSORPTION TEST

A test sometimes employed to determine whether blood in the urine has its source in the bladder consists in injecting a solution of iodid of potassium into the bladder and later testing the saliva for iodin. Ordinarily there will be no absorption from the healthy bladder, but, if raw or ulcerated surfaces are present, absorption of the iodid of potassium is quite rapid and iodin will be eliminated in the saliva.

Apparatus.—There will be required an ordinary soft-rubber irrigating catheter, a Janet syringe, and a test-tube.

Asepsis.—The usual aseptic precautions employed when introducing an instrument into the bladder should be observed.

Technic.—The patient first empties his bladder. The soft catheter is then introduced and the bladder is well irrigated with normal salt solution. From 2 to 3 ounces (60 to 90 c.c.) of a 1 per cent. solution of potassium iodid are then injected into the bladder and the catheter is removed. At the end of ten or fifteen minutes some of the patient's saliva is collected in a test-tube and is tested for iodin. This is readily done by adding a few drops of a dilute solution of cooked starch and stirring with a glass rod dipped in fuming nitric acid. If iodin is present in the saliva, the mixture will turn blue.

CYSTOSCOPY

Cystoscopy is the inspection of the interior of the bladder by the aid of an instrument especially devised for the purpose, the cystoscope. It is a method of examination that may be of the greatest value when employed by an expert, but it is of limited use in the hands of the inexperienced, for it is absolutely essential that the examiner be familiar with the appearance of the normal bladder before he can recognize and correctly interpret pathological conditions, and this can only be learned by practical experience.

By a cystoscopic examination properly carried out it is possible to obtain an accurate picture of the interior of the bladder and to study the appearance of the ureteral orifices as well as the condition of the urine that escapes from them; that is, whether it contains pus or blood. Cystoscopy thus becomes of service not only for diagnosis of obscure vesical affections that may escape recognition by other means, but also in the diagnosis between a possible vesical and kidney lesion.

The method has, however, certain limitations. It cannot be employed with success in the presence of marked hypertrophy of the prostate, when the bladder is greatly contracted, or when there is an active vesical hemorrhage going on which obscures the view. It is contraindicated in the presence of acute urethritis, acute prostatitis, epididymitis, or acute cystitis. The urethra must, as a rule, be of a caliber of 22 to 24 French, and, if the meatus is narrow, it must be first cut, or, if strictures are present, they must be sufficiently dilated before the instrument can be introduced.

Instruments.—Cystoscopes are of two types, the direct view, in which the light is on the convex side of the beak and the eye looks down a straight tube through a window in the distal end, and the indirect view, in which the light is placed on the concave side and the image is reflected at right angles to the eye-piece, thus giving an inverted picture. Some of the newer indirect view instruments, however, give an upright picture.

For the simple examination of the bladder the use of an indirect view cystoscope gives the best results, as with such an instrument the roof, floor, and walls of the bladder—excepting a part of the posterior wall—may be readily inspected. The examination may be satisfactorily performed either by means of a special exploring cystoscope, such as the Nitze, Otis, Schapira, etc., or by means of one of the ureter-catheterizing cystoscopes to be described later on (see page 759). The exploring cystoscope has an advantage over the catheterizing instruments, however, in that its shaft being small the examination is less painful.

The Nitze instrument (Fig. 716) is the oldest type of the indirect or right-angled view cystoscope. It consists essentially of a metal tube 9 inches (23 cm.) long and from 15 to 24 French scale in size, having at the distal end a short beak fitted with a small electric lamp and on the concave side of the instrument at the point where the beak joins the shaft a lens, beneath which is placed a prism. From the prism the image is reflected at right angles through a series of lenses to the eye-piece. A small knob soldered on the circumference of the eye-piece indicates the position of the cystoscopic window. The instrument is fitted with two-way stopcocks for irrigation should the lens become cloudy. Space does not permit a description of the many modifications of the Nitze instrument, each of which has advantages of its own.

The illumination for cystoscopes may be furnished from a six- or eight-cell battery or from the street current provided a controller is employed.

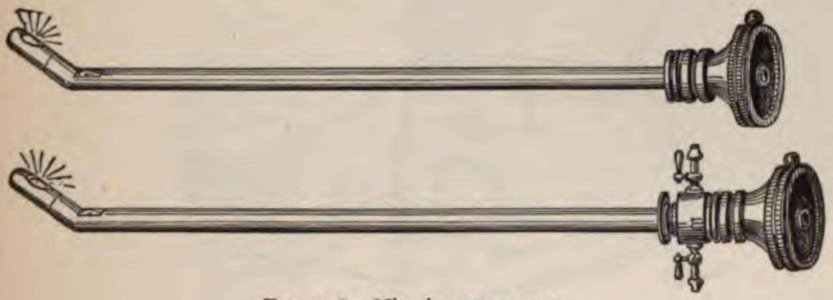


FIG. 716.—Nitze's cystoscopes.

Additional instruments required are a Janet syringe, holding from 3 to 4 ounces (90 to 120 c.c.), or an irrigating jar, and a catheter.

Asepsis.—Formalin vapor may be employed or the instrument may be immersed in a 1 to 20 carbolic acid solution for ten minutes followed by rinsing in alcohol and then sterile water. The external genitals should be cleaned with soap and water followed by a 1 to 5000 bichlorid solution. The examiner's hands are to be likewise sterilized.

Position of the Patient.—The examination is performed with the patient in the lithotomy position and with his buttocks close to the edge of the table or, as preferred by some operators, in the semi-recumbent posture. The best form of table to use is one provided with uprights which are surmounted with double inclined rests about 15 inches (37 cm.) above the level of the table for the support of the patient's thighs and knees (Fig. 717). It is a great convenience to have a table provided with a wheel within reach of the operator, by turning which it may be raised or lowered at will.

Anesthesia.—Local anesthesia of the urethra is generally necessary, though in exceptional cases cystoscopy may be performed without anesthesia. The instillation into the deep urethra of a few drops of a 2 per cent. solution of cocain may be sufficient. A sensitive bladder may be rendered anesthetic by first emptying it and then filling it with 5 ounces (150 c.c.) of a warm 0.1 per cent. solution of cocain to which is added 20 drops (1.25 c.c.) of adrenalin and having

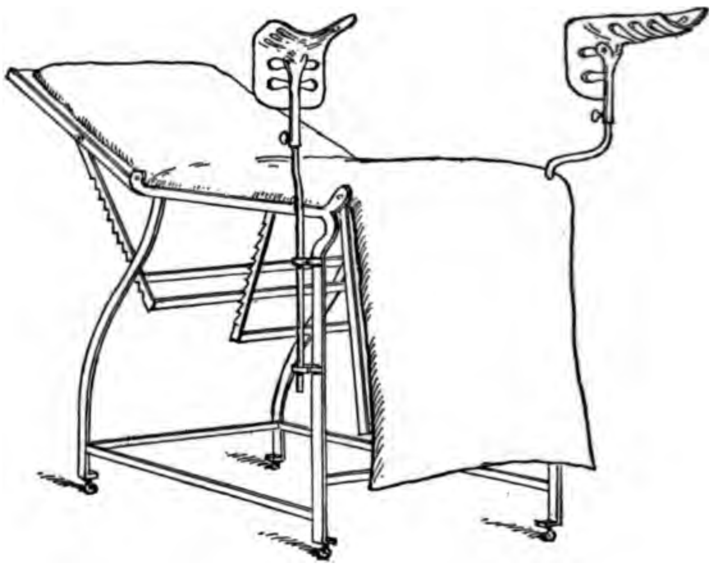


FIG. 717.—Table with Bierhoff's leg supports for cystoscopy. (Greene and Brooks.)

the whole amount retained for fifteen to twenty minutes. Guyon's method of obtaining local anesthesia consists in injecting into the rectum three-quarters of an hour beforehand a mixture containing:

Antipyrin,	gr. xiv (0.9 gm.)
Laudanum,	♏x (0.6 c.c.)
Water,	ʒiii (90 c.c.)

In some adult cases, where the urethra, bladder, or prostate are extremely sensitive, and in children general anesthesia may be required.

Preparations.—The bladder should first be emptied and should then be thoroughly irrigated with a saturated solution of boric acid by means of a catheter and Janet syringe until the fluid returns clear, as a satisfactory examination can be made only in a clean bladder. If an irrigating cystoscope is employed, the irrigation may be performed through the sheath of the instrument. Four to 6 ounces (120 to 180 c.c.) of a saturated solution of boric acid or normal salt solution are then injected into the bladder and allowed to remain so as to smooth out the folds of mucous membrane and furnish space for the cystoscope to be moved about.

If there is bleeding from the bladder sufficient to interfere with the examination, a solution of 1 to 3000 adrenalin chlorid may be injected through the catheter and allowed to remain for about ten or fifteen minutes, when it is drawn off and the bladder is distended.

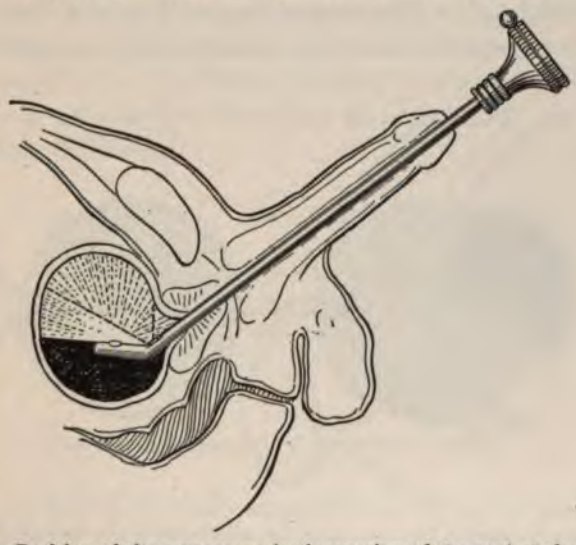


FIG. 718.—Position of the cystoscope for inspection of the roof of the bladder.

Everything that will be required during the examination should be placed near at hand, and the cystoscope light should be tested under water before the instrument is introduced.

Technic.—The instrument after being thoroughly tested, is lubricated with glycerin or lubrichondrin and is gently passed into the bladder in the same manner one would pass a sound. Great care should be taken not to use any force in introducing the instrument. If there is any difficulty in making the beak enter the opening in the triangular ligament, pressure applied on the perineum by the fingers of the free hand will assist in its passage into the membranous urethra (see Fig. 640). As soon as the instrument has entered the bladder, it can be freely moved about.

The operator then takes his seat with his eyes on a level with the ocular end of the instrument, the light is turned on, and the interior of the bladder is systematically inspected, care being taken not to touch the mucous membrane with the light. It should be remembered that in using a prism form of indirect view cystoscope the image will be reversed, as in the laryngoscope. The instrument being introduced with its beak turned up, the roof of the bladder will first come into view (Fig. 718). In order to see as much of this portion of the bladder as possible, the instrument should be rotated first in one direction and then in the other and then pushed farther in, repeating these movements until the entire roof has been inspected. By depressing or elevating the shaft a more complete view of the anterior or posterior wall is obtained. The beak of the instrument is then rotated so that it faces toward the floor of the bladder (Fig. 719), and the instrument is withdrawn until the prostate appears as a clear dark red crescent. If hypertrophied, it will appear deformed in the picture, and the degree of its enlargement and its location may be recognized. The instrument is next pushed slowly backward in the median line as far as the fundus, the examiner carefully inspecting the floor of the bladder as the instrument is advanced. By slightly rotating the instrument first to one side and then to the other a large extent of the floor may be viewed.

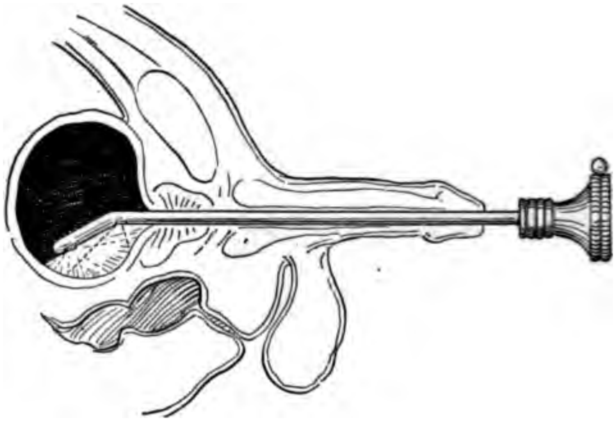


Fig. 719.—Position of the cystoscope for inspection of the floor of the bladder.

The mucous membrane normally has a salmon or grayish-pink tint and is smooth and glossy with the superficial vessels standing out here and there. When acutely inflamed, it becomes a dark red color and has a velvety appearance and there is a general hyperemia so that the small blood-vessels disappear. In chronic inflammation the mucous membrane may take on a grayish tint and the folds appear much thickened. This region should be carefully examined for small stone, tuberculous ulcers, and new growths.

Having inspected the floor, the instrument is turned 45 degrees to one side and is gradually withdrawn from the fundus. In this way the opening of the ureter on that side will come to view as an oblique slit or as a small dimple (Fig. 720) in a prominent papilla, and, if it is watched, it will be seen to emit a gush of urine every ten to fifteen seconds. If not immediately found, the interureteric line, which runs transversely across the central field between the two ureters, should be identified and, by tracing this to one side or the other, the ureteral orifice may be located. The appearance of the ureteral orifice should be carefully inspected for signs of ulceration, erosions, or inflammation which might indicate a diseased kidney on that side, and likewise the character of the urine which escapes should be noted, *i.e.*, whether clear, purulent, or bloody.

FIG. 720.—Appearance of the ureteral orifices.

The lateral wall is carefully inspected as far as the vesical neck. The instrument is then rotated 90 degrees to obtain a view of the opposite side and it, including the ureter of that side, are examined while the instrument is slowly passed to the fundus again. Following some such scheme, the entire bladder may be inspected except a portion of the posterior wall which is invisible with an indirect view instrument. During the examination it is well to shut off the light at intervals so as to allow the instrument to cool.

At the end of the examination the light is turned off and the instrument is carefully withdrawn, taking care to see that the beak is again turned up before this is done. The patient's bladder is then emptied and irrigated with boric acid solution.

CYSTOSCOPY IN THE FEMALE

The examination of the female bladder may be performed by using an ordinary male cystoscope or a somewhat shorter female

Position of Patient.—The patient should be in the dorsal position.

Preparation of Patient.—The bladder should be empty. The external genitals are washed with soap and water followed by a 1 to 5000 bichlorid of mercury solution, and the urethra is irrigated with a boric acid or 1 to 5000 potassium permanganate solution.

Technic.—1. *Single Catheter Method.*—The catheter, well lubricated, is gently passed into the bladder, and any residual urine is

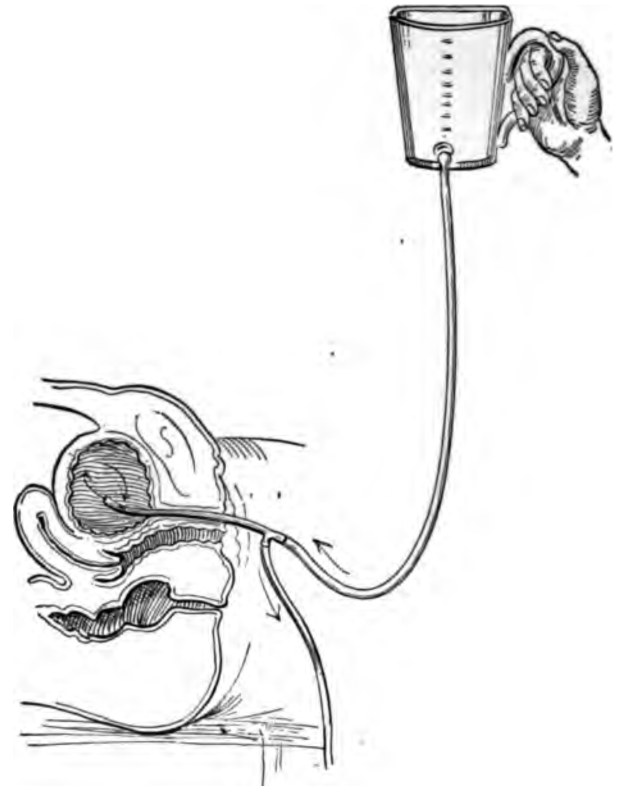


FIG. 731.—Irrigation of the bladder with a double-flow catheter.

allowed to escape. The funnel is filled with from 3 to 6 ounces (90 to 180 c.c.) of the solution, and the tubing leading from the funnel is attached to the catheter, first taking care to see that air or any cold solution is expelled from the tube. The funnel is then raised 2 or 3 feet (60 to 90 cm) above the patient and the solution is permitted to slowly flow into and distend the bladder. As soon as the patient complains of the distention, the flow is shut off. After allowing the solution to remain in the bladder a few moments, the funnel is lowered below the level of the bladder and the fluid is allowed to escape into the waste-pail (Fig. 730). The funnel is then refilled and the process repeated until the fluid returns clear.

In performing the irrigation care must be observed not to overdistend the bladder. Just how much can be injected at a time depends upon the individal case, but it should not be sufficient to cause any pain. Entrance of air into the bladder should also be guarded against.

2. *Double-flow Catheter Method.*—The technic varies a little from that just described. The catheter is passed into the bladder and the irrigating tubing is attached to the inflow tube of the catheter. The reservoir, filled with the entire amount of fluid to be used during the irrigation, is then raised 2 to 3 feet (60 to 90 cm.) above the bladder and the solution is allowed to flow. As fast as it enters the bladder, it is carried off again through the outflow tube (Fig. 731); but, by occasionally compressing the outflow tube, the bladder may be more or less completely filled before the fluid is permitted to escape.

AUTO-IRRIGATIONS

While it is not advisable to allow a patient to irrigate his own bladder in the presence of a severe cystitis, auto-irrigation may be safely performed for the purpose of keeping the bladder clean by those who are compelled to lead a catheter life The patient should, however, be carefully instructed how to sterilize the catheter, his hands, etc., and in the proper method of performing the irrigation, and he should be fully warned of the dangers of neglecting to follow the strictest rules of cleanliness.

Apparatus.—A douche bag with a capacity of 1 quart (1 liter), 4 feet (120 cm.) of rubber tubing, a T-shaped glass tube, a soft-rubber catheter, and a waste-pail comprise the necessary outfit. The T-shaped glass connection is placed between the catheter and the tubing of the reservoir and to its long arm is attached another piece of tubing that leads to the waste-pail. A shut-off clip is placed on the tube leading from the irrigator and another upon the waste tube (Fg. 732).

Solution Used.—It is better not to entrust the patient with strong antiseptic solutions; instead a saturated (4 per cent.) solution of boric acid should be used. It is prepared by dissolving about 5 teaspoonfuls (20 gm.) of boric acid crystals in 1 pint (500 c.c.) of hot water.

Position of Patient.—The irrigation is most conveniently given with the patient sitting in a chair and with the waste-pail on the floor between the legs.

instrument. Such examination, which is less difficult than in the male on account of the short length of the urethra, requires no separate description, as the technic differs in no essential way from the method used in the male. Another method of vesical inspection is

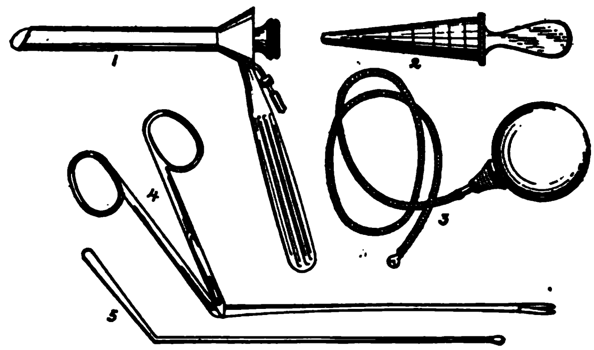


FIG. 721—Instruments for cystoscopy in the female. 1, Electric-lighted open-tube cystoscope; 2, urethral dilator; 3, urine evacuator; 4, alligator-jawed forceps; 5, ureteral searcher.

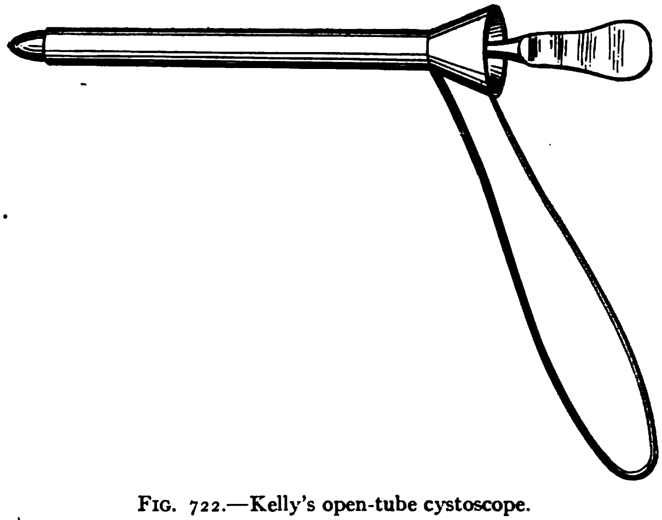


FIG. 722.—Kelly's open-tube cystoscope.

by means of Kelly's open straight tubes and atmospheric distention of the bladder.

Instruments.—For cystoscopy according to Kelly's method there will be required: Kelly's specula, or some of their modifications, an electric head light or head mirror, a Kelly dilator to stretch the external urethral orifice, a urine evacuator to draw off residual urine, alligator forceps for holding cotton swabs, and a ureteral probe for probing the mucous membrane or locating the ureteral orifices (Fig. 721).

The specula consist of cylindrical tubes 3 1/5 inches (8 cm.) long, of equal length throughout, and in sizes of from 1/5 inch (5 mm.) in diameter up to 4/5 inch (20 mm.). Those below No. 12 are generally employed for diagnostic purposes. The tubes are of German silver or nickel-plated, each having a conical expansion at the ocular end to which is fastened a strong handle (Fig. 722) Each tube is supplied with an obturator having a conical end-piece. The illumi-

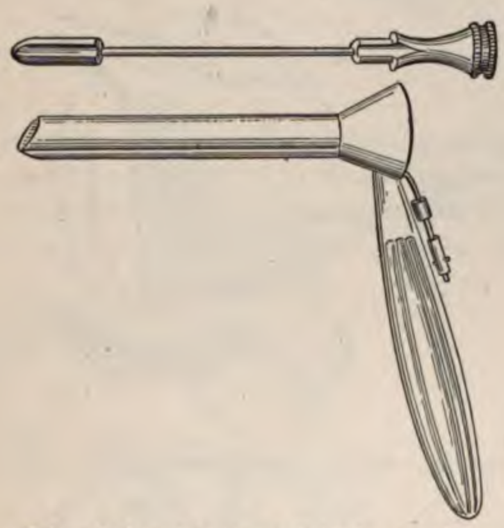


FIG. 723.—Enlarged view of an electric-lighted open-tube cystoscope.

nation is furnished by reflected light or from an electric head light, the latter being preferable. These specula, however, may be obtained furnished with an electric light at the distal end (Fig. 723), an instrument which simplifies the operation for one not accustomed to the use of a head light.

The urethral dilator is a cone-shaped metallic instrument which gradually increases in size from the point until at the base it measures 16/25 inch (16 mm.) in diameter. The instrument is graduated so that the examiner can determine the required amount of dilatation.

The urine evacuator is necessary for the purpose of removing the urine that collects in the floor of the bladder which would otherwise interfere with the examination. It consists of a suction bulb attached by means of a long delicate rubber tube to a small perforated glass bulb. In the Luys' open tube cystoscope an aspirating tube is incorporated in the instrument.

Asepsis.—All the instruments with the exception of the light carrier may be boiled for five minutes in a 1 per cent. soda solution. The latter may be sterilized by immersion in a 1 to 20 carbolic acid solution followed by rinsing in sterile water. The operator's hands should be carefully sterilized and the external genitals and mouth of the urethra should be cleansed with soap and water, followed by a 1 to 5000 solution of bichlorid of mercury.

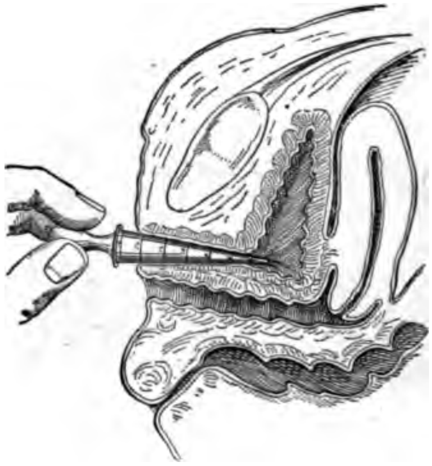


FIG. 724.—Method of dilating the urethra. (Ashton.)

Position of Patient.—Two positions are employed, the dorsal and the knee-chest. In the dorsal position the patient lies with the head and thorax resting on the table and the hips elevated 8 to 10 inches (20 to 30 cm.) upon cushions so as to raise the pelvis and permit the bladder to distend with air when the cystoscope is introduced. While the dorsal posture is the least wearing on the patient, it is not suited for stout persons. In such cases, the knee-chest posture, with the knees separated 10 or 12 inches (25 or 30 cm.), is more suitable.

Preparations of Patient.—Before the patient is placed upon the table the rectum and bladder should be emptied.

Anesthesia.—Local anesthesia is generally sufficient except in very nervous women. A pledget of cotton saturated with a 2 per cent. solution of cocain introduced upon an applicator within the meatus and allowed to remain for five minutes will anesthetize the urethra sufficiently to allow it to be dilated.

Technic.—As a rule, it is first necessary to dilate the urethral

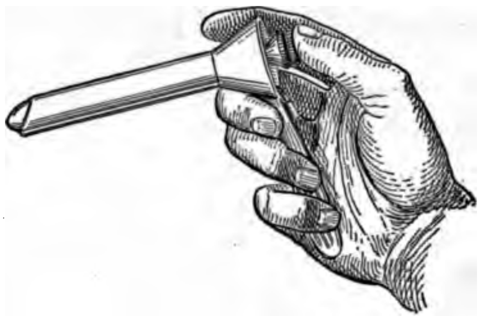


FIG. 725.—Method of holding the open-tube cystoscope during its introduction into the bladder.

orifice; the rest of the canal, being very dilatable, is easily stretched by the cystoscope in its passage. The dilator is lubricated with one of the Irish-moss preparations and is introduced into the urethra with a slight boring motion until the required amount of dilatation is

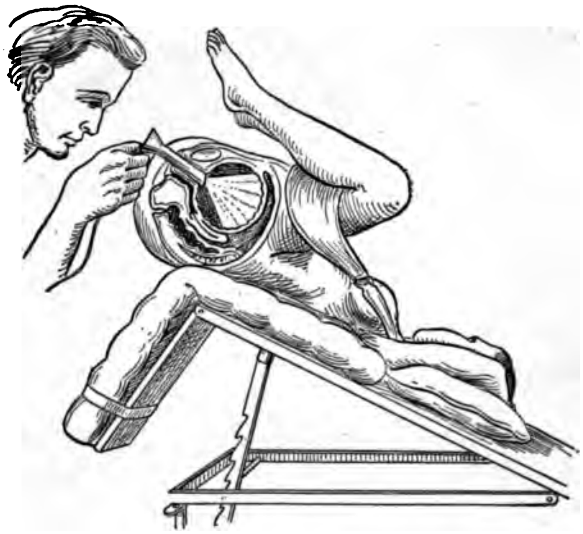


FIG. 726.—Inspection of the female bladder through an open-tube cystoscope.

reached (Fig. 724). Dilatation to about No. 12 on the dilator is generally sufficient. A speculum of a size from 7 to 10, depending upon the age of the patient, is then selected. It should be grasped in

Technic.—Having tested the cystoscope and the high frequen current, the cystoscope, well lubricated and with the electrode one of the catheter chambers is introduced into the bladder (see pa 717). The end of the wire to be introduced into the tumor, shou have been previously cut off flush with the insulation. The tum is located and the electrode is inserted into it as near the base

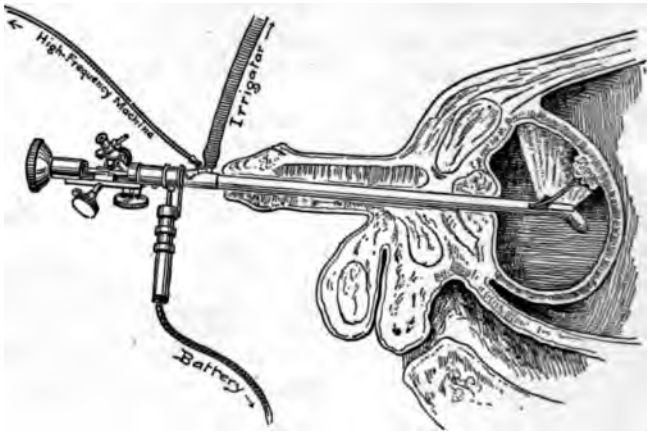


FIG. 735.—Destruction of vesical growth by means of the high frequency curre (After Oudin.)

possible (Fig. 735). The current is then turned on for 15 to 30 se onds and a rapid blanching of the tissues at the point of conta occurs. The wire is then allowed to cool and is reinserted in another portion of the tumor and the dessication continued until t whole mass has been treated. At subsequent treatments portions the growth that remain viable are similarly dealt with. When t entire mass has sloughed away the base is likewise treated.

CATHETERIZATION OF THE BLADDER

Catheterization of the bladder is indicated in all cases of comple retention of urine and in some cases of partial retention, as, f example, in prostatic hypertrophy when the residual urine amoun to more than 2 ounces (60 c.c.). Retention may be the result obstructon from stricture, spasm of the compressor urethræ muscl hypertrophy or congestion of the prostate, clots of blood, calcu foreign bodies or tumors in the bladder or urethra, perineal absces traumatism, etc., etc., and as the result of defective expulsion pow of the bladder through impairment of the nervous mechanism, as i hysteria, certain diseases of the brain and spinal cord, shock, fever

SKIAGRAPHY

The X-rays are sometimes used in locating a vesical stone which, from being buried in a pocket or being situated behind the prostate, may escape detection by other means. The success of the skiagraph depends to a large extent upon the composition of the calculus. Oxalate and phosphate stones cast a dense shadow, but those composed of urates and uric acid cast very faint shadows, and so may be missed entirely. The bony walls of the pelvis may likewise interfere and give a negative result. To secure a satisfactory radiograph it is essential that the bowels be emptied by a purge administered the night before followed by an enema in the morning.

By injecting into the bladder a solution of bismuth or one of the silver salts and taking a radiograph immediately, much valuable information as to the size and position of the bladder and the presence or absence of diverticula, sacculations, tumors, or obstruction at the vesical neck may be obtained.

Bismuth is used in a 10 per cent. watery solution. Of the silver salts, collargol in 2 to 10 per cent. solution and argyrol in 25 per cent. solution are generally employed. Eight ounces (250 c.c.) of solution will be sufficient.

Therapeutic Measures

IRRIGATIONS

Irrigation of the bladder may be employed either for simple cleansing purposes, as is required in preparation for an instrumental examination or operative procedure, or to produce a local effect upon the mucous membrane. Irrigations are thus of the greatest value in the treatment of various inflammatory affections of the bladder. In acute cystitis, however, on account of the distention produced, they often increase the pain and may aggravate the trouble. They should be employed, however, in acute cases if the bladder does not completely empty itself and there is decomposition of urine. Irrigations are also contraindicated where the bladder cannot hold more than 1 ounce (30 c.c.) of fluid without exciting a desire to urinate; in such cases, instillations should be substituted.

There are two methods of performing vesical irrigation; (1) by injecting the fluid in sufficient quantity to distend the bladder and having it retained a short time before allowing it to escape, and (2) by using a double-flow catheter which allows the fluid to escape as fast

In the presence of strictures a gum elastic olivary catheter (Fig. 738) and a set of Gouley's tunneled catheters and filiforms (Fig. 739) will be required. In place of the latter a whip catheter (Fig. 740) may be employed. This consists of a flexible gum elastic catheter tapering off for several inches into a filiform.

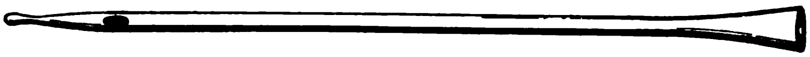


FIG. 738.—Gum-elastic olivary catheter.

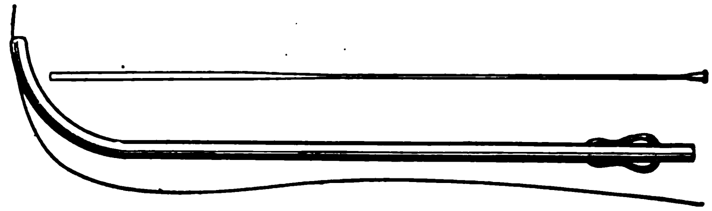


FIG. 739.—Gouleys tunneled catheter and filiform.

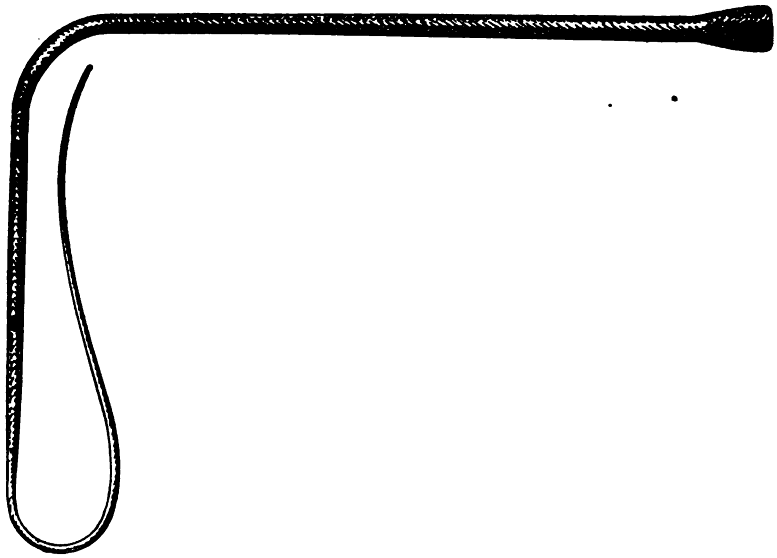


FIG. 740.—Whip catheter.

The best form of catheter to use when the prostate is enlarged is a Mercier coudé catheter (Fig. 741). The slight angle at the end of this instrument permits it to override an obstruction. Guyon's mandrin coudé catheter (Fig. 742) and a *long-curved* prostatic catheter (Fig. 743) should also be provided. The caliber of the insruments for this class of cases should be fairly small, say from 15 to 18 French.

Asepsis.—The greatest care should be taken to avoid infection of the bladder. Metal and rubber catheters, as well as the better make gum elastic instruments are boiled for five minutes. Instruments

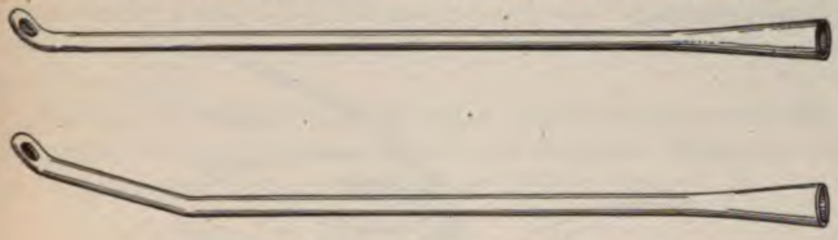


FIG. 741.—Catheters with a coudé and bicoudé curve.

that will not stand boiling are sterilized by formalin vapor (page 640) or by immersion in a 1 to 20 carbolic acid solution followed by rinsing in sterile water. The operator's hands are to be sterilized as carefully as for any operation.

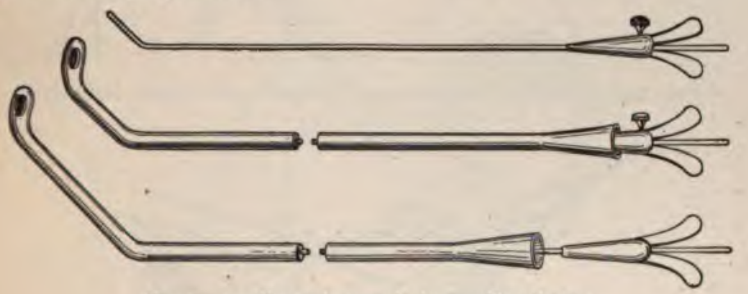


FIG. 742.—Guyon's mandarin coudé catheter.

Quantity of Urine Withdrawn.—Except when the distention is slight and of short duration, the bladder should not be emptied completely at the first catheterization. As the result of long-standing vesical distention there occurs a dilatation of the ureters and renal

FIG. 743.—Silver prostatic catheter.

pelvis with changes in the kidney structure, and a sudden evacuation of the urine is apt to be followed by suppression of urine, or hemorrhage from the vesical mucous membrane or kidneys may result from the sudden relief of pressure upon the distended veins. Therefore, not more than 8 ounces (240 c.c.) of urine should be withdrawn at the first catheterization, gradually increasing the amount at subsequent catheterizations.

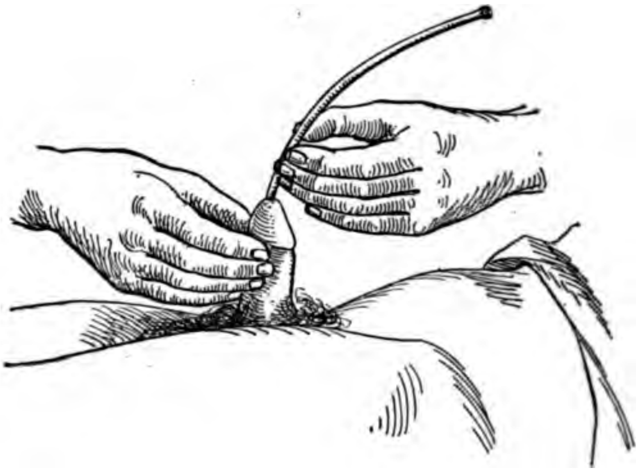


FIG. 744.—Showing the method of passing a soft rubber catheter.

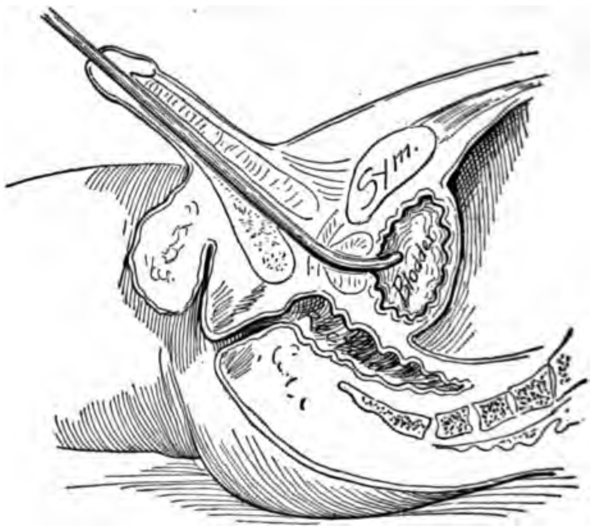


FIG. 745.—Showing soft-rubber catheter passed into the bladder.

Frequency.—As a rule, in complete retention the bladder requires emptying every four to eight hours. When the catheter is employed for withdrawing the residual urine of prostatic hypertrophy the frequency will depend upon the amount of residual urine. Thus, if this amounts to from 2 to 4 ounces (60 to 120 c.c.), one daily catheterization before the patient retires in the evening will suffice, if it amounts to from 4 to 6 ounces (120 to 180 c.c.), the catheter should be used twice a day, *i.e.*, in the evening and morning, larger quantities of residual urine demand that the bladder be emptied three or four times a day.

Position of Patient.—Catheterization should be performed with the patient in the dorsal position with his shoulders slightly raised and thighs somewhat flexed and rotated slightly outward.

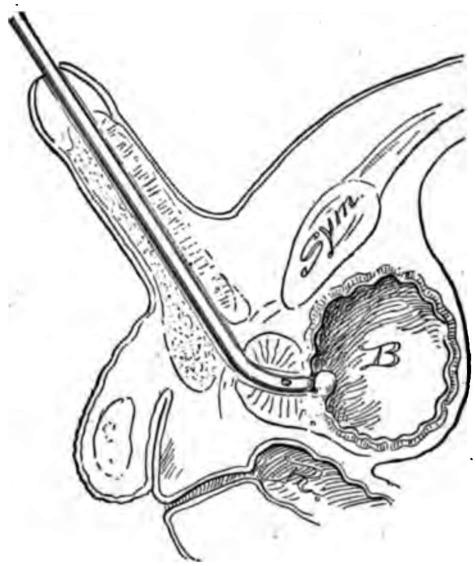


FIG. 746.—Showing an ordinary catheter obstructed by an enlarged middle lobe of the prostate gland.

Preparation of Patient.—The glans penis and meatus should be washed with soap and water, followed by a 1 to 5000 bichlorid of mercury solution and then sterile water. The urethra is irrigated with a warm saturated solution of boric acid or a 1 to 5000 solution of potassium permanganate.

Technic.—1. *In Cases Uncomplicated by Stricture or Enlarged Prostate.*—A *full-sized* soft-rubber catheter is tried first. It is well lubricated and, while the penis is held upright, is slowly fed into the urethra a little at a time (Fig. 744). If the catheter becomes obstructed, the penis should be put upon the stretch to obliterate any wrinkles in the mucous membrane, and the instrument is again advanced as before or by rotating it while the attempt is made to make it pass. In this way a soft instrument can usually be made to enter the bladder when the retention is simply due to defective ex[p]sive power. In withdrawing a catheter the instrument should compressed between the thumb and forefinger, or the tip of the fir should be placed over the opening at the proximal end to prev the urine which remains in the catheter from dripping out and wet the patient's clothes.

In cases of spasmodic stricture, failing in attempts to pass a instrument, a full-sized metal catheter should be resorted to. S a catheter is passed precisely as one would a sound (see page 6

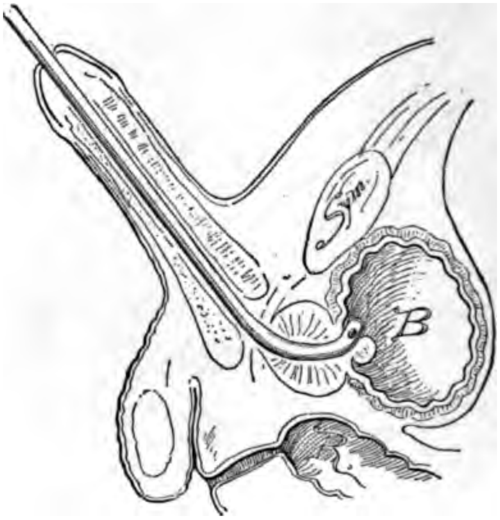


FIG. 747.—Showing a coudé catheter passing the obstruction.

When the point of the instrument has been introduced as far as obstruction, it should be held pressing steadily against the face the stricture for a few minutes until the spasm passes off, when may be easily slipped into the bladder.

2. *In the Presence of Stricture.*—In dealing with a retention due stricture a small soft-rubber catheter should be given first trial. unsuccessful, attempts may be made to pass an olivary poin catheter. If this fails, a filiform should be introduced through stricture (see page 690) and a Gouley tunneled catheter passed o this as a guide, or, in its stead, a whip catheter may be employ Should the stricture be of such small caliber that it is only possi to insert a filiform, the latter should be left in place to act as a ca[pil]lary drain, taking care, however, to fasten it in such a way that cannot slip out (page 694). In this way the bladder will empty

self in a few hours, and, by the end of twenty-four hours, sufficient dilatation will usually have taken place to allow the passage of a tunneled catheter. Failing to pass even a filiform the bladder should be aspirated (page 746).

3. *In the Presence of Prostatic Hypertrophy.*—A soft flexible catheter should be tried and then a coudé catheter. The latter will often succeed where a soft catheter fails because the bend of the tip of this instrument keeps the point in contact with the upper wall of the urethra and thus permits it to more easily override a median prostatic enlargement (Fig. 747). Sometimes, if an ordinary coudé catheter will not pass, an elbowed catheter with a stylet can be made to do so. With this instrument it is possible to elevate the point more sharply, when obstructed, by withdrawing the mandarin a little, so that the point of the instrument passes upward over the obstruction into the bladder.

After repeated and unsuccessful efforts with the above instrument a metal prostatic catheter should be tried before resorting to aspiration. Great gentleness should be employed in its introduction to avoid making a false passage. Sometimes assistance in guiding its point may be derived from placing a finger in the rectum.

CATHETERIZATION IN THE FEMALE

Catheterization of the female bladder is a simple procedure. It should always be done, however, by direct sight; the old method of passing a catheter by touch carries with it the great risk of infection.

FIG. 748.—Glass female catheter. (Ashton.)

Instruments.—A glass female catheter, 5 inches (13 cm.) long and 1/5 of an inch (5 mm.) in diameter with a gentle curve in opposite directions at both ends (Fig. 748), is the best instrument to employ.

Asepsis.—The catheter is boiled for five minutes and the operator's hands are carefully scrubbed in soap and water, followed by immersion in an antiseptic solution.

Position of Patient.—The patient should be in the dorsal position with the thighs flexed and the legs well separated.

Preparations of Patient.—The external genitals and meatus are cleansed with soap and water followed by a 1 to 5000 bichlorid of mercury solution.

Technic.—The operator separates the labia with the thumb and forefinger of the left hand so as to expose the meatus. The catheter, held near the proximal end in the fingers of the right hand, is then

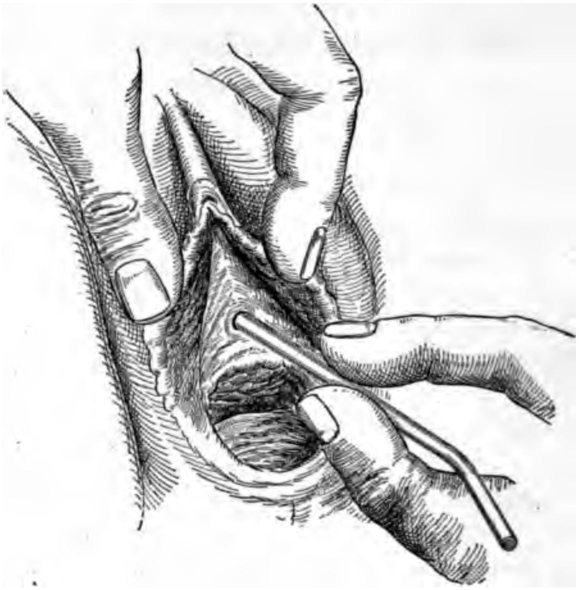


FIG. 749.—Method of passing a catheter in the female. (Ashton.)

FIG. 750.—Showing the method of preventing urine dripping from the catheter as it is withdrawn. (Ashton.)

introduced through the urethra into the bladder (Fig. 749). When the bladder has been emptied, the forefinger is first placed over the proximal end of the catheter to prevent the escape of the urine it contains (Fig. 750) and the instrument is then withdrawn.

CONTINUOUS CATHETERIZATION

A catheter may be introduced into the bladder and left in place in cases where drainage of the bladder for a brief period is desired. It may be employed in chronic cystitis accompanied by the presence of large amounts of pus, frequent urination, and tenesmus, in vesical

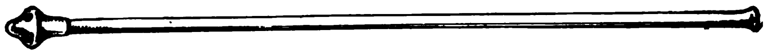


FIG. 751.—The Pezzer retention catheter.

hemorrhage, and in cases of obstruction from an enlarged prostate where the constant introduction of a catheter causes spasm or hemorrhage, or where catheterization is difficult. The bladder is thus put at rest and at the same time is kept constantly emptied, the beneficial effects of which are shown by a rapid decrease of the inflamma-

FIG. 752.—The Malécot retention catheter.

tion and congestion, decline of the fever, and relief of the pain and tenesmus. Continuous catheterization is also indicated in wounds of the urethra or after certain operations upon the urethra when it is desirable to prevent the contact of infected urine with raw surfaces.

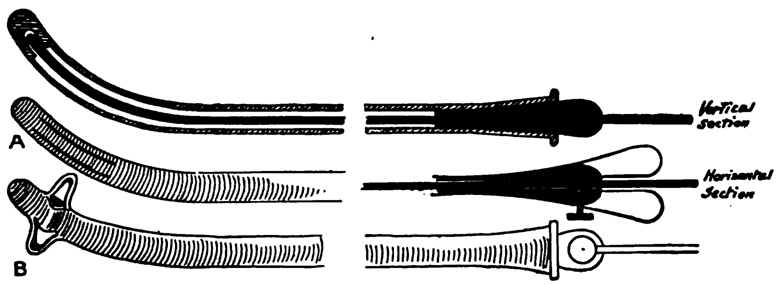


FIG. 753.—Stylet in place in Malécot catheter. *a*, Mandarin pushed forward; *b*, mandarin withdrawn.

At first, when the catheter is inserted, there may be a feeling of weight in the perineum, but this soon passes off. In some instances a mechanical urethritis is set up which may persist until the instrument is removed and, if neglected, urethral abscess or extension of the infection backward into the bladder may result.

Instruments.—A plain soft-rubber catheter of about 18 French with the eye near the end or the retention catheters of Pezzer or Malécot may be employed. The Pezzer catheter (Fig. 751) has a flange to rest against the vesical neck, while the Malécot instrument (Fig. 752) has wings on either side. When introduced over a stylet (Fig. 753), these projections are made to disappear, but reappear when the stylet is removed.

Duration.—This will depend upon the toleration of the urethra. In some cases, continuous drainage may be kept up for over two weeks, without the catheter causing much irritation; in others, the

Fig. 754.—Showing the method of securing a catheter in the bladder. (After Sinclair, *Polyclinic Journal*, July, 1908.)

presence of an instrument in the bladder produces so much irritation and vesical spasm that it cannot be used at all.

Preparation of Patient.—The glans penis and meatus are washed with soap and water followed by a 1 to 5000 solution of bichlord of mercury, and the urethra is thoroughly irrigated with a mild antiseptic solution.

Asepsis.—The catheter should be thoroughly sterilized by boiling or by formalin vapor and, if the latter method is employed, care must be taken to remove all trace of the formalin by thoroughly rinsing the catheter in sterile water. The operator's hands should likewise be perfectly sterile.

Technic.—1. *By the Ordinary Catheter.*—If an ordinary rubber catheter is employed, it is well lubricated and is then introduced in the usual way until its eye lies just within the bladder. It is quite important that the point of the catheter be not introduced too far, for, if so, it will not only fail to drain the bladder properly, but will irritate the vesical floor. To insure that the instrument is properly placed, it should first be introduced into the bladder until the urine flows freely and then slowly withdrawn until the flow just stops, when it is pushed into the bladder again, this time for a distance of ¼ inch (6 mm.). It is then secured in place as follows:

The portion of the catheter protruding from the meatus is thoroughly dried and all grease is removed. Then four pieces of adhesive plaster, each about 4 inches (10 cm.) long and 1/4 inch (6 mm.) wide, are secured to the catheter at the point it emerges from the meatus in such a way that one strip lies upon the dorsum, one on the ventral surface, and one on either side of the penis. Each strip is carried back over the foreskin and is made to adhere to the body of the penis. An additional strip of adhesive 1 inch (2.5 cm.) wide is placed horizontally about the penis back of the corona, covering the four small strips (Fig. 754). Care should be taken, however, not to have this strip entirely encircle the penis. The penis is then wrapped in sterile gauze and is supported over one groin by a T-bandage. If upon

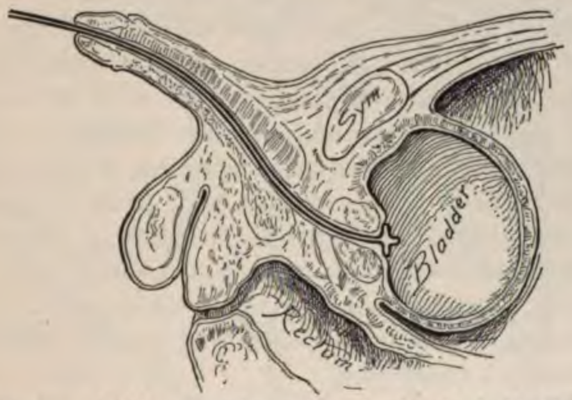


FIG. 755.—Malécot retention catheter in place in the bladder.

inspection it is found that the urine escapes freely, the free end of the catheter is finally connected with a drainage-tube which conducts the urine to a receptacle at the side of the bed. The receptacle should be half-full of some antiseptic solution.

If the retained catheter is employed in a case of long-standing retention where it is dangerous to empty the bladder at once, an intermittent form of drainage may be employed by discarding the drainage-tube and simply inserting a plug in the end of the catheter, which is removed at definite intervals and an increasing quantity of the urine drawn off each time until it is considered safe to empty the bladder completely, when the above method is used.

2. *By the Self-retaining Catheter.*—In inserting a special self-retaining catheter, a stylet curved to the shape of a sound is introduced within the instrument so as to obliterate the projecting collar or wings (see Fig. 753). When the catheter is in place, the stylet is

withdrawn, thus allowing the bladder end of the catheter to expand again so that the catheter is retained in place unless some force is used in withdrawing it (Fig. 755). In spite of this, however, it is safer to fix the catheter in place by the method above described, after first withdrawing it until the resistance shows that the terminal enlargement is at the vesical neck.

After-care.—The catheter rapidly becomes encrusted with lime salts, blood, or pus and should, therefore, be changed every two or three days to permit of its being cleansed. At this time the urethra and bladder should be thoroughly irrigated with a mild antiseptic solution and the catheter thoroughly sterilized before it is reinserted. In the presence of pus or blood the bladder may be irrigated through the catheter as frequently as seems indicated.

If urethritis develops, the urethra should be irrigated once or twice daily with a saturated solution of boric acid. This may be accomplished by withdrawing the catheter until its extremity lies in front of the bulbous urethra and then flushing out the urethra from behind through the instrument by means of an irrigating apparatus. The catheter is then pushed back to its original position. Constant watch should be kept lest ulceration of the urethral wall develop at the penoscrotal junction from pressure of the catheter. To avoid this, the penis should be supported in such a position that the sharp angle formed at the penoscrotal junction when the organ hangs vertically is obliterated.

ASPIRATION OF THE BLADDER

Suprapubic aspiration of the bladder is indicated as a temporary expedient when there is complete retention of urine and catheterization is impossible from the presence of a tight stricture, prostatic enlargement, or from any other cause. The operation is easily performed and, if properly done, is a safe procedure. At times after a single aspiration the congestion is so much lessened that within a few hours it becomes possible to pass a catheter, or the patient voids spontaneously, but, if necessary, the bladder may be emptied several times a day for several days by this method without danger.

Where a permanent drainage for some time is desired, suprapubic puncture by means of a trocar and cannula may be performed. Puncture through the perineum or rectum, on the other hand, should be avoided as unsafe.

Instruments.—For temporary relief an aspirating needle and syringe should be employed. The needle should be fairly fine and about 3 inches (7.5 cm.) long. The Potain aspirator (Fig. 756) is the best to use. This instrument has already been described (page 340).

When a trocar and cannula are used, a curved instrument with the convexity of the curve upmost should be obtained. A scalpel to nick the skin is also required.

Asepsis.—The instruments are boiled for five minutes in a 1 per cent. sodium carbonate solution and the operator's hands are sterilized in the usual way as for any operation.

Site of Puncture.—The puncture is made in the median line about ½ inch (1 cm.) above the pubes. The extraperitoneal space above

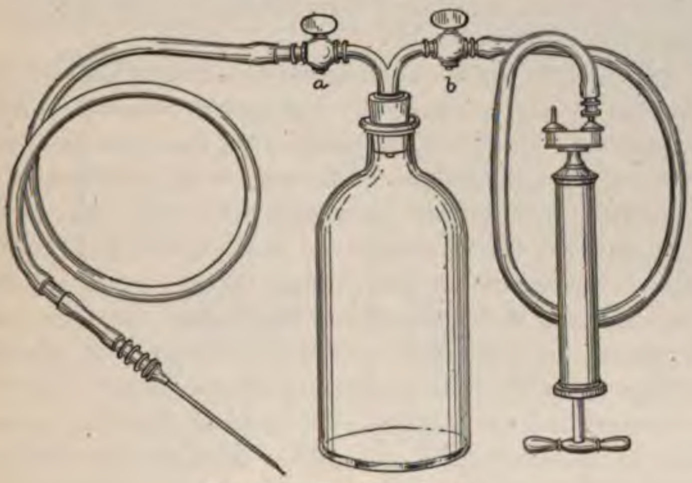


Fig. 756.—Potain aspirator.

the pubic bone is increased when the bladder is distended and a needle or trocar may be inserted here without danger of entering the peritoneum. When a number of punctures are made, the site may be changed a little each time.

Position of Patient.—The operation may be performed with the patient recumbent or sitting partly up.

Preparations of Patient.—The pubes should be shaved and then painted with tincture of iodin.

Anesthesia.—Sufficient anesthesia is obtained by freezing the surface tissues with ethyl chlorid or salt and ice to render the operation painless.

Technic.—1. *By the Aspirator.*—The suprapubic region is first carefully percussed to make sure that there are no coils of intestine lying in front of the bladder. The aspirator is assembled, tested, and the air in the bottle exhausted. A small nick is then made in the skin at the spot chosen for the puncture and the needle, held in the right hand with the index-finger placed on its shaft as a guide, is introduced through the tissues, directed downward and backward, until a lessened resistance signifies that the bladder has been entered This will usually be when the needle has entered from 1½ to 2½ inches (4 to 6 cm.), depending upon the thickness of the abdominal wall. The aspirator is then attached and the vacuum is extended to the needle-point by opening the inflow cock. If no urine is withdrawn, the needle is introduced still further until fluid is reached. The contents of the bladder are then partly or completely emptied, depending upon the duration of the retention and the amount of the distention (see page 737).

In removing the needle, care should be taken to keep up the suction until the needle is completely withdrawn, otherwise some urine may escape from the tip of the needle as it traverses the prevesical space and cause an infection. The site of the puncture is finally covered with a piece of sterile gauze held in place by adhesive plaster.

2. *By the Trocar and Cannula.*—A small nick is made in the skin as before at the chosen site and through this the trocar and cannula with the convexity up is inserted into the bladder, care being taken to guard against the instrument entering too deeply by placing the index-finger on the shaft of the instrument as a guide. The trocar is then removed and the cannula is secured in place for permanent drainage by means of tapes. A rubber drainage-tube leading to a receptacle half filled with an antiseptic solution is fastened to the cannula.

The bladder, if it contains much pus, may be irrigated through the cannula once or twice daily. The cannula should be removed and sterilized every few days. To do this a small catheter is passed through the lumen of the cannula into the bladder where it is maintained while the catheter is being cleansed. The cannula is then easily reintroduced over the catheter as a guide.

The permanent cannula should be removed as soon as it is possible to pass a catheter through the urethra without difficulty. The sinus remaining is allowed to close by granulation.

CHAPTER XXII

THE KIDNEYS AND URETERS

Anatomic Considerations

The Kidneys.—The kidneys are two bean-shaped organs, each measuring on an average from 4 to 4¾ inches (10 to 12 cm.) in length and 2½ inches (6 cm.) in breadth. They lie deeply situated in the abdominal cavity on each side of the vertebral column behind the peritoneum, embedded in a loose layer of areolar tissue, the perirenal fat, resting upon the diaphragm, the quadratus lumborum,

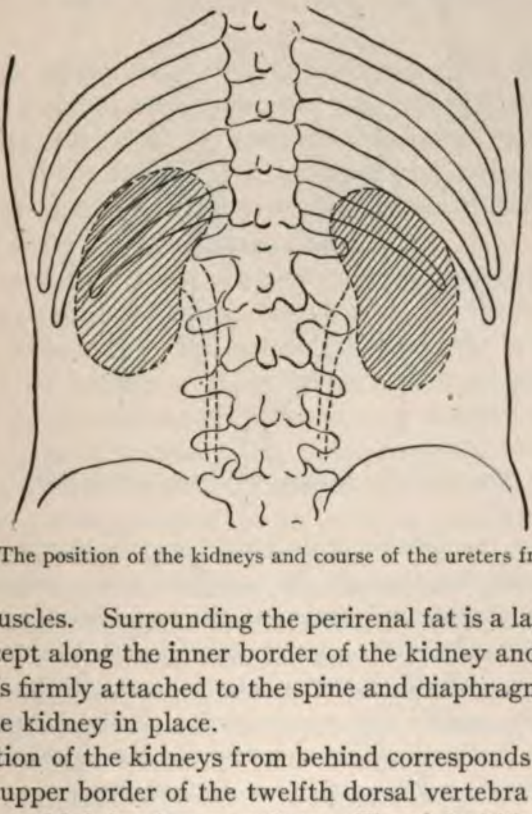


FIG. 757.—The position of the kidneys and course of the ureters from behind.

and psoas muscles. Surrounding the perirenal fat is a layer of fascia, complete except along the inner border of the kidney and at its lower pole, which is firmly attached to the spine and diaphragm, and serves to anchor the kidney in place.

The position of the kidneys from behind corresponds to the space between the upper border of the twelfth dorsal vertebra and the first and second, or third, lumbar vertebræ. The right kidney generally lies about ⅓ to ½ inch (8 to 12 mm.) lower than the left on account of the position of the liver above it, the upper extremity of the right kidney usually reaching to the level of the lower border of the eleventh rib and that of the left to the upper border of the eleventh rib. The inferior pole of the kidney, on the right, reaches to within 1½ inches (4 cm.) and, on the left, to within 2 inches (5 cm.) of the crest of the ilium. During deep inspiration or when the patient stands erect the kidney will descend to a somewhat lower level. The long axis of the kidney is directed obliquely downward and outward, so that the superior poles lie from ½ to 1 inch (1 to 2.5 cm.) nearer the median line than the lower poles.

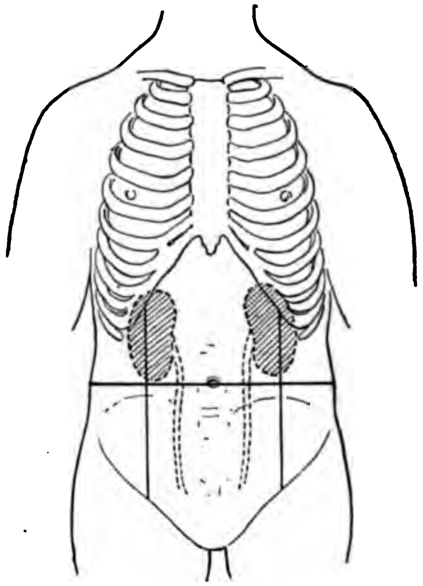


FIG. 758.—The kidneys and ureters from the front.

Anteriorly, the position of the kidney may be mapped out by passing a horizontal line through the umbilicus and a vertical line from the middle of Poupart's ligament to the costal border perpendicular to the horizontal line—the former passes just below the lower poles of the kidneys, while the latter cuts the long axis of the kidney at the junction of its middle and outer thirds. If the kidney lies to the outer side of the vertical line or below the horizontal umbilical line, it is indicative of enlargement or a displacement.

Relations of Kidneys.—Behind, the kidneys are in relation with the diaphragm, quadratus lumborum, psoas muscles, and with the last dorsal, iliohypogastric, and ilioinguinal nerves. The close relations of these nerves account for the referred pains sometimes encountered in diseases of the kidneys.

In front of the right kidney are the under surface of the right lobe of the liver, the second portion of the duodenum, the ascending colon, and the hepatic flexure. The left kidney is in relation in front with the spleen, the fundus of the stomach, the tail of the pancreas, the splenic vessels, and the descending colon.

Ureters.—The ureters are two in number, one for each kidney. They measure about 12 inches (30 cm.) in length and have a caliber equal to that of a goose quill. The ureter begins at the neck of the renal pelvis opposite the lower pole of the kidney and passes down on the psoas muscle behind the peritoneum to the brim of the pelvis. A line drawn on the abdominal wall vertically upward from the junction of the middle and inner thirds of Poupart's ligament roughly represents the course of the ureter from the kidney to the pelvic brim.

The ureter in the male, after crossing the pelvic brim and the common iliac vessels, passes downward and backward in front of the sacroiliac joint and enters the parietal attachment of the posterior false ligament of the bladder. It then passes forward and inward to the base of the bladder which it enters just above the seminal vesicle, first passing under the vas deferens.

The ureter in the female, after crossing the pelvic brim and iliac vessels, passes downward and backward along the lateral wall of the pelvis as in the male. It then enters the base of the broad ligament and passes down parallel with the cervix and upper portion of the vagina, at a distance of about ½ inch (1 cm.) external to the cervix and posteriorly to the uterine artery. After crossing the upper third of the vagina the ureter enters the bladder opposite the middle of the vagina. The pelvic portion of the ureter in the female is thus readily palpated through the vagina or rectum.

The ureters enter the bladder 1½ to 2 inches (4 to 5 cm.) apart and, after passing obliquely forward and inward for a distance of ¾ of an inch (2 cm.) through the bladder wall, they appear on the mucous membrane about 1¼ inches (3 cm.) apart and the same distance posterior to the internal urethral orifice. Through this oblique insertion of the ureters into the bladder regurgitation of urine when the bladder is distended is effectually guarded against.

The ureters are composed of three coats, an outer fibrous, a middle or muscular, and an internal or mucous. Normally the walls are collapsed and lie in contact. The lumen of the ureter presents three constrictions and two intermediate dilated portions. The constrictions are: First, about 2½ inches (6 cm.) from the hilum of the kidney, second, at the point where the ureter crosses the pelvic brim, and, third, at its entrance into the bladder.

Diagnostic Methods

In suspected disease of the kidney or ureter a careful history of the past ailments and present symptoms should first be obtained. Frequently pain will be the only symptom complained of. In such case its exact location should be determined; that is, whether limited to the loin or radiating along the course of the ureter, and whether unilateral or bilateral. Severe attacks of pain radiating from the loin down toward the bladder, testicle, and thigh are strongly suspicious of calculus. The character of the pain should also be ascertained; whether it is dull or aching, or paroxysmal and lancinating, and whether continuous or periodic. Periodic attacks of sharp pain accompanied by a considerable diminution in the amount of urine secreted, followed by relief of the pain and an abundant flow of urine are characteristic symptoms of hydronephrosis due to a movable kidney. The patient should also be questioned as to the character of his urine, *i.e.*, whether bloody, etc., supplemented by inquiry as to special points along the lines mentioned in the sections upon the urethra and bladder. This is followed by a thorough physical examination.

The methods available for examination of the kidneys and ureters include inspection, palpation, percussion, urinalysis, cystoscopic examination, ureteral catheterization, pyelometry, segregation of urine, determination of the functional capacity of the kidneys, skiagraphy, and exploratory incision.

INSPECTION

On account of the deep situation of the kidney in the abdomen, inspection gives no information if the kidney is normal. When, however, the kidney is greatly enlarged it may produce a visible swelling in the loin or protrude anteriorly and cause a bulging of the lower ribs upon the side affected.

Inspection should be performed from in front with the patient lying flat on the back, and also from behind and laterally with the patient standing and bending forward, so as to make any bulging more prominent through relaxation of the abdominal muscles.

PALPATION OF THE KIDNEYS

Palpation is by far the most valuable of the methods of physical diagnosis for determining the presence of enlargement or displacements of the kidney. While the normal kidney can seldom be felt, unless the individual is very thin and the abdominal wall is lax, and then it is ony possible to palpate the lower pole of the kidney, an increase in the size of the organ or undue mobility is readily recognized. By palpation it is also possible to determine the sensitiveness of the kidney and in the presence of a tumor, its characteristics—namely, its size, shape, and whether soft, hard, or fluctuating.

Palpation is sometimes performed with one hand, so placed that the fingers press in the loin while the thumb lies on the abdomen beneath the costal arch, but a more satisfactory method is the bimanual.

FIG. 759.—Palpation of the kidney with the patient in the dorsal position.

Position of Patient.—The patient should lie flat on the back with the head and shoulders elevated upon a small pillow and the lower extremities flexed so as to thoroughly relax the abdominal walls. Sometimes in cases of movable kidney additional information may be elicited by palpating with the patient standing, his body bent forward from the hips, and with his hands resting on the arm of a chair for support; or else the patient may assume the lateral position, lying on the sound side, and with the thighs slightly flexed (Fig. 760).

Preparations of Patient.—Care should be taken to have the colon empty at the time of the examination; if necessary a cathartic should be administered the night before for this purpose. All clothing that is likely to interfere with the examination should be removed.

Anesthesia.—If palpation is difficult through rigidity of the abdominal muscles or from increased sensitiveness, a general anesthetic may be required in order to make a satisfactory examination.

Technic.—The examiner should stand upon the side he wishes to examine. When palpating the right kidney the fingers of the left hand are placed under the loin just below the last rib and the right hand is placed flat on the abdomen below the costal arch (Fig. 759);

FIG. 760.—Palpation of the kidney with the patient on the side.

to palpate the left kidney the position of the hands is reversed. The patient is instructed to breathe deeply but quietly, and any manipulations should be gentle in character to avoid inciting muscular contraction. The kidney descends during inspiration and, if at this time forward pressure is made with the hand under the loin and the hand upon the abdomen is pressed backward under the ribs, the kidney, if enlarged, will be felt. If the kidney is displaced, it may be caught between the two hands as it descends during deep respiration and may be prevented from returning to its former position. In the presence of a tumor, the size, shape, and consistence of the growth should be determined and its sensitiveness ascertained. Palpation of the normal kidney causes a peculiar sensation which has been likened to pressure on the testicle; actual pain will be elicited, however in the presence of some tumors, kidney calculus, or pus formation.

Tumors of the colon, gall-bladder, pylorus, spleen, or a pedunculated ovarian or uterine growth may be mistaken for a renal tumor or a movable kidney. The symptoms complained of and the relation of the colon to the tumor, however, will usually settle the diagnosis. The colon lies in front or to the inner side of the kidney and, if necessary, it should be inflated to more accurately map it out.

At times the so-called "ballottement of the kidney" may be obtained if the kidney is freely movable. To elicit this sign sudden sharp pressure is applied to the loin by the posterior hand, when, if movable or enlarged, the kidney will be driven forward with a slight impact against the hand on the abdomen in front.

PALPATION OF THE URETERS

The ureters may be palpated through the abdominal wall, through the vagina, or through the rectum. Abdominal palpation is only of value if the patient is thin and the abdominal walls lax, and then it is only possible to palpate the ureter if thickened or if it contains a calculus. In some cases, however, if inflamed and painful, the ureter may be traced from the kidney pelvis to the pelvic brim from the pain elicited on palpation. Through the vagina it is possible to palpate the ureter from the base of the broad ligament to its entrance into the bladder. Calculi, thickening, or inflammation of this portion of the ureter is thus readily recognized. In the male by rectal examination the ureter may be palpated in its course from the pelvis to the bladder.

Positions of Patient.—For abdominal palpation the patient should lie flat on the back with the head and shoulders slightly elevated and the thighs flexed.

Vaginal or rectal palpation is performed in the dorsal position with the thighs flexed.

Preparations of Patient.—The bladder and bowels should be empty at the time of examination.

Technic.—1. *Abdominal Palpation.*—The examiner stands on the side to be palpated and first locates the promontory of the sacrum by deep palpation with the examining hand. The ureter crosses the pelvic brim at a point about 1¼ inches (3 cm.) to the side of the promontory and a little below it. A thickened ureter may be palpated at this point if the patient has thin, relaxed abdominal muscles. Beginning at this point, the ureter may be traced upward along its course by making deep pressure along the outer border of the rectus muscle (Fig. 761). If the ureter is inflamed, palpation will elicit pain. On the right side such pain must be differentiated from that of cholecystitis or appendicitis.

2. *Vaginal Palpation.*—The right hand is employed to palpate the right ureter and the left hand for palpation of the left ureter. The index-finger is inserted in the vagina and is carried to the vaginal

FIG. 761.—Abdominal palpation of the ureter.

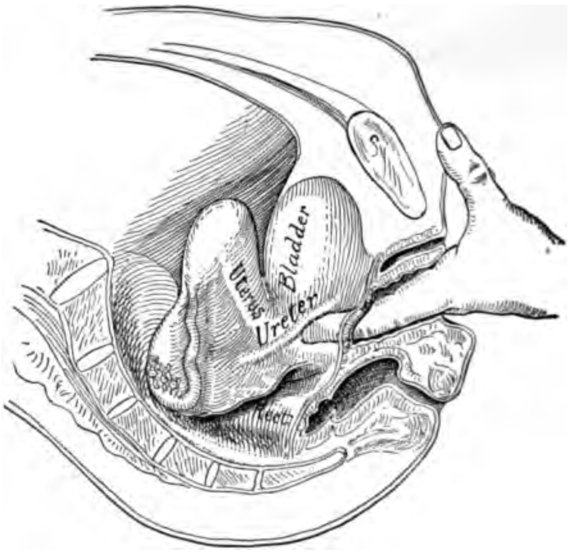


FIG. 762.—Vaginal palpation of the ureter. (Ashton.)

fornix corresponding to the ureter to be palpated. From this point it is pushed upward and outward toward the pelvic wall, and a careful search is made for the ureter which will be recognized as a flat cord passing forward and inward from the pelvic wall around the cervix to the bladder (Fig. 762). Sometimes, by means of a bimanual examination, with the external hand placed on the abdominal wall and exerting downward pressure the ureter may be more satisfactorily examined.

3. *Rectal Palpation.*—The right hand palpates the right ureter and *vice versa.* The index-finger well lubricated is inserted into the rectum and is carried upward a little higher than the level of the base of the seminal vesicle. The finger is then turned toward the lateral wall of the pelvis and the ureter is sought by moving the finger backward and forward. It will be recognized as a flat cord-like structure passing at first downward along the side of the pelvis and

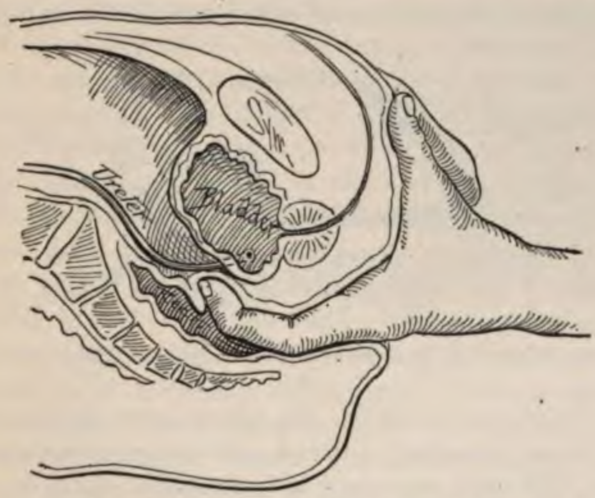


Fig. 763.—Palpation of the ureter per rectum.

then forward. It may be traced as far as the bladder and will be recognized passing forward and inward from the pelvic wall to the base of the bladder, where it will be felt a little above the seminal vesicle.

PERCUSSION

Percussion of the kidney is of slight value unless the organ is greatly enlarged. At best it is difficult on account of the thick layer of muscles in the dorsal and lumbar regions and the depth of the kidney from the anterior abdominal wall. In fat individuals the difficulties are increased in proportion. Percussion is important, however, for the purpose of showing the position of the colon in relation to a tumor occupying the region of the kidney and in differentiating growths of the kidney from the spleen and liver.

Position of Patient.—To percuss from behind the patient should lie face downward with a firm cushion or several pillows under the abdomen to make the lumbar region more prominent (Fig. 764).

For anterior percussion the patient lies in the dorsal posture with the legs extended.

Preparations of Patient.—The colon must be emptied so as not to obscure the results.

Technic.—It is necessary to employ very strong percussion to outline the organ, but in fat individuals even this may yield unsatisfactory results. In a normal case the kidney dulness will be found to extend about 2 inches (5 cm.) below the last rib, merging above

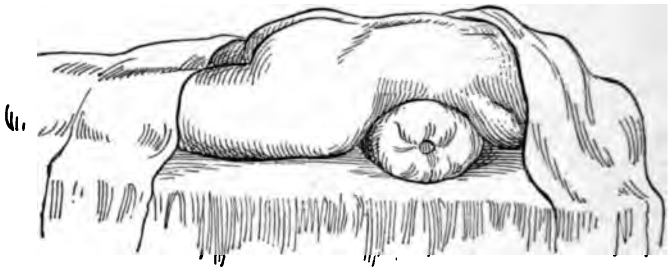


FIG. 764.—Position of the patient for percussion of the kidneys from behind.

into that of the liver or spleen. In a large renal growth percussion will give dulness extending outward and downward beyond the normal limits, with colon resonance in front or internal to the tumor.

Tumors of the spleen or liver may give much the same area of dulness, but the colon resonance will be behind. Inflation of the colon (page 573) may be necessary before its position can be accurately determined.

URINALYSIS

The examination of the urine is of the greatest importance. It should comprise a complete physical, chemical, microscopical, and bacteriological analysis. Abnormality may be due to general diseases, renal diseases, or to lesions in the lower genitourinary tract, so that it is not sufficient to simply recognize a departure from the normal, but the seat of the trouble, *i.e.*, whether in the bladder, ureter, or kidney, must be determined and, if the ureters or kidneys are affected, which side is involved as well. For this purpose the cystoscope and ureteral catheter are of the greatest aid. Other methods for determining the source of abnormal urinary constituents have already been described (see page 699).

CYSTOSCOPY (See page 713)

CATHETERIZING THE URETERS

The use of the ureteral catheter is of the greatest diagnostic aid in diseases of the kidney or ureter, as it is possible by this means to collect urine separately from each kidney for analysis uncontaminated by contact with the bladder or urethra, and to explore the entire length of the ureter from the bladder to the kidney pelvis. This method of examination is thus of value in determining whether both kidneys are present, in estimating the functional capacity of either kidney, and in the presence of blood or pus in the urine in determining whether its source is the kidney or the ureter and from which side it comes. It is also of the greatest aid in recognizing stricture or calculus of the ureter, hydroureter, hydronephrosis, etc.

Ureteral catheterization has certain drawbacks that should be mentioned. Under the most favorable conditions it requires considerable skill to catheterize the ureters, and in some cases, complicated by the presence of tight urethral strictures, enlargement of the prostate, tumors, or thickening of the bladder mucous membrane it may be impossible. Then there is always present the danger of carryng infection from the bladder into a healthy ureter or kidney. With proper aseptic precautions in performing the operation, however, this danger may be disregarded.

Fig. 765.—Bransford Lewis cystoscope.

Instruments.—Catheterizing cystoscopes, like the exploring cystoscopes, are of two types, the direct view and the indirect view.

The direct view cystoscope of which the Brenner, Brown, Bransford Lewis, Elsner, etc., instruments are types, are arranged with the light either on the convex side of the beak, or with a window both on the convexity and concavity so that the light is shed in both directions, and are provided with a straight observation telescope having a window at the distal end. The catheter chambers are placed on the under surface of the telescope so that the catheters protrude at the lower part of the field of vision in a straight line. An obturator takes the place of the telescope when the instrument is being inserted into the bladder.

The indirect catheterizing cystoscope, such as the Nitze, Casper, Albarran, Bierhoff, Buerger, etc., have the light upon the concave side of the beak, while the image is reflected at right angles, by means of a prism, to the eye-piece at the proximal end. The catheter chambers are enclosed within the sheath of the instrument lying above the telescope. A small movable tongue or finger, which can be raised or lowered by means of a screw at the ocular end of the instrument, is provided for the purpose of changing the angle of the catheters as they emerge from the instrument. Irrigating cocks are provided with both styles of cystoscope.

Instruments may also be obtained with which it is possible to employ either the direct or indirect methods of observation and catheterization, as McCarthy's composite cystoscope, which has

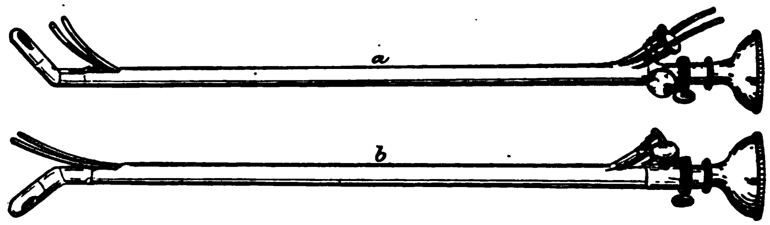


FIG. 766.—The Bierhoff cystoscope. *a*, Showing the instrument with the telescope in position for catheterization; *b*, showing the telescope rotated within the sheath to facilitate removal of the instrument.

both indirect and direct view telescopes and an indirect double catheterizing attachment, and the universal cystoscopes of Tilden Brown and Bransford Lewis, which combine in one instrument direct and indirect observation and double catheterization by either the direct or indirect method.

While the choice of the type of instrument must rest with the individual operator, there is no doubt that in the majority of cases it is easier to catheterize with the direct view instrument, exceptions being the presence of intravesicular hypertrophy of the prostate and a trabeculated bladder, in which class of cases the indirect view instrument is essential; on the other hand, it is far easier to locate the ureteral orifices by indirect view.

The catheters, which are of silk elastic material about 24 inches (60 cm.) long and 5 to 7 French in size, should be of different colors to differentiate them. The distal end is either blunt or olive pointed. Before using, it should be seen that the catheters are smooth and the eyes perfect; the patency of the catheters should also be tested by injecting water through them. They are best kept at full length in glass tubes plugged with cotton at either end.

For the purpose of recognizing calculi the end of the catheter may be dipped in melted wax (2 parts of dental wax and 1 part of olive oil) and allowed to harden in the air (Fig. 767). On coming in contact with a stone scratch marks will be produced on the wax tip. The wax catheters can only be used, however, with the direct view instrument and to avoid scratching the wax they should be threaded through the instrument from the vesical end backward.

FIG. 767.—Wax-tipped ureteral catheter.

In addition to the ureteral catheters an irrigating jar or a Janet syringe holding 3 to 4 ounces (90 to 120 c.c.) of solution and a soft-rubber catheter should be provided for irrigating the bladder.

Illumination for the cystoscope may be obtained from a six- or eight-cell battery or from the street current provided a controller is employed.

Asepsis.—The cystoscope should be well cleaned with tincture of green soap and water and is then placed in a 1 to 20 carbolic acid solution or 95 per cent. alcohol, or it may be sterilized by formalin. Before using, it should be rinsed off in a saturated solution of boric acid. The catheters are sterilized by formalin vapor or by boiling for one or two minutes in plain water, care being taken to wrap them separately in gauze to prevent their sticking together and to place them at full length in the sterilizer. The examiner's hands are carefully sterilized in the usual way.

Position of Patient.—The patient may be in the lithotomy position with the buttocks close to the edge of the table, or as preferred by some operators in a semirecumbent posture. The table should be provided with uprights which are surmounted with double inclined rests for the thighs and knees. (See Fig. 717.)

Anesthesia.—If any anesthesia is necessary, local anesthesia usually suffices. It may be obtained by the instillation into the deep urethra of a small quantity of a 2 per cent. solution of cocain or by filling the empty bladder with 5 ounces (150 c.c.) of a warm 0.1 per cent. solution of cocain to which is added 20 drops (1.25 c.c.) of adrenalin. This must be retained for at least fifteen to twenty minutes. Guyon's method may also be employed (see page 716). In some few cases it may be necessary to employ general anesthesia; for children general anesthesia should always be used.

Preparations of Patient.—The external genitals should be cleansed with soap and water followed by a 1 to 5000 bichlorid of mercury solution The bladder is then emptied and thoroughly irrigated with a saturated solution of boric acid by means of a catheter and a large syringe or through the sheath of the cystoscope if the instrument is supplied with an irrigating cock, until the fluid returns clear. Four to 6 ounces (120 to 180 c.c.) of a saturated boric acid or normal salt solution are then injected into the bladder and allowed to remain for the purpose of distention.

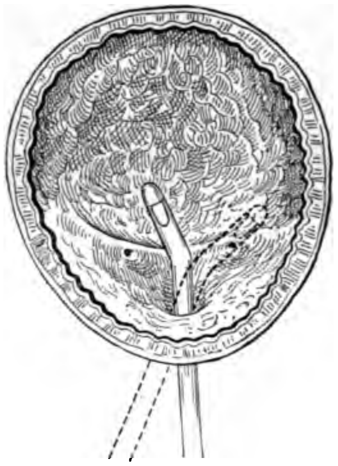


FIG. 768.—Catheterization by the direct method, showing the cystoscope as introduced and with the vesical end deflected toward the ureter.

If hemorrhage from the bladder is sufficient to interfere with the operation, a 1 to 3000 adrenalin chlorid or 1 to 15,000 silver nitrate solution should be injected through the catheter and allowed to remain in the bladder for ten to fifteen minutes before it is distended.

Technic.—1. *Direct Catheterization.*—The cystoscope and catheters having been thoroughly tested, the instrument, well lubricated with glycerin or lubrichondrin and with the obturator in place, is introduced into the bladder. The obturator is then removed and the catheterizing telescope is inserted in its place, after which the light is turned on and the ureteral orifices are sought for. They are located at the upper angles of the trigone about ¾ inch (2 cm.) from the median line and 1 inch (2.5 cm.) from the internal opening of the urethra. By first locating the apex of the prostate and then pushing the instrument in about 1 inch (2.5 cm.) the interureteric line which passes between the two ureters, forming the base of the trigone, will come to view and if this is traced to one side or the other the orifice of the ureter will be recognized in the lateral angle of the trigone. It may appear either as a slit or as a dimple on the apex of a papilla, and, if carefully watched, urine will be seen coming from it in intermittent spurts. It may be extremely difficult to locate the ureter, but a careful search will usually reveal it. In all manipulations of the cystoscope it is of the utmost importance to employ extreme gentleness, otherwise bleeding will supervene and interfere with the examination.

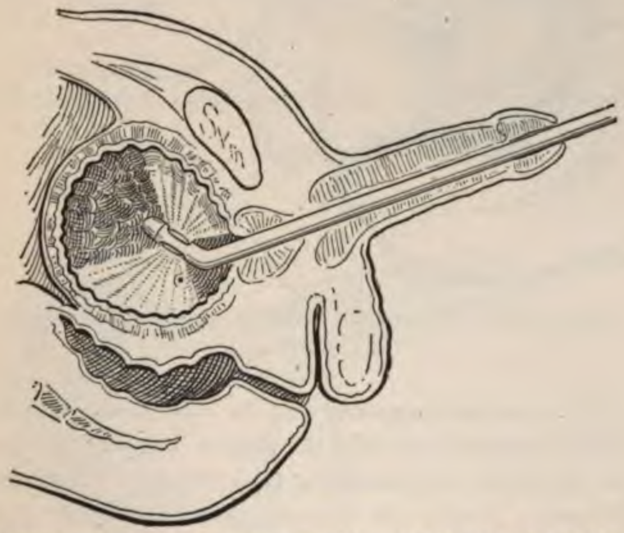


FIG. 769.—Catheterization by the direct method, showing the heel of the cystoscope brought close to the mouth of the ureter.

With the direct view cystoscope the instrument is not rotated about an axis, but the beak is kept constantly pointing upward while the vesical end is turned from one side to the other or up and down as the case may be (Fig. 768). The mouth of the ureter having been located, the heel of the cystoscope is brought close to it (Fig. 769) and an attempt is made to engage the catheter in its lumen. The catheter is then slowly and gently threaded up the ureter to the desired distance (Fig. 770). If the purpose of the catheterization is simply to withdraw urine from the ureter, the catheter is introduced 3 to 4 inches (7.5 to 10 cm.); in exploring the ureter for stone or stricture, or to determine whether pus has its origin in the ureter or kidney pelvis, the catheter should be passed as far as the renal pelvis—13 to 15 inches (32 to 37 cm.). If less than 11 inches (27 cm.) of catheter can be inserted, an obstruction must be inferred (Braasch). The other ureter is located and catheterized in the same manner.

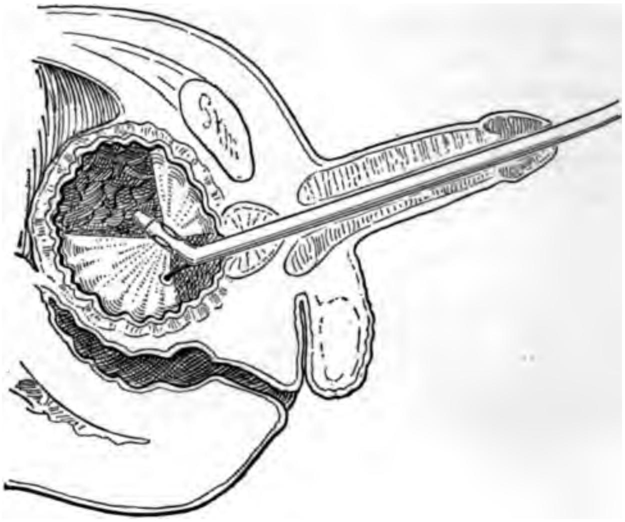
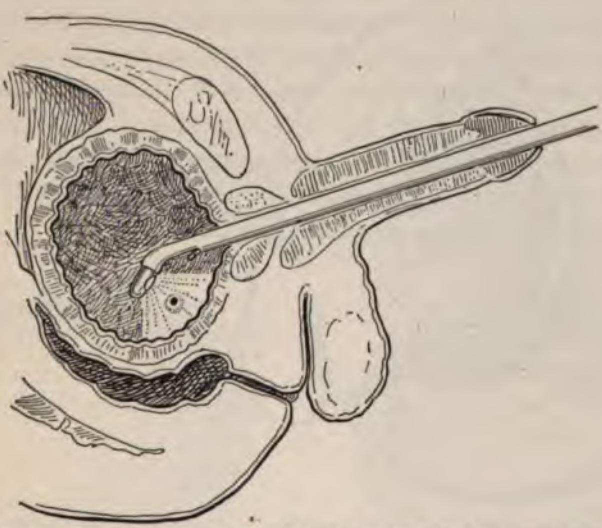


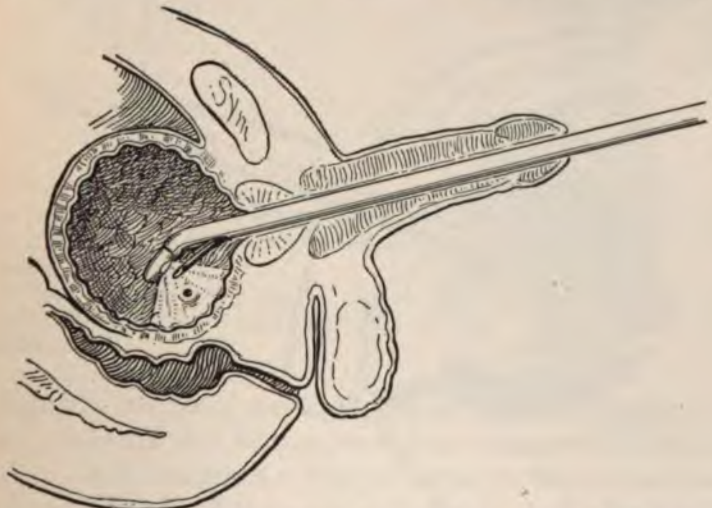
FIG. 770.—Catheterization by the direct method, showing the catheter entering the ureter.

The light is then extinguished and the catheterizing attachment is first carefully removed and then the sheath, keeping the catheters in position in the ureter by threading them through the instrument as it is withdrawn. Unless the catheters are of different colors, they should be labeled "left" or "right" in order to distinguish them. The first urine that flows is discarded and the ends of the catheters are then wiped off and inserted into sterile bottles plugged with cotton. A catheter may become plugged with mucus, blood clots, or pus. If so about 15 ♏ (1 c.c.) normal salt solution may be injected through it by means of a syringe.

From 2 to 4 ounces (60 to 120 c.c.) of urine are, as a rule, sufficient for examination. While the urine is being collected, the patient's legs should be released from the crutches holding them and should be allowed to assume as comfortable a position as possible. the completion of the operation the catheters are carefully re- ›ved and the bladder is irrigated with a saturated solution of boric d.



. 771.—Catheterization by the indirect method, showing the cystoscope in position.



. 772.—Catheterization by the indirect method, the catheter being pushed into the instrument until its tip passes slightly beyond the ureteral orifice.

2. *Indirect Catheterization.*—The instrument, well lubricated, is roduced into the bladder and is then rotated completely around so ‹t its beak looks posteriorly. The prostate is thus located and by

rotating the instrument through an angle of 30 to 45 degrees the lateral ridge of the trigone may be traced running backward at an angle

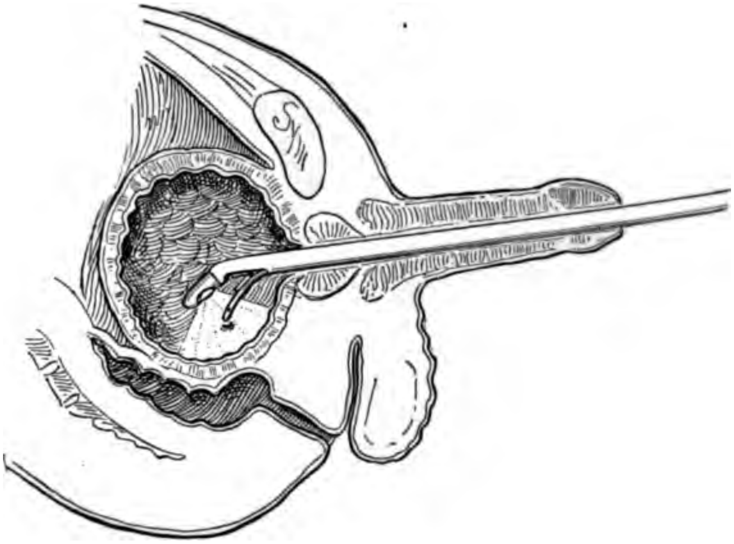


FIG. 773.—Catheterization by the indirect method, showing the tip of the catheter being deflected toward the ureteral orifice by elevating the director.

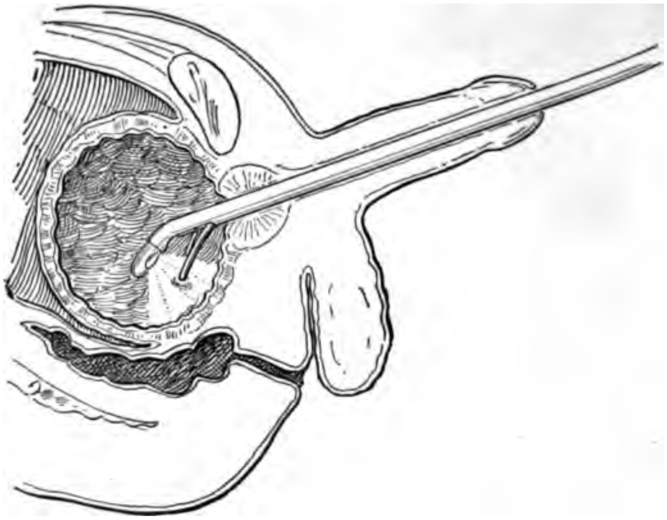


FIG. 774.—Catheterization by the indirect method, showing the catheter inserted in the ureter.

from the prostate. At the point of the junction of this ridge with the interureteric line will be found the ureteral orifice. It should be remembered that with this form of instrument the image will appear inverted, that is, the prostate will appear at the upper portion of the field instead of at the lower. Having located the ureteral orifice the instrument is brought close to it (Fig. 771) and the catheter is pushed gently forward until its tip passes slightly beyond it (Fig. 772). The small director is then elevated slightly (Fig. 773) and the catheter is again pushed forward. If it misses the orifice, the catheter is withdrawn a little and a second attempt made to introduce it. By pushing the catheter forward a little or withdrawing it and changing its angle of deflection slightly, it is finally introduced into the ureter (Fig. 774). The other ureter is then located and the catheter is

Fig. 775.

Fig. 776.

Fig. 775.—Removal of the sheath. First step, showing the telescope removed and the catheters lying loosely in the sheath. (After Buerger, *Annals of Surgery*, Feb., 1909.)

Fig. 776.—Removal of the sheath. Second step, showing the ocular end depressed and carried to the left until clear of the catheters. (After Buerger, *Annals of Surgery*, Feb., 1909.)

introduced in the same way. The catheterizing telescope is then carefully removed, *first turning the deflector down* and extinguishing the lamp. It is sometimes a difficult matter to remove the sheath of the cystoscope and still leave the catheters in place when using this form of instrument. The following manipulations, however, described by Buerger (*Annals of Surgery*, February, 1909), simplify this portion of the operation:

"After having introduced the catheters a little higher than we would if the instrument were to remain in the bladder, and after removal of the telescope, the following movements should be carried out: first, the ocular is depressed and carried a little to the left, thus separating the beak from the line of the catheters (Fig. 776); second, the whole instrument is rotated to the right on its longitudinal axis through an arc of 190 degrees, retaining the relative position just described, thus making the beak point upward (Fig. 777); third (still in the same plane, with the ocular a little to the left), the ocular is raised and brought back to the median line in order to bring the convexity of the beak against the trigone of the bladder (Fig. 778); and fourth, the sheath is removed, its inferior aspect being made to hug the posterior wall of the urethra."

Removal of the Bierhoff instrument is comparatively simple, as it is arranged so that the telescope may be rotated within the sheath until the beak points upward without disturbing the catheters (see Fig. 766).

FIG. 777.

FIG. 778.

FIG. 777.—Removal of the sheath. Third step, showing the beak being turned upward. (After Buerger, *Annals of Surgery*, Feb., 1909.)

FIG. 778.—Removal of the sheath. Final step, the beak in position for removal of the sheath. (After Buerger, *Annals of Surgery*, Feb., 1909.)

URETERAL CATHETERIZATION IN THE FEMALE

Ureteral catheterization in the female has the same field of usefulness as when applied to the male (see page 759). In addition, catheters are often inserted into the ureters as a guide to their position so as to avoid injuring them in difficult pelvic operations. Catheterization may be performed, as in the male, by means of one of the catheterizing cystoscopes, the method of performing which requires no further explanation than that given above, or by means of open tubes under air distention after the method of Kelly. This latter method requires separate description.

Instruments.—The ordinary Kelly speculum with illumination furnished by reflected light or some of the modifications of Kelly's tubes with the light at the distal end may be employed. The latter are preferable.

In addition there will be required a cone-shaped urethral dilator, alligator-jaw-shaped forceps, a residual urine evacuator, Kelly's ureteral searcher, silk flexible catheters. a metallic catheter, and hard-rubber flexible sounds (Fig. 779).

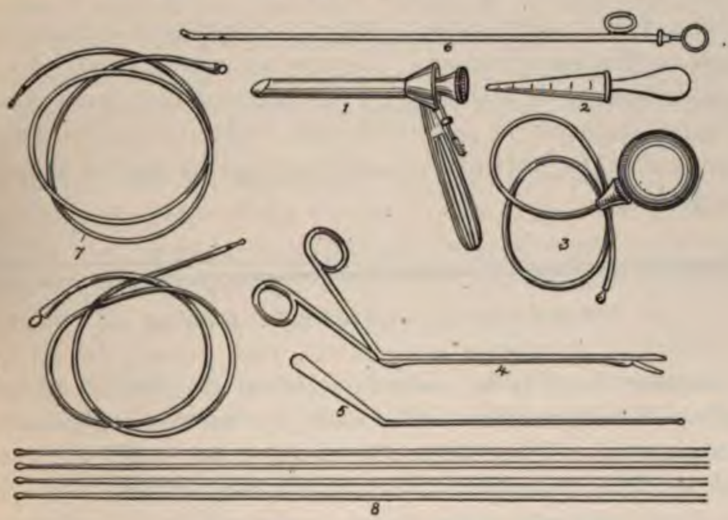


FIG. 779.—Instruments for catheterizing the ureters in the female. 1, Open-tube cystoscope; 2, Kelly urethral dilator; 3, residual urine evacuator; 4, alligator-jawed forceps; 5, ureteral searcher; 6, metal ureteral catheter; 7, flexible ureteral catheters with stylets; 8, ureteral bougies.

The cystoscope, alligator-jaw forceps, urethral dilator, and searcher have been previously described (page 720).

The flexible silk catheters are made in two lengths: 12 inches (30 cm.) long for ordinary ureteral catheterization and 20 inches (50 cm.) long for catheterization of the kidney pelvis. The tips are blunt or olivary and have an oval eye about 3/4 inch (2 cm.) from the distal end. They may be obtained in sizes running from 1/16 to 1/8 inch (1.5 to 3 mm.) in diameter. A wire stylet is introduced within the catheter to furnish it with the necessary stiff-

ness for passage into the ureter, or forcep
780), may be employed for this purpose.
a calculus the ends of the catheters may be

Metal catheters are 12 inches (30 cm.) l
in diameter and are supplied with three e
point which is conical in shape and slig
employed when a stricture low down in the
passage or a flexible catheter.

FIG. 780.—Ashton's forceps for guiding the cathete

Solid, flexible, hard-rubber bougies are
ureters or dilating strictures. They are 20
1/12 inch (2 mm.) in diameter. When war
and in this state may be passed the entire le
danger. For the purpose of locating a ston
(Fig. 781).

FIG. 781.—Wax-tipped bougie.

Asepsis.—Great care should be take
details. The operator's hands should be
precautions should be taken not to allow
touch the table or patient's body during t
instruments and hard-rubber bougies are st
minutes in a 1 per cent. soda solution.
sterilized by immersion in a 1 to 20 solutio
by rinsing in alcohol. Silk catheters ar
vapor or are boiled for not over two minut
then placed in cold sterile water to make
be taken when boiling the catheters to pl
at full length and to wrap them separatel
their surfaces from becoming glued togeth

After use the catheters should be thoro
outside with warm water and tincture of
away at full length in a glass receptacle.

Position of the Patient.—As for cysto
employed, namely, the dorsal elevated anc

former the patient lies with the head and thorax resting on the table and the hips elevated 8 to 12 inches (20 to 30 cm.) upon a cushion so as to raise the pelvis sufficiently to allow the bladder to distend with air when the cystoscope is in place. If the bladder does not inflate with the patient in the dorsal position, the knee-chest posture is employed. The latter position is usually necessary in stout people.

Preparations of Patient.—It should be seen that the rectum and bladder are empty before beginning the examination. The external genitals are then washed with soap and water followed by a 1 to 5000 solution of bichlorid of mercury, and the bladder is irrigated with a warm saturated solution of boric acid until the fluid returns clear. The solution is then all drained off before the cystoscope is inserted.

Anesthesia.—Local anesthesia, obtained by inserting into the meatus a small pledget of cotton saturated with a 2 per cent. solution of cocain and allowing it to remain for five minutes, is generally sufficient. In extremely nervous patients general anesthesia may be required.

Technic.—The urethra is first dilated and the cystoscope is introduced in the manner already described (page 723). The obturator is then removed, when, if the patient is in the proper position, air rushes in and distends the bladder. The light is then adjusted and a search is made for the ureteral orifices. In doing this it is well to first withdraw the instrument until the mucous membrane of the internal urethral orifice begins to close over the end of the instrument, and then to advance it ½ to ¾ inch (1 to 2 cm.) turned either to the right or left about 30 degrees from the center line along the dark lateral ridge of the trigone. The distal end of the instrument is then brought close to the base of the bladder by raising the handle of the cystoscope if the patient is in the dorsal position, or depressing the handle if the knee-chest position is used. By moving the instrument carefully about, the mouth of the ureter will be located somewhere near the end of the cystoscope. It may appear as a small slit, a distinct hole, or a dark point in the bladder mucous membrane. If it is not readily found, the speculum should be directed toward its normal location and a careful search made for it with a ureteral searcher in the folds of mucous membrane.

Having located the orifice, the end of the cystoscope is brought close to it and the catheter is introduced. Metal catheters or sounds are not difficult to introduce. They should be well lubricated and, while the cystoscope is maintained in position with the left hand, they are guided by means of the right hand into the ureteral orifice.

Flexible catheters may be introduced in two ways, either by the use of a stylet to give them stiffness or by the aid of a specially made forceps, such as Ashton's (see Fig. 780). By the former method the catheter, well lubricated, with the stylet in place, is gently inserted in the same manner as a metal catheter into the mouth of the ureter (Fig. 782). The stylet is then withdrawn and the catheter is pushed on until it has entered the desired distance. For ordinary purposes of catheterization this will be 3 or 4 inches (7.5 to 10 cm.). In intro-

FIG. 782.—Catheterization of the ureter in the female by means of a flexible catheter armed with a stylet.

ducing these flexible catheters care must be observed that the portion outside the cystoscope does not become contaminated by touching the patient or the table.

If it is desired to catheterize both ureters, the mouth of the other one is then located and the catheter introduced in the same manner. The cystoscope is then withdrawn and the catheters are labeled right and left to distinguish them. After wiping the ends of the catheters, they are placed in two small sterile bottles plugged with sterile cotton, and about 2 to 4 drams (8 to 15 c.c.) of urine are collected from each kidney (Fig. 783).

Variation in Technic.—The following method, devised by Kelly, for collecting urine from one kidney without using a catheter

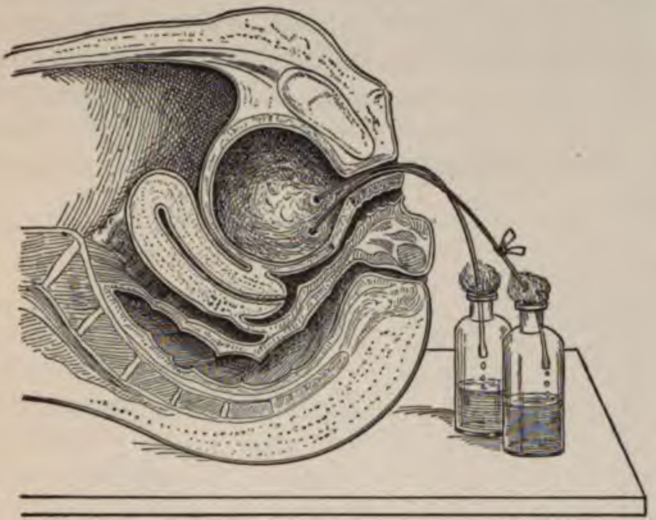


FIG. 783.—Method of collecting separate urine from each kidney. (Ashton.)

FIG. 784.—Kelly's method of collecting urine from a kidney without using a catheter. (After Kelly.)

is sometimes employed when it is undesirable to introduce a catheter into the ureter for fear of carrying in infection from the bladder or from other causes. Briefly, it consists in placing the patient in the knee-chest posture, introducing into the bladder a speculum with the end cut on the slant, and exposing to view the ureteral orifice from which it is desired to obtain a specimen of urine. The orifice of the ureter is then wiped clean and the speculum is held close against the bladder wall so that the urine escapes into the speculum whence it is collected by means of a small glass graduate (Fig. 784). In this way often in a short time sufficient urine may be collected for purposes of examination.

PYELOMETRY

By distending the renal pelvis with fluid its capacity may be measured, and from this it may be determined whether the pelvis is normal, contracted, or dilated. The test is based upon the fact that if the kidney pelvis is overdistended an artificial renal colic is produced. A normal pelvis will hold from 1¼ to 4 drams (5 to 15 c.c.) of fluid without pain. According to Braasch if the renal pelvis has a capacity of less than 50 ♏ (3 c.c.) it indicates irritability or a contraction generally due to stone, tumor, acute or chronic pyelitis, or spasm; a pelvis allowing distention up to 1 ounce (30 c.c.) may be found in neurotic subjects, the condition being explained by the presence of a hysterical anesthesia; while a capacity of 10 drams (40 c.c.) and over indicates hydronephrosis.

Instruments.—A direct or indirect catheterizing cystoscope, ureteral catheters, a catheter and syringe for irrigating the bladder, a small syringe with a capacity of 2½ drams (10 c.c.) with a nozzle that will fit the end of the ureteral catheter, as the Record syringe, and a glass measuring graduate will be required.

Asepsis.—See under ureteral catheterization (pages 761, 770).

Solution Used.—A 2 per cent. boric acid solution, colored with a drop or two of methylene blue, is employed.

Temperature.—The solution should be at a temperature of about 100° F. (38° C.).

Position of Patient.—Same as for ureteral catheterization (pages 761, 770).

Anesthesia.—(See pages 761, 771).

Preparation of Patient.—Same as for ureteral catheterization (pages 762, 771).

Technic.—A catheter of sufficient size to occlude the ureter and prevent the escape of the solution beside it is introduced into the ureter of the affected side as far as the pelvis (see ureteral catheterization, pages 762, 771). The colored solution is then injected into the catheter while the operator notices through the cystoscope if any of it leaks back into the bladder; if not, the injection is slowly continued until colicky pain is produced in the region of the kidney, showing that the pelvis is distended. The quantity injected indicates the capacity of the pelvis.

SEGREGATION OF URINE

Special instruments, known as segregators, which separate the bladder into two halves through the formation of an artificial dam, may be employed to collect the urine separately from the kidneys when a catheter cannot be passed into the ureter or ureteral catheterization is contraindicated. They are easier to employ than the ureteral catheter and with their use there is no danger of carrying infection into the ureters, but, on the other hand, they are not so accurate, as an incomplete watershed may be formed allowing the urine from the two sides to mingle, and the introduction of the instruments may incite vesical bleeding and give misleading results. Again, if the bladder is diseased, the urine obtained is, of course, contaminated and it is not possible to determine whether the source of blood or pus is the bladder, ureter, or kidney. If the bladder is very irritable or bleeds easily, as is the case in the presence of acute cystitis, vesical calculus, tumors, and prostatic hypertrophy, a segregator should not be used. In healthy bladders, however, segregation properly performed is fairly reliable.

Instruments.—There are several types of urine separators among which may be mentioned the instruments of Harris and Luys.

The Harris segregator (Fig. 785) consists of two catheters having a common sheath except at the distal and proximal ends. The intravesical ends when in contact form a cylinder with a double curve and are supplied with numerous small eyes which lead to the interior of the catheter. The extravesical portion ends in curved metal tubes to which are connected by means of pieces of rubber tubing two aspirating bottles. A long lever, connected to the shaft of the instrument by means of a fulcrum and spring, which is inserted into the rectum or vagina for the purpose of raising up the bladder wall in the mid-line in the form of a dam, is also provided.

Luys' instrument (Fig. 786) consists of two catheter tubes separated by a metal partition, the vesical end of which has a Béniqué form of curve. On the concave side of the intravesical portion is a small chain covered with a thin India-rubber membrane, so arranged that, after the instrument is within the badder, by turning a thumb-screw at the proximal end of the instrument the rubber membrane is made to partition the badder into two halves. Near the proximal

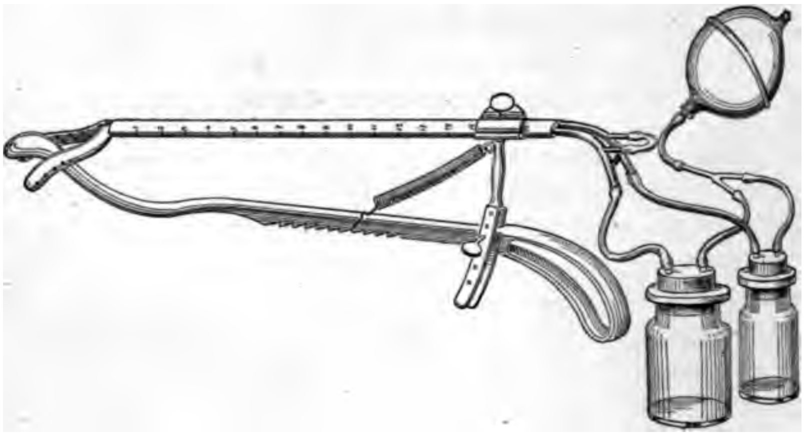


FIG. 785.—The Harris segregator. (Ashton.)

end are two discharge tubes which empty into small bottles. In males this instrument causes less discomfort than does the Harris segregator.

Asepsis.—The instruments and the bottles for collecting the urine should be sterilized by boiling for five minutes, and the operator's hands are cleansed as for any operation.

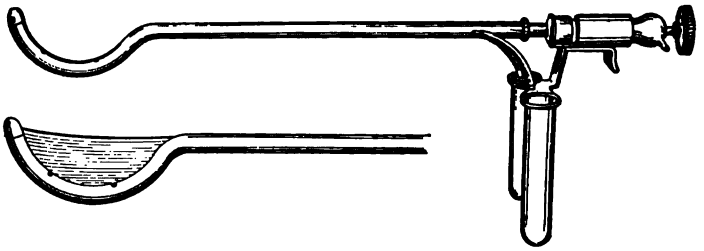


FIG. 786.—The Luys segregator.

Position of Patient.—In using the Harris instrument the patient lies flat on the back with the feet, hips, and head on a level and with the thighs flexed.

The same position is employed in inserting the Luys instrument, but, when the instrument is in the bladder, the patient is elevated to a semi-sitting position.

Preparations of Patient.—The rectum should be empty. The external genitals are cleansed with soap and water followed by a 1 to 5000 solution of bichlorid of mercury. The urethra is irrigated with a 1 to 5000 solution of potassium permanganate. The bladder is emptied by means of a catheter and is then irrigated with a saturated solution of boric acid or sterile water. About 5 ounces (150 c.c.) of solution is left in place when using the Harris instrument to permit manipulation of the instrument, less distention being necessary with the Luys instrument.

Anesthesia.—Local anesthesia may be required if the urethra or bladder are hyperesthetic.

Technic.—1. *Harris' Method.*—The instrument, closed so the catheters form a continuous tube, is well lubricated and is introduced

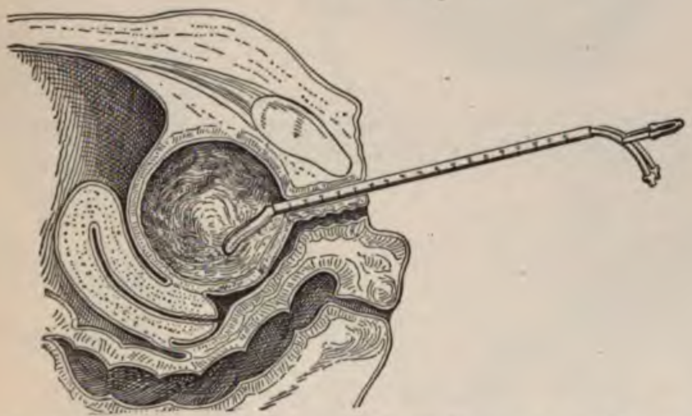


FIG. 787.—Segregation of urine by means of the Harris segregator. First step, instrument in position in the bladder. (Ashton.)

into the bladder until its beak lies just within the vesical neck (Fig. 787). The proximal ends are then rotated outward so that the vesical ends are made to lie on either side of the ureteral orifices and are fixed in this position by the small spring at the proximal end of the instrument (Fig. 788). The long lever, well lubricated, is then introduced into the rectum of the male or the vagina of the female and is secured by a clamp to the sheath of the catheters. By means of a spiral spring the rectal or vaginal end is forced upward causing a longitudinal ridge of bladder wall to be formed in the mid-line between the two ureteral orifices with the end of each catheter lying at the bottom of the correspondng compartment of the bladder. The fluid left in the badder is then allowed to escape from each catheter until it has all been drained off. The aspirating apparatus is then attached and the urine is *gently* sucked out of the viscus from time to time by means of the suction bulb and is collected in two sterile bottles (Fig. 789). The instrument must be left in place about half

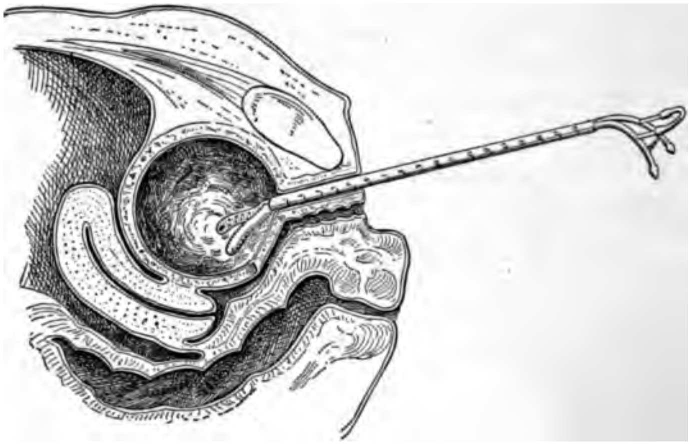


FIG. 788.—Segregation of urine by means of the Harris segregator. Second step, vesical ends of the instrument separated. (Ashton.)

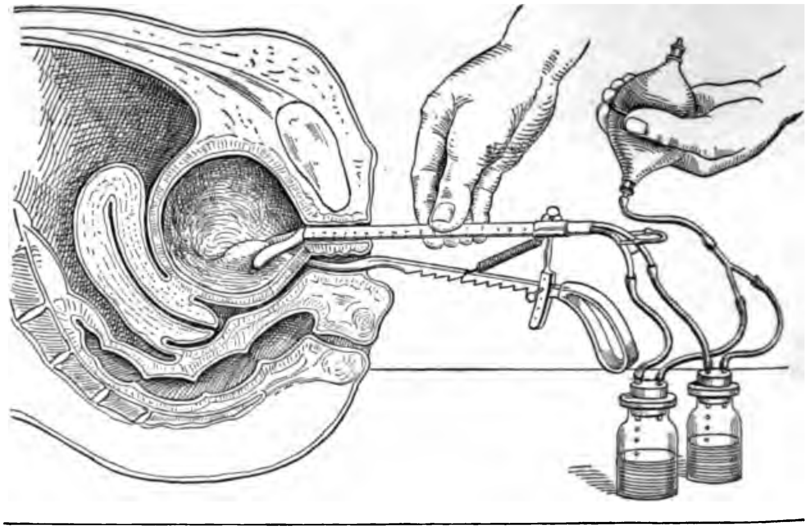


FIG. 789.—Segregation of urine by means of the Harris segregator. Third step, the instrument in place. (Ashton.)

an hour to collect sufficient urine for examination. Care must be taken to avoid too vigorous aspiration or hemorrhage will be incited.

At the completion of the operation the lever is detached, the catheters are folded back in place, and the instrument is carefully removed, following which the bladder is irrigated with a saturated solution of boric acid.

2. *Luys' Method*—The rubber dam is first carefully examined to see if it is intact. The instrument, well lubricated, is then introduced in the same manner one would insert a sound, depressing the handle well between the thighs as soon as the tip enters the prostatic urethra so as to carry the curved portion into the bladder. As soon as the instrument is well within the bladder, the patient is raised to a semi-sitting posture and the diaphragm is raised, carefully keeping the instrument exactly in the median line. The handle of the instrument is then elevated until resistance shows that the intravesical portion is in contact with the base of the bladder. This should be confirmed

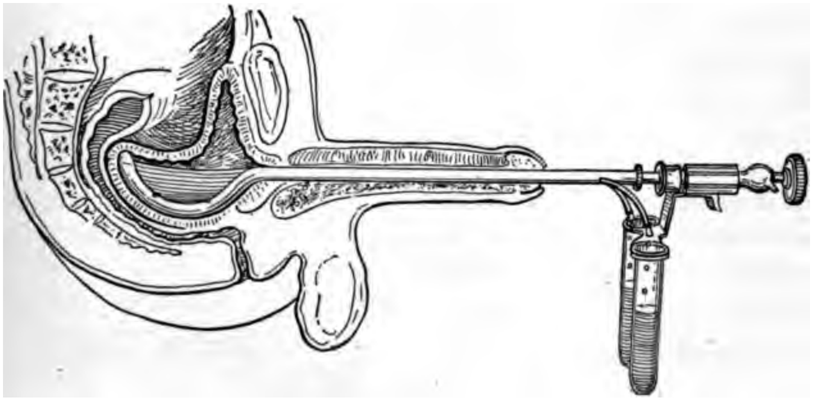


FIG. 790.—Showing the method of using the Luys segregator.

by vaginal or rectal palpation. After all solution has been drained from the bladder, the urine, as it trickles into the bladder, is carried off by a catheter on each side and is collected in the small tubes at the proximal ends of the instrument (Fig. 790).

At the completion of the operation the diaphragm is lowered and the instrument is withdrawn. This is followed by a vesical irrigation of boric acid.

TESTS OF KIDNEY FUNCTION

The function of the kidney is to maintain the normal concentration of the fluids of the body by eliminating in the urine waste products of metabolism which, if accumulated in the blood and tissues, would produce serious results. Numerous tests for determining the functional efficiency of the kidneys have been devised which are based on the principles that under conditions of impaired renal activity, the urine will contain a smaller amount of its normal constituents or will be less able to artificially eliminate certain foreign substances, while the blood will show a concentration of substances normally excreted in adequate amounts. These tests may be thus divided into three classes: (1) Tests of excretion, (2) tests of retention, and (3) a combination of tests of excretion and retention.

From a medical standpoint tests of kidney function are of diagnostic value in determining the kidney activity in acute and chronic nephritis, uremia, cardiopathies, arteriosclerosis, and myocardial insufficiency. They are also of considerable prognostic importance as by repeated tests it is possible to determine whether a disease is progressive, stationary, or responding to treatment.

In surgery, in addition to being a means of estimating operative risks by showing whether the two kidneys are properly performing their functions, functional tests are of great importance when the removal of one kidney is contemplated in determining the activity of each kidney. But, although they demonstrate which kidney is functionating best, they are not infallible and do not absolutely prove that a particular kidney is capable of doing sufficient excretory work after removal of its mate.

The Elimination of Substances Normally Present in the Urine as an Index of Renal Function

Urinalysis.—While urinalysis is of great importance in the diagnosis of diseases of the kidneys and urinary organs, estimation of the specific gravity and the amount of water, nitrogen, and salts excreted by the kidneys is not sufficient by itself in determining the functional capacity of the kidneys, as the quantity of these substances is markedly influenced by the intake of fluids and food, by exercise, by the condition of the nervous system, and by the condition of other organs. It is of little use unless combined with a chemical examination of the blood, or unless the intake and the loss through other channels is determined as well. In other words it must be combined with a study of body metabolism. The most that can be assumed from an ordinary urinalysis is that, if the elimination of the constituents of the urine are constantly normal, the kidney function is probably not deficient, while if there is much variation from the normal and this is constantly present, the kidney function is likely to be impaired. Thus, as a test of kidney function urinalysis alone has only the value of contributory evidence and it is necessary to employ other tests to corroborate the findings and determine the extent of deficiency, if present.

Experimental Polyuria Test.—A method of estimating the functional activity of the kidneys is by the response to the ingestion of an increased amount of fluid, known as the experimental polyuria test, devised by Albarran, which consists essentially in obtaining the urine from each kidney when the patient is dry and comparing the two specimens and then having the patient drink a large quantity of water and noting the effect upon the activity of the two kidneys.

The test is based upon the following laws: First, a diseased kidney has a more uniform function than a healthy one, and the more extensively its parenchyma is destroyed the less will its function vary from time to time; second, when one kidney alone is diseased or is more diseased than the other, if the urinary function is disturbed, its function is less modified than the other. In other words, if an increased excretory demand is placed upon the kidneys through the ingestion of large quantities of water and the urine is collected separately, the less diseased organ should show a greater increase in activity, manifested by the excretion of a larger total amount of fluid and solids, though the *percentage* of solids will be diminished, while the diseased kidney will show a relatively small or no increase in activity. The test thus becomes of value not only in examining the renal function of both kidneys but also in determining which kidney is functionating best and the power of each to accommodate itself to increased demands for excretory work.

Technic.—The patient should not have eaten anything for four hours or taken any liquids for three hours. A single catheter is placed in one ureter and the urine from the other side is collected by means of a small catheter passed into the bladder. The urine which flows for the first ten or fifteen minutes is discarded in order to permit the reflex polyuria or oliguria which may follow the introduction of the ureteral catheter to subside, and the urine that then flows is collected for half an hour. This is saved for comparison with specimens taken after the administration of the fluid. At the end of half an hour the patient is given two to three glasses (300 to 400 c.c.) of mineral water and the urine is collected separately and examined at half hour intervals for one and a half hours. For estimating the total function, ureteral catheterization is not necessary, the urine being collected by voiding. Not only is the total quantity of urine noted, but the specimens are tested as to the freezing-point, quantity and percentage of urea and sodium chlorid, and, if phloridzin has be given, the amount of sugar is estimated.

Normally the polyuria appears within the first half hour, reachi its maximum during the third half hour, and then rapidly declin The total amount of solids remains constant or increases, while t the percentage sinks in proportion to the polyuria.

If the functional activity of the kidney is impaired, there is polyuria or it is delayed and the content of solids is unaffected.

Test Meal for Kidney Function.—This functional test w originally suggested by Hedinger and Schlayer in 1914 and was la more fully elaborated by Mosenthal (*Archives of Internal Medici* Nov., 1915). It is a composite test for substances normally eli nated in the urine, the specific gravity, salt, nitrogen, and wa excretion being determined in 2 hourly periods during the day a for a 12 hour period at night. The test has come into quite gene use and is of recognized value in the study of renal function and the diagnosis of various forms of kidney and cardiac diseases, a dropsical conditions.

Technic.—The directions for the test meal are contained in t following form (Mosenthal):

DIET

TEST MEALS FOR KIDNEY FUNCTION

For . . . . Date . . . .

All food is to be *salt-free* food from the diet kitchen.

Salt for each meal is to be furnished in weighed amounts. O capsule of salt containing 2.3 gm. sodium chloride, is furnished wi each meal. The salt which is not consumed is returned to the la oratory, where it is weighed, and the actual amount of salt tak calculated.

All food or fluid not taken must be weighed or measured aft meals, and charted in the spaces below.

Allow no food or fluid of any kind except at *meal times.*

Note any mishaps or irregularities that occur in giving the di or collecting the specimens.

BREAKFAST, 8 A. M.

Boiled oatmeal, 100 gm.
Sugar, 1–2 teaspoonfuls.
Milk, 30 c.c.

Two slices bread (30 gm. each).
Butter, 20 gm.
Coffee, 160 c.c.
Sugar, 1 teaspoonful. } 200 c.c.
Milk, 40 c.c.
Milk, 200 c.c.
Water, 200 c.c.

DINNER, 12 NOON

Meat soup, 180 c.c.
Beefsteak, 100 gm.
Potato (baked, mashed or boiled), 130 gm.
Green vegetables, as desired.
Two slices bread (30 gm. each).
Butter, 20 gm.
Tea, 180 c.c.
Sugar, 1 teaspoonful. } 200 c.c.
Milk, 20 c.
Water, 250 c.c.
Pudding (tapioca or rice), 110 gm.

SUPPER, 5 P. M.

Two eggs, cooked any style.
Two slices bread (30 gm. each).
Butter, 20 gm.
Tea, 180 c.c.
Sugar, 1 teaspoonful. } 200 c.c.
Milk, 20 c.c.
Fruit (stewed or fresh), 1 portion.
Water, 300 c.c.

8 P. M.—No food or fluid is to be given during the night or until 8 o'clock the next morning (after voiding), when the regular diet is resumed.

Patient is to empty the bladder at 8 A. M. and at the end of each period, as indicated below. The specimens are to be collected for the following periods in properly labelled bottles:

8 A. M.–10 A. M., 10 A. M.–12 N., 12 N.–2 P. M., 2 P. M.–4 P. M., 4 P. M.–6 P. M., 6 P. M.–8 P. M., 8 P. M.–8 A. M.

The above diet contains approximately 13.4 gm. of nitrogen, 8.5 gm. of salt, and 1760 c.c. of fluids and a considerable amount of purin material in the meat, soup, tea, and coffee. These all act a diuretics and the test depends upon the manner in which the kidney responds to these stimuli. Mosenthal emphasizes that the urin must be collected punctually every 2 hours, that no solid food o fluid be taken between meals, and that the 12 hour night specime be completed before the breakfast is touched. The quantity an specific gravity of each specimen is determined. Originally the tota and percentage content of salt and nitrogen of each specimen wa also estimated, but it is now considered sufficient if this is limite to the total day and night specimens.

Mosenthal gives at length the responses and the test in healt and disease, which may be summarized as follows: In normal i dividuals the urine will show variations in the specific gravity in th 2 hour specimens of nine points or more from the highest to t lowest. The quantity of water, salt, and nitrogen eliminated a proximately balances the intake.[1] The night urine is of high specif gravity (1018 or more), is high in its percentage of nitrogen (abo 1 per cent.), and small in amount (400 c.c. or less), regardless of t amount of fluid taken or the quantity of urine voided during the da

When the functional activity of the kidney is diminished, t night urine usually shows the effects first, the quantity increasin the specific gravity being lowered, and the concentration of nitrog diminishing. More marked impairment of function is characteriz by a decided lowering and fixation of the specific gravity, a dimi ished output of salt and nitrogen, a tendency to total polyuria, an a night urine showing an increase in volume, low specific gravit and low concentration of nitrogen. Fixation of the specific gravit in additon to occurring in nephritis, may be an indication of im paired renal function secondary to extrarenal conditions, as pyeliti cystitis with prostatic hypertrophy, hydronephrosis, pyonephrosi polycystic kidneys, renal congestion due to cardiac diseases, diabete and anemias.

The Elimination in the Urine of Foreign Substances as an Index o Renal Function

The Phloridzin Test.—This test depends upon the property o the healthy kidneys to form sugar from phoridzin. The bladder i

[1] The quantity of urine excreted will be about 400 c.c. less than the fluid intake, th loss occurring through the skin, lungs, and intestines. Ninety per cent. of the nitrog intake should be eliminated, the balance being lost in the feces. Sodium chloride i excreted entirely in the urine, except in diarrhœa (Mosenthal).

first emptied and then 16♏ (1 c.c.) of an aqueous solution of phloridzin containing 0.005 to 0.01 gm. (approximately 1/12 to 1/6 gr.) of the drug is injected into the buttock. If the kidneys are healthy, glycosuria should appear within fifteen minutes to half an hour after the administration of the phloridzin and should persist for about two to four hours. Delay in its appearance or the excretion of only small amounts of sugar points to renal insufficiency, while an entire absence of sugar indicates that the kidneys are seriously affected. If the functional activity of each kidney is to be determined, a catheter is placed in each ureter and the relative proportion of sugar in the separate specimens of urine thus obtained is estimated.

Methylene-blue and Indigo-carmin Test.—Another method of testing the functional activity of the kidneys is to inject drugs, such as methylene blue or indigo-carmin, which color the urine after entering the circulation. For this purpose the bladder is emptied and 16♏ (1 c.c.) of a 5 per cent. solution of methylene blue or 5 drams (20 c.c.) of a 0.4 per cent. solution of indigo-carmin is injected intramuscularly. If the kidneys are normal, upon cystoscopic examination within half an hour after administration of the methylene blue and within nine to twelve minutes after the administration of the indigo-carmin, stained urine will be seen escaping from the ureteral orifices. On account of the slow elimination of methylene blue, requiring observations over a long period ot time, this test has not the same value as the indigo-carmin.

It is claimed for these tests that if the coloring of the urine is delayed or its intensity lessened it tends to show that there is some impairment of the renal function.

The Phenolsulphonephthalein Test.—In 1910 Rowntree and Geraghty proposed a new colorimetric test for estimating the renal function by using phenolsulphonephthalein. As this drug is very rapidly and almost exclusively eliminated from the body by the kidneys, the test is one of the most delicate and reliable for determining the functional efficiency of the kidneys. When the kidney function is not impaired, the drug is present in the urine within five to ten minutes after a subcutaneous injection, from 40 to 60 per cent. of it being excreted within the first hour and from 20 to 25 per cent. during the second hour. After an intramuscular injection, the drug appears in the urine in about the same time as after a subcutaneous injection, but from 5 to 10 per cent. more is eliminated during the first hour. Following an intravenous injection, the drug appears in the urine in from three to five minutes, and from 35 to 45 per cent. of it is eliminated within the first half hour and 63 to 80 per cent. the first hour.

The quantity of the drug eliminated during a given time in the excretory capacity of the kidneys, that is, in impaired activity the appearance of the drug in the urine will be delay the quantity will be diminished according to the amount of involvement present. It is thus a valuable test in cardi cases in determining the degree of kidney impairment and diagnosis of uremia from conditions that may simulate it. types of nephritis the elimination of phthalein is decreas surgical work the test is of great value as in addition to fur information as to the functional capacity of the two kidne possible to determine the amount of work performed by each

Technic.—Twenty minutes to half an hour before making the patient is given two or three glasses (300–400 c.c.) of w order to assure a free urinary secretion. Under the usual precautions the patient is catheterized, the catheter being lef empty bladder. Sixteen minims (1 c.c.) of the standard solution of phenolsulphonephthalein containing 0.006 gm. (a mately 1/10 gr.) of the drug is then injected subcutaneously muscularly, or intravenously[1] and the time of injection is The urine is allowed to flow into a test-tube containing a drop per cent. solution of sodium hydroxid and the time of the fir pinkish tinge is noted. The catheter is now withdrawn, the being required to urinate into a receptacle at the end of an ho the first appearance of the drug and in a second receptacle end of the second hour. In the presence of urinary obstructi catheter is left in the bladder, the hourly specimens being sep collected. Twenty-five per cent. solution of sodium hydroxid added to the urine in sufficient quantity to render it strongly and bring out the characteristic color—a brilliant purple red.

To determine the amount of dye present a Duboscq colorin a modified Hellige hemoglobinometer is employed. The s containing the urine is diluted with sufficient distilled water to quart (1 liter) and, after thoroughly mixing, a small filtered po compared with a standard in the colorimeter. A simpler an accurate method is to prepare a series of standard solutions tubes containing 5, 10, 15, 20 per cent., etc., of the drug up to

[1] Rountree and Geraghty (*Journal of American Medical Association*, Sept. advocate for general use the intramuscular injection in the lumbar muscles.

cent., and then selecting the standard tube which matches the color of the diluted urinary specimen.

To determine the functional efficiency of each kidney, the ureters are catheterized and, as soon as the urine flows freely, the drug is injected. The time of injection is recorded and the collection of urine from each side is continued for one hour from the time of the first appearance of the drug. If the drug is given intravenously the urine need only be collected for fifteen minutes after the appearance of the drug. The quantity excreted in each specimen is then estimated as described above.

The Concentration in the Blood of Substances Normally Excreted in the Urine as an Index of Renal Function

Blood Chemistry.—The estimation of the retention in the blood of certain nitrogenous products of metabolism is the basis of a number of tests of kidney function. The most important determinations from the standpoint of renal function are the total non-protein nitrogen, urea, uric acid, and creatinin. Through the failure on the part of the kidney to eliminate these nitrogenous products which are present in the blood in a constant amount in health, they are retained and accumulate in the blood. An estimation of the concentration of these substances in the blood, therefore, gives a fairly reliable indication of the renal efficiency, and it becomes of still greater value if combined with a simultaneous examination of the urine. Tests of retention are also of the greatest help in prognosis and in furnishing a guide as to the necessity for a restricted protein diet in nephritis.

Retention tests require the collection of from ½ to 2½ drams (2 to 10 c.c.) of blood from the patient, the technic of which will be found described on page 302. For the details of the actual quantitative estimations, the reader is referred to works on laboratory technic or clinical chemistry. It will be only possible here to refer to the normal concentration of these substances in the blood and the significance of variations.

Non-protein Nitrogen in the Blood.—The normal content is from 22 to 30 mg. per 100 c.c. of blood. In health approximately 50 per cent. of this is represented by blood urea. Non-protein nitrogen is markedly influenced by the quantity and quality of the food taken, and on a full meal with meat diet Tileston and Comfort found an average rise of 4.7 mg.

A concentration above 30 mg. per 100 c.c. of blood may be regarded as indicating some degree of renal impairment. Tileston and Comfort (*Archives of Internal Medicine*, Nov., 1914), from observation of a large series of cases, draw the following conclusions: A rise of non-protein nitrogen of from 30 to 35 mg. per 100 c.c. of blood indicates slight impairment of kidney function, from 35 to 50 mg. considerable, and from 50 to 100 mg. a very marked impairment, while 100 mg. or over is of dangerous significance. They only encountered a concentration of over 100 mg. in two conditions besides uremia, *i.e.*, acute intestinal obstruction and profound anemia from hemolysis. In disease from 32 to 85 per cent. of the increase is accounted for by urea.

Urea in the Blood.—In health, blood urea is present in from 11 to 15 mg. per 100 c.c. of blood, forming about 50 per cent. of the non-protein nitrogen. It is very markedly affected by a high protein diet, on a full meal with meat diet the rise averaging 2.5 mg. (Tileston and Comfort). With deficient elimination it accumulates in the blood and the greater the amount of concentration the more serious is the prognosis. A concentration of urea above 15 mg. per 100 c.c. of blood may be taken as indicative of retention. From 15 to 50 mg. per 100 c.c. of blood are met in moderate degrees of impairment, and in the presence of from 100 to 200 mg. the prognosis is serious.

Urea and non-protein nitrogen parallel each other to such an extent that frequently the estimation of only one is made.

Uric Acid and Creatinin in the Blood.—In health uric acid is present in from 2 to 3 mg. per 100 c.c. of blood, and creatinin in from 1 to 1.5 mg. per 100 c.c. of blood. Creatinin on a meat-free diet is entirely of endogenous origin and, for this reason, it is considered by many as a more reliable indication of renal insufficiency than blood urea. A rise of creatinin to 3.5 mg. per 100 c.c. of blood is of dangerous significance, while 5 mg. usually means a fatal result in a short time.

In studies of renal function in nephritis by Chase and Myers (*Journal of the American Medical Association*, Sept. 23, 1916), it was observed that high uric acid estimations were frequently found without any other retention, while creatinin appeared to be retained only in the last stages of the disease. They found that normally creatinin is the most readily, and uric acid the least readily, eliminated by the kidney, urea being intermediate, and that therefore uric acid retention should constitute one of the early signs of incipient interstitial nephritis, while a considerable creatinin retention should indicate a grave functional impairment of the kidney and should be a valuable prognostic sign.

Ambard's Coefficient and the McLean Index of Urea Excretion.— The relation between the concentration of urea in the blood and urea excreted by the kidneys as expressed by Ambard's constant or the McLean index is considered of more value in determining slight degrees of renal impairment and as an indication of prognosis than the estimation of blood urea or non-protein nitrogen. Kidney impairment may be thus indicated in cases that show normal ranges in the blood of nitrogenous products.

Ambard found that when the kidneys are normal certain laws govern the relationship between the urea content of the blood and urine. His conclusions, known as Ambard's laws, are as follows:

1. When the concentration of urea in the urine is constant, the rate of excretion varies directly as the square of concentration of urea in the blood.

2. When the concentration of urea in the blood remains constant, the rate of excretion varies inversely as the square root of the concentration in the urine.

3. That other factors being the same, the rate of excretion varies directly with the weight of the individual.

He demonstrated a constant ratio between the concentration of urea in the blood and the rate of excretion in the urine. This numerical constant, known as Ambard's Coefficient, is determined by the following mathematical formula:

$$\text{Constant } (K) = \frac{Ur}{\sqrt{D \times \frac{70}{Wt} \times \sqrt{\frac{C}{25}}}}$$

Ur = Grams of urea per liter of blood.
D = Grams of urea excreted per 24 hours.
Wt = Weight of individual in kilograms.
C = Grams of urea per liter of urine.

25 grams per liter is taken as the standard concentration of urea in the urine and 70 kg. as the standard weight.

The normal value of the Coefficient is between 0.07 and 0.09. In impaired function with inability of the kidney to eliminate in proportion to the concentration of urea in the blood there is a rise in the constant in proportion to the degree of renal insufficiency. Values of from 0.09 to 0.12 indicate slight impairment, 0.13 to 0.2 a moderate degree of impairment, and above 0.2 severe renal impairment.

McLean modified the above by using a formula adapted from

Ambard's laws which he has termed the index of urea excretion. It is determined by the following formula:

$$\text{Index } (I) \ \frac{D\sqrt{c} \times 8.96}{Wt \times (Ur)^2}$$

An index of 100, corresponding to a value for Ambard's Coefficient of 0.08, is the standard normal index. Variations are expressed in terms of the normal. Thus an index of 50 equals the rate of excretion of 50 per cent. of normal under conditions of concentration in the blood and urine. An index below 80 is considered abnormal and one below 50 in renal disease is an evidence of marked kidney impairment.

These tests are not available for use in general practice, as they require very accurate collections of urine and time measurements, and the services of an expert chemist to carry out the various estimations. For the technic the reader is referred to works on laboratory methods.

Cryoscopy of the Blood and Urine.—Cryoscopy is the determination of the freezing-point of a liquid compared to that of distilled water. The underlying principle of this test is that fluids containing a small amount of solid material give a high freezing-point while liquids with greater concentration freeze at a lower temperature. Applied to the blood and urine, cryoscopy is valuable in determining the renal activity of the kidneys and in some cases may be of prognostic value when renal impairment exists. For example, if the kidneys are doing an insufficient amount of excretory work, there will be an accumlation of solid material in the blood which will, therefore, freeze at a lower temperature than normal, and at the same time the urine in such a case, through impairment of the power of the kidneys to eliminate properly, will give a higher freezing-point than normal.

The freezing-point of normal blood is 0.56° C. below that of distilled water. In weakened anemic individuals, however, it may rise to −0.55° C. or even as high as −0.53° C. or −0.52° C. If cryoscopy of the blood gives a freezing-point below −0.56° C., it is regarded as indicating some impairment of the renal function with retention of waste products in the blood. According to Kummell, if the freezing-point of blood falls to −0.60° C. it indicates such a degree of renal impairment that nephrectomy is contraindicated.

Cryoscopy of the urine is of less value than when the test is applied to the blood. Healthy urine freezes at −0.9° C. to −2° C., and if the freezing-point is higher than $-0.9°$ C. it is considered to be indicative of insufficient activity. Cryoscopy of urine collected separately from each kidney by ureteral catheterization will give more information than when the test is applied to the bulk of urine.

To carry out this test 2½ drams (10 c.c.) of blood and urine are required. For comparative examination the two should be collected at the same time, the former by venous puncture (page 302) and the latter by ureteral catheterization (page 759).

For the technic of cryoscopy, which requires a considerable amount of skill to properly carry out, the reader is referred to some of the manuals on clinical laboratory methods.

SKIAGRAPHY

The X-ray is of the greatest aid in the diagnosis of ureteral and renal calculi. A good picture will give positive information as to the position of a calculus, that is, whether it is located in the ureter or kidney and will demonstrate the number and size, as well as the position of the kidneys. In order to interpret the results of the X-ray correctly the plate should show the following anatomic landmarks. The eleventh and twelfth ribs, the transverse processes of the vertebræ, the crests of the ilia, and the psoas muscle. If these points are shown, the position of a calculus may be determined with accuracy. The shadows cast by tumors, fecal concretions, calcified retroperitoneal glands, buried sutures which have become calcified, phleboliths, foreign bodies in the intestines, the thickened tip of an appendix, etc., are sometimes wrongly interpreted as calculi. Such errors may be avoided if a catheter filled with a 30 per cent. bismuth paste or a catheter in which a lead wire stylet has been placed is inserted into the ureter and renal pelvis, and an X-ray is then taken. The shadow of a calculus will be shown to be in close relation to that produced by the wire in the ureter. Thus, while a positive picture can usually be taken as proof of the presence of a calculus, this cannot always be said of the negative evidence furnished by an X-ray. It must be remembered that great thickness of the abdominal wall may interfere with the success of a picture and that the chemical composition of the stone is also an important element, for while oxalate and phosphate stones give a deep shadow, those composed of uric acid furnish but faint shadows and may escape recognition. In all cases to obtain a successful picture it is absolutely essential that the stomach be empty and the bowels be thoroughly cleared by a purge given the night before and an enema the morning of the examination.

Pyelography.—This consists in the injection of an opaque fluid into the ureter and renal pelvis followed by an immediate radiograph. This method of diagnosis is of the greatest value in demonstrating the extent and character of dilatations of the renal pelvis and ureter, distortions of the pelvis by tumors or stones and of the ureter by the presence of stones or strictures.

A 10 to 15 per cent. solution of collargol, a 50 per cent. solution of argyrol, a 5 per cent. silver iodid emulsion, and a 10 per cent. thorium nitrate solution are among those frequently employed. The catheter is inserted into the renal pelvis and the contents are allowed to run off. A quantity of the warmed opaque solution sufficient to distend the renal pelvis is then allowed to slowly flow in under the force of gravity; it should not be injected with a syringe, as it has been shown that collargol solution injected even under moderate pressure may pass up the tubules into the kidney tissue producing infarcts. The quantity of fluid used will depend upon the size of the pelvis previously determined by pyelometry (see page 774) or by the production of pain when the pelvis is distended. To study the ureter the catheter is partly withdrawn so that the ureter may be filled up and distended by the solution. The catheter is then plugged to prevent the escape of the solution and the opposite side is similarly injected, a radiograph being taken immediately. The plugs are finally removed from the catheters and the solution is allowed to drain off. To aid in removing the solution it is well to induce a polyuria by giving the patient a glass of water to drink at the completion of the operation.

EXPLORATORY INCISION

In cases of contemplated nephrectomy where other means of diagnosis fail to give satisfactory results, an exploratory operation will determine the exact condition of the second kidney. The kidney requiring removal is first exposed and thoroughly explored. If its removal seems indicated, it is replaced for the time being and the kidney supposed to be healthy is then cut down upon by a lumbar incision, the capsule is incised, and the organ is palpated and if necessary inspected. If it is found to be healthy, the wound is closed and the other kidney may then be removed. Should, however, such exploration reveal serious disease of the second kidney, nephrectomy is contraindicated.

Therapeutic Measures

MEDICATION OF THE RENAL PELVIS AND URETERS

Lavage of the kidney pelvis and ureter has been employed with considerable success in treating subacute and chronic affections of the kidney pelvis and ureter. The procedure is not difficult for one skilled in the passage of the ureteral catheter, and properly performed seems to be without danger. It is not a suitable method of treatment, however, in acute infections, and in chronic cases, even, other measures should be first given a trial.

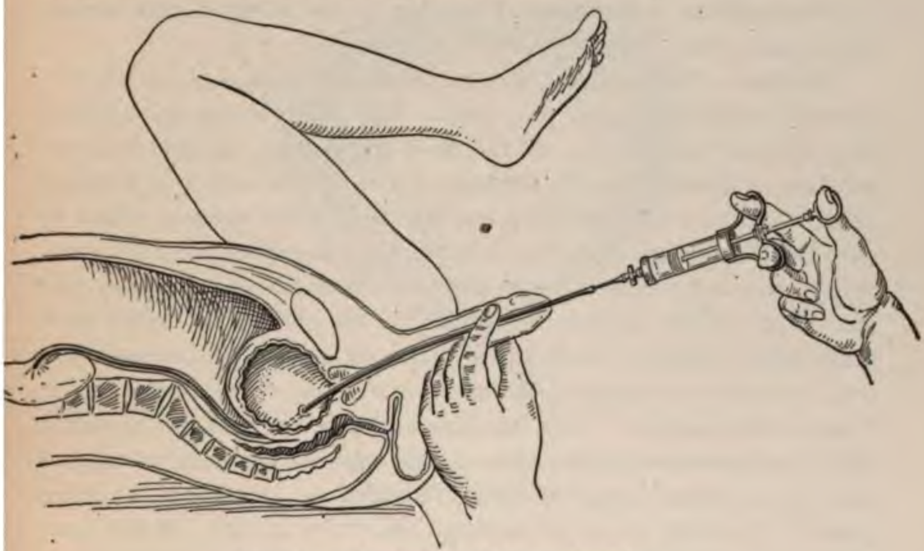


Fig. 791.—Medication of the renal pelvis.

Instruments.—In addition to the apparatus necessary for ureteral catheterization (see pages 759, 769) there will be required a glass syringe, with a capacity of 2½ drams (10 c.c.), supplied with a blunt nozzle sufficiently small to fit into the end of the catheter.

Asepsis.—The same precautions against infection should be observed as detailed under ureteral catheterization (pages 761, 770).

Solutions Used.—Sterile water, a saturated solution of boric acid, silver nitrate in the strength of 1 to 8000 increased in strength up to 1 to 2000, protargol 1 to 500 to 2 per cent., argyrol 2 to 5 per cent., collargol 4 per cent., bichlorid of mercury 1 to 150,000 to 1 to 16,000 may be employed. Too strong solutions will result in colic.

For the purpose of aiding the passage of an impacted calculus injections of sterile olive oil have been employed.

Temperature.—The solution should be at a temperature of 100° F. (38° C.).

Quantity.—One to 2 drams (about 5 to 10 c.c.) of solution are generally injected at a time. If large amounts are employed, overdistention of the renal pelvis will result with consequent colic.

Frequency.—The treatments may be applied once or twice a week.

Position of Patient.—Same as for ureteral catheterization (pages (761, 770).

Anesthesia.—(See pages 761, 771.)

Preparations of Patient.—The same as for ureteral catheterization (pages 762, 771).

Technic.—The catheter is inserted into the renal pelvis as previously described (pages 762, 771). Any fluid or pus collection is then allowed to drain off, and the tip of the syringe, charged with the solution, is introduced into the end of the catheter and 1 or 2 drams (about 5 to 10 c.c.) of solution are injected. Care must be taken to see that the syringe contains no air and the injection must be given very slowly and evenly to avoid a sudden distention of the kidney pelvis. The syringe is then disconnected, the patient is raised to a semiupright position, and the solution is allowed to escape; if a small catheter is employed, the solution may, however, escape beside it into the bladder. This washing-out process may be repeated until the solution returns clear. The syringe is again connected with the catheter which is slowly withdrawn, the solution being injected the while so as to medicate the entire ureter. At the completion of the operation the bladder is irrigated.

To aid the passage of a ureteral calculus by the injection of olive oil, the following technic is employed: a ureteral catheter is passed beyond the stone if possible, and, if not, up to it, and a few drops of sterile olive oil are injected. This acts as a lubricant and the stone is often readily passed as a result.

THE DILATATION OF URETERAL STRICTURES

The gradual dilatation of ureteral strictures may be performed by suitable bougies, introduced with the aid of the cystoscope. While it is doubtful if a permanent cure can be obtained in many cases by this method, as such strictures, like those of the urethra, rectum, etc., tend to recontract in the majority of cases, the patient is greatly benefited for the time being through relief of the distention of the ureter and kidney pelvis caused by the obstruction. The majority of strictures are located near the ureteral orifices, and these are most readily dilated, though the method may be applied with success to strictures in any part of the canal.

Instruments.—Dilatation may be effected by means of flexible whalebone bougies, flexible catheters or, if the stricture is near the vesical end, by metal catheters. These instruments as well as the cystoscopes have been already described (pages 759, 769).

Asepsis.—(See pages 761, 770.)

FIG. 792.—Showing the method of dilating a ureteral stricture. (After Kelly and Noble.)

Frequency of Dilatation.—Treatments are employed every two or three days.

Position of Patient.—Same as for ureteral catheterization (pages 761, 770).

Preparations.—(See pages 762, 771.)

Anesthesia.—(See pages 761, 771.)

Technic.—The ureteral orifice is located as already described and the dilator is introduced into the ureter in the same manner as the ureteral catheter (pages 762, 771). Choosing an instrument that the stricture will readily admit, it is passed completely through the stricture and is left in place for a few moments and then a larger size is inserted. At the next treatment the stricture is dilated one or two sizes more until finally it is stretched sufficiently to admit a No. 5 or 6 catheter with ease. Following each treatment lavage of the kidney pelvis and ureter may be practised as described above.

CHAPTER XXII

THE FEMALE GENERATIV

Anatomic Considerati

The Vagina.—The vagina is a muscul
tending from the uterus to the vulva, lying
urethra in front and the rectum behind. W
posture it is directed downward and forward
with the horizon. The anterior wall, which
rior wall, due to the position of the cervix, n
(5 to 6 cm.) in length, while the posterior
inches (7.5 to 9 cm.). Normally the walls
distended the vagina becomes conical in sha
below. That portion surrounding the cervi
roof or fornix. It is divided for description
rior fornix, in which is normally felt the bo
terior fornix, the deepest portion, which is
cul-de-sac of Douglas; and the lateral forni

Relations.—Anteriorly, in its lower port
tion with the urethra and in its upper half wi
the bladder. Posteriorly, it is in relation
its lower quarter, in its upper quarter with t
and between the two with the rectum.

Structure.—It consists of a mucous, m
tissue coat. The mucous membrane, whic
riety, exhibits on the anterior and posterio
or rugæ, which extend out transversely from
are more distinct on the anterior wall.

The muscular coat is arranged in two lay
and an outer circular.

The connective-tissue coat is a thin fibr
few smooth muscle fibers. In its meshes th
plexus of veins.

The Uterus and Appendages.—The ut
low pear-shaped organ lying in the pelvis
the rectum. It measures about 3 inches (7.
(5 cm.) in breadth, and 1 inch (2.5 cm.) in

Externally, it is flattened from before backward, and at the point where the peritoneum is reflected from the uterus to the bladder there appears a constriction, the isthmus, which corresponds with the position of the internal os and divides the uterus into two portions. The portion lying below the isthmus is the cervix, that part between the isthmus and a line joining the entrance of the tubes is known as the body, while the portion above the plane of the entrance of the tubes is known as the fundus. The cervix in turn is also divided into three portions: an infravaginal portion, below the attachment of the anterior vaginal wall; a supravaginal portion, above the attachment of the posterior vaginal wall; and an intermediate portion, lying between the two.

FIG. 793.—The normal position of the uterus. (Ashton.)

The interior of the uterus measures about 2 1/2 inches (6cm.) in length and is divided into two portions by the internal os. That portion of the canal above this point is triangular in shape with the base upward and with the walls normally in contact. In the cervical portion the canal is fusiform in shape. The uterus opens into the vagina through the external os, a transverse aperture having an anterior and a posterior lip, while above it connects with the peritoneal cavity through the Fallopian tubes.

Position of Uterus.—Normally the uterus lies in a slightly anteflexed position with the fundus pointing toward the umbilicus (Fig. 793). Its position, however, is modified from time to time by the neighboring organs. Thus a distended bladder will push it toward the sacrum, while a full rectum pushes it forward.

Structure.—The uterus is made up of a mucous, muscular, and a peritoneal coat. The mucous membrane of the body of the uterus is smooth and pale in color, with the mouths of numerous tubular glands opening upon its surface. The lining epithelium is of the ciliated variety having a motion from within outward.

In the cervix it is firmer in structure and is thrown into numerous folds, the arbor vitæ. These are arranged in the form of a median ridge on the anterior and posterior walls, from which branch secondary ridges in an upward and outward direction. Between these ridges are located the openings of tubular and racemose glands. In the upper portion of the cervix the mucous membrane is the same as that found in the body of the uterus and below it is similar to that in the vagina.

Extending out from either superior angle of the uterus are the two Fallopian tubes. They measure 3 to 5 inches (7.5 to 12.5. cm.) in length and lie in the free borders of the broad ligaments between the ovaries behind and the round ligaments in front. They are lined with ciliated epithelium having a direction toward the uterus. The external apertures, the fimbriated extremities, open into the peritoneal cavity near the ovary. Internally, each tube opens into the uterine cavity at its superior angle.

The ovaries, two in number, lie on either side of the uterus, about on a level with the pelvic brim, near the abdominal extremities of the tubes. Each ovary measures 1 1/2 inches (4 cm.) in length, 3/4 inch (2 cm.) in breadth, and 1/3 to 1/2 inch (0.8 to 1 cm.) in thickness.

Diagnostic Methods

In making a gynecological examination the investigation should comprise an inquiry into the patient's general condition as well as an examination of the pelvic organs. A clear and concise history of the subjective symptoms should be the first step in every case. It is preferable to allow the patient to first detail her own symptoms and to supplement this by inquiry as to essential points. In doing this it is well to follow a routine system in order to avoid omitting some important point that may have direct bearing upon the case, and also that the examiner may have a complete record for future reference.

In addition to the usual questions commonly asked in obtaining a history, special information should be sought in regard to the following points. First the menstrual history should be inquired into, ascertaining the age at which menstruation began, the precautions taken during menstruation, the interval between the periods, the regularity of the periods, the duration of the flow, and its character, whether painful, whether accompanied by the passage of clots, and whether scanty or profuse. The latter is especially important, as excessive menstrual bleeding points to the presence of some pathological condition.

With a history of painful menstruation the time the pain begins and ceases in relation to menstruation should be ascertained. It should also be found out whether there has been any bleeding between the periods. If the menopause has occurred, its date and the presence or absence of any bleeding since are to be noted. If the patient is married, certain data relating to child-bearing should be sought, comprising the number of children, the dates of their births, a history of the labors, whether easy, difficult, or instrumental and whether they were followed by a long and protracted convalescence.

With a history of abortions or miscarriages the period of pregnancy at which they occurred and their probable cause should be ascertained. At times it is also important to know something of the marital relations, that is, the frequency of coitus, whether the act is painful and whether measures to prevent conception have been employed, and, if so,the methods used.

The patient is next questioned as to the presence or absence of a vaginal discharge. If present, its character should be inquired into, whether foul, blood-tinged, or having the characteristics of an ordinary leucorrhea. The quantity of discharge is also to be noted, and whether it is always present or only occurs midway between the monthly periods.

Pain is another frequent and important complaint upon which full information should be sought. The character and situation of the pain should always be determined. The pain complained of may be in the form of a headache, a bearing-down feeling, backache, or its situation may be referred to some part of the pelvis, the coccyx, or the inguinal region. Inguinal pain generally points to some disease of the uterine appendages or ligaments; on the other hand, backache is found as an accompaniment of a number of conditions, such as chronic constipation, uterine displacements, pelvic tumors, etc., while pain in the coccyx is often a symptom of neurasthenia. It should also be ascertained if the pain is modified by menstruation, and if so, whether it is worse before the flow begins, during the flow, or afterward, also whether it is affected by exercise, any sudden jolt or jar, or by coitus.

Finally, since many gynecological patients have in addition t their pelvic troubles other disorders, the general symptoms and th functions of other organs should be similarly inquired into. Thu the patient should be questioned as to her appetite, loss of weigh nausea and vomiting, and if the latter is present, its character an relation to the taking of food, the condition of the bowels, and whethe she sleeps well or suffers from nervousness, hysteria, palpitation of th heart, hot flashes, etc., etc.

The methods available for such examination include abdomin inspection, palpation, percussion, auscultation, and mensuratio internal examination by inspection and palpation, the use of specul and the uterine sound, digital exploration of the uterus, test excisio test curettage, and exploratory incision.

Preparation of Patient.—Certain preparation of the patient essential for a thorough examination, otherwise the results will b unsatisfactory. If an anesthetic is to be given, the preparations f such, previously detailed (page 18), should be carried out. In an case, the bowels should be thoroughly evacuated by means of a mil purgative taken the day before, followed by an enema on the mornin of the examination. The bladder is emptied spontaneously ju before the patient presents herself for examination.

A suitable examining-table should be provided, and the simpl it is the better. It should be about 3 feet (90 cm.) high, strong i construction, provided with adjustable foot-rests, and capable being lengthened so that the patient may be placed upon it in th horizontal position. A small step, to aid the patient in mountin is also necessary. A second small table should be placed near a hand, upon which are placed solutions, instruments, etc., that may b required during the examination.

When it is necessary to make a vaginal examination in th patient's home, an ordinary kitchen table or the bed may be utilize In the latter case the patient is placed lengthwise across the bed, wit an ironing-board covered by several thicknesses of a sheet placed o the mattress under the patient's hips, and with the patient's fee supported on two chairs (Fig. 794).

With the patient in the desired position upon the table it shoul be seen that the corsets and any constricting bands are removed fro about the waist and that the patient is so covered by sheets that onl the region to be examined is exposed. For an abdominal examina tion two sheets are employed, one draped over the pelvic region an lower part of the abdomen and the other over the upper abdomen

For a vaginal examination the sheet is thrown over the lower extremities and is then separated so as to expose the vulva. If the examiner is provided with a nurse, these details may be left to her. While a nurse is not absolutely necessary, it is always preferable to have some woman present at the examination, not only for the greater comfort of the patient, but for the protection of the physician against malicious charges at the hands of unscrupulous females.

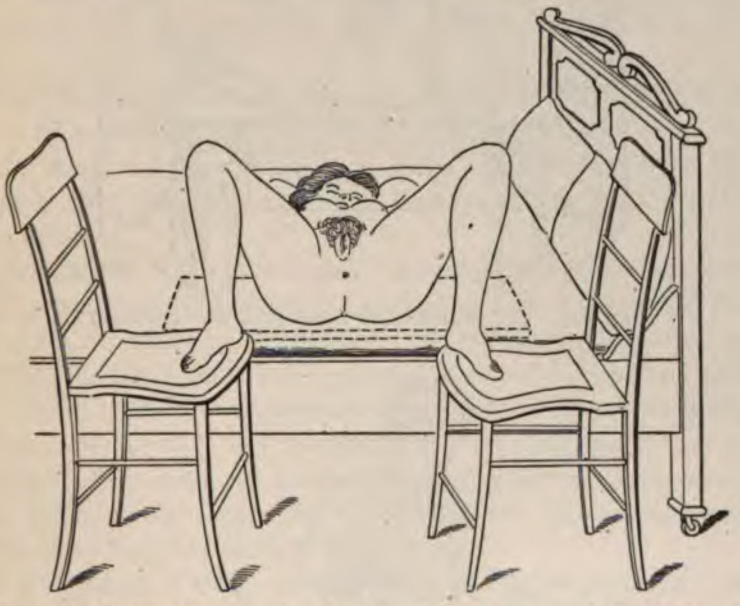


FIG. 794.—Position of the patient for an examination upon a bed. (Ashton.)

Gynecological Postures.—In examining the female pelvic organs a number of postures are available. These include the dorsal, the Sims, the knee-chest, the erect, and the squatting positions.

The dorsal position, which is the best for digital or bimanual examinations, is obtained by placing the patient, facing the light, flat on the back, with the hips near the edge of the table and with the feet supported upon the foot-rests (Fig. 795).

The Sims position is obtained by placing the patient upon her left side, with the left side of the face, the left shoulder, and left breast resting upon a flat pillow. The left arm lies behind the back, the thighs are well flexed upon the body, and the right knee is drawn up nearer the body than the left (see Fig. 570). In this position an excellent view may be obtained of the vaginal fornices, the anterior vaginal walls, and the cervix, but it is not satisfactory for a digital examination, as the pelvic organs are more difficult to reach with the patient in the dorsal posture.

The knee-chest position is obtained by having the patient

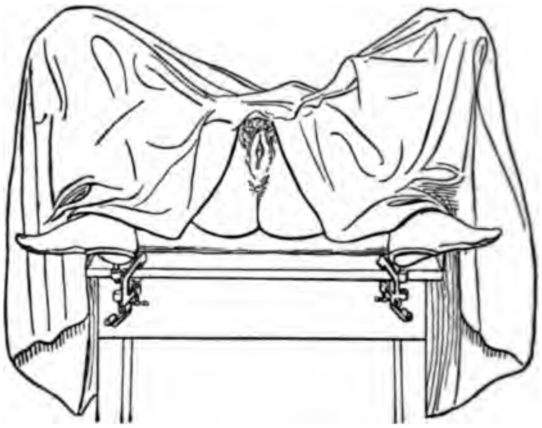


Fig. 795.—The patient in the dorsal position. (Ashton.)

Fig. 796.—Examination with the patient standing erect. (Ashton.)

upon a table, with the thighs at right angles to the legs, the resting upon a pillow placed upon the same level as the knee Fig. 572). In this posture the intestines gravitate toward th phragm, and the vagina becomes distended so that the numerous folds of mucous membrane are spread out smoothly.

The Erect Posture.—The patient, with her clothes elevated and a sheet fastened about her hips, stands with one foot on the floor and the other resting upon a stool 6 to 8 inches (15 to 20 cm.) high. The examiner kneels in front of the patient and passing his hand beneath the sheet, makes a digital examination of the vaginal outlet and the uterus (Fig. 796). In this position a prolapse of the uterus or a relaxation of the vaginal outlet is more readily recognized than in the dorsal posture.

The squatting posture is sometimes useful in ascertaining the degree of a uterine prolapse and the relaxation of the vaginal walls. The patient takes the same position as when at stool and, by a slight straining effort, any tendency to prolapse is readily made visible to the examiner.

Asepsis.—In all gynecological examinations every precaution must be taken to avoid infecting a patient as well as to prevent infection of the examiner by the patient. All instruments that are used are boiled for five minutes in a 1 per cent. soda solution, and no instrument should be used on more than one patient without resterilization. The examiner's hands are sterilized by a thorough scrubbing with tincture of green soap and water, following by immersion in an antiseptic solution. The examiner should also see that his finger-nails are cut short to avoid hurting the patient.

If the patient is suspected of having syphilis or gonorrhea, or in the presence of a septic discharge, the examiner should protect himself by wearing rubber gloves previously sterilized. In the majority of cases it is sufficient to wipe off the vulva with a swab soaked in a 1 to 2000 bichlorid solution, but where a profuse or foul discharge is present a vaginal douche may be required. When it is desired to obtain a specimen of a discharge for examination, antiseptic solutions or douches should be omitted until this has been done.

I. Examination of the Abdomen

INSPECTION

From the appearance of the skin, the shape of the abdomen, and the effect of respiration upon a tumor valuable information may be obtained.

Position of Patient.—The patient should lie with the body symmetrically placed upon a firm flat table in the horizontal position.

Technic.—With the patient's abdomen
light falling obliquely upon the abdomen,
first from the side and then from the foot c
The color of the skin of the abdomen, tl
striæ, eruptions, scars, edema, and dilated
abdominal walls, whether rigid or lax, and
of the abdomen should all be noted.

In enlargement of the abdomen due to
of the abdominal wall usually hangs down
In ascites the abdomen is more or less
bulge outward. In the presence of pregnai
enlargement is smooth and regular, in tl
men being symmetrically enlarged, while a
if small, may distend one side only. Fibrc
irregular and nodular growths. If a tumc
ence or absence of mobility with respirat
dominal walls move over the growth should
weakened condition of the recti muscles oı
should also be sought by having the patier

PALPATION

Palpation of the abdomen is the most s
of abdominal examination and should forı
gynecological examination. By it the pre
fluctuation, or local tenderness that might
simply to a vaginal examination may be re
ence of an enlargement, its situation, ori
consistency may be determined.

Position of Patient.—The patient lies i
the shoulders slightly elevated and the t
secure thorough relaxation.

Technic.—The examiner first thorou
Then, taking his place upon one side of the
palpates all portions of the abdomen. In
hand—usually the right—is placed upon t
ward, and firm but gentle pressure is made
finger tips should be avoided as it incites
Local or general rigidity of the abdominal
the presence of a tumor are thus ascertain
To differentiate obesity from intraabdo

are employed and make deep pressure from the sides toward the mid-line, at the same time lifting upward on the abdominal walls (Fig. 797). The situation, origin, size, or mobility of a tumor is

Fig. 797.—Showing the method of estimating the thickness of the abdominal walls.

determined by making deep pressure with both hands in all directions about the mass (Fig. 798). An enlarged uterus is mapped out in the same manner. In examining the lateral regions of the abdo-

Fig. 798.—Bimanual palpation of an abdominal tumor. (Ashton.)

men bimanual palpation is often of service, one hand being placed under the flank and making forward pressure while the other hand palpates the antero-lateral surface of the abdomen.

Fluid collections are recognized by a thrill or wave produce placing one hand with the palm flat on one side of the abdome tapping the abdomen from the opposite side with the fingers o other hand. To avoid confusing a wave produced by tapping abdomen with that of fluid the examiner should have an assi place the ulnar edge of his hand firmly on the summit of the a men while the tapping is performed (Fig. 799). In the case c the wave is then absent.

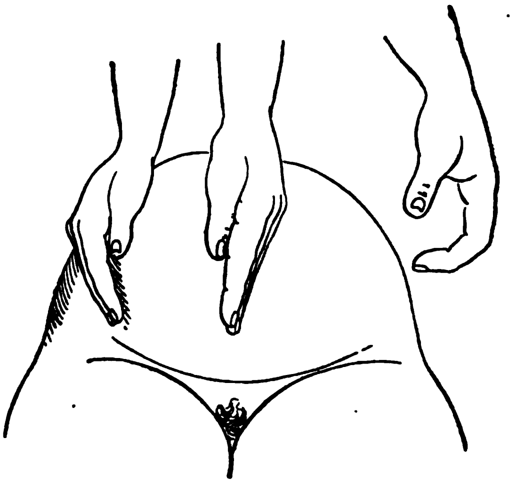


FIG. 799.—Mehod of differentiating between a wave produced when tappin abdomen and one containing fluid. (Ashton.)

PERCUSSION

Abdominal percussion is valuable when employed as an ad to inspection and palpation in differentiating between tym ascites, cystic and solid tumors, and in determining the siz shape of a tumor, and its origin. To avoid errors, the large tine should be emptied by an enema before the examination.

Position of Patient.—Percussion is performed, first, wit patient lying on the back and, then, turned upon the side.

Technic.—The examiner places the palmar surface of the n finger of the left hand firmly upon the area to be percussed using the tip of the middle finger of the right hand, bent at a angle, as a plexor, strikes quick, sharp blows (see Fig. 529). normal resonance of the abdomen is tympanitic except in the re of the liver and spleen where it is dull. Fecal masses, cystic and tumors, and fluid collections give dulness on percussion.

distended intestines overlie a growth, however, the note will be tympanitic, and it will be necessary to employ deep and strong percussion to bring out the dulness. By carefully percussing around the

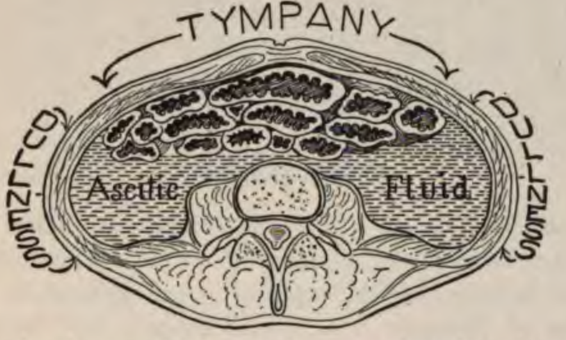


FIG. 800.—Showing the area of dulness and tympany in ascites when the patient is recumbent. (Ashton.)

margins of a tumor and noting where tympanitic resonance is absent, it is often possible to determine the origin of the growth.

In the presence of ascites with the patient in the dorsal position, dulness will be elicited in the flanks, while the center of the abdomen

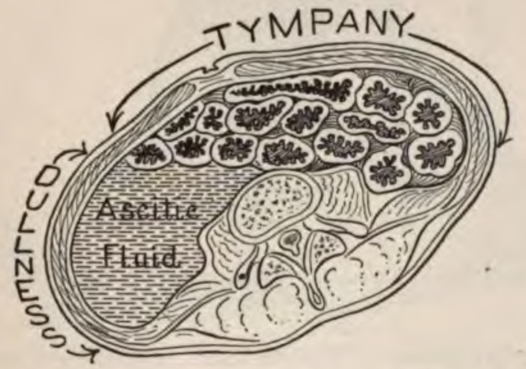


FIG. 801.—Showing the area of dulness and tympany in ascites when the patient lies on her side. (Ashton.)

will be tympanitic, as the intestines float to the highest point (Fig. 800). With a change in the patient's position the fluid gravitates to the lowest point and the location of the dulness and tympany is likewise changed (Fig. 801). On the other hand, the area of dulness due to tumors is not affected by changes in the patient's position.

AUSCULTATION

Auscultation is of limited use except in the differential diagn between pregnancy and other tumors. In the former case the f heart sounds and the funic souffle settle the diagnosis. Much im tance cannot be attached to the uterine bruit, however, in the sence of other signs pointing to pregnancy, as it is also heard in l fibroid tumors. In some cases of peritonitis it may be possibl hear a friction note.

MENSURATION

Mensuration of the abdomen is useful in determining whether abdomen is symmetrically enlarged or not, in noting any increas ascites, and in recording the rapidity of enlargement in a tumor

Position of Patient.—The measurements are taken with patient in the horizontal recumbent position.

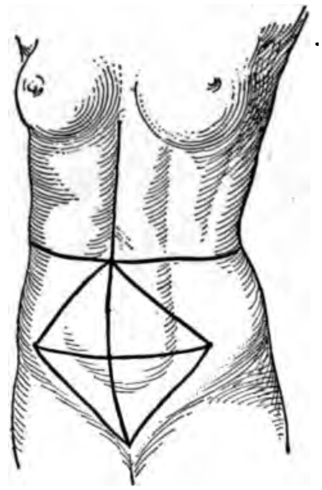


FIG. 802.—Showing the measurements taken in recording the growth of an abdo tumor.

Technic.—An ordinary tape measure is employed and the fol ing measurements are taken: (1) the circumference of the abdc at the level of the umbilicus, (2) the distance from the ensiform c lage to the pubes, (3) the distance from the umbilicus to each ant superior spine, (4) the distance between the two anterior sup spines, and (5) the distance from the anterior superior spines t pubes (Fig. 802). To have any value for purposes of compar these measurements should be taken from the same points time and with the patient in exactly the same position.

II. Examination of the Pelvic Organs

INSPECTION

A careful inspection of the external genitals and the vaginal orifice should always be made as a routine before a digital examination, otherwise lesions involving the vulva and neighboring parts may escape notice. Inflammations, new growths, the presence of abnormal secretions, prolapse of the anterior or posterior vaginal walls, lacerations of the perineum, and many other pathological conditions are readily recognized by inspection.

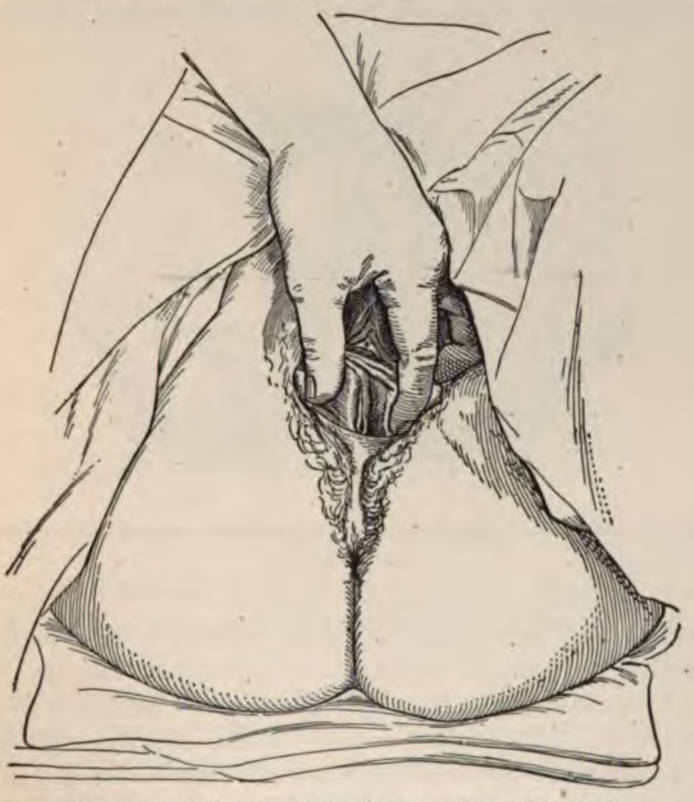


FIG. 803.—Inspection of the vaginal outlet. (Bandler.)

Position of Patient.—Inspection is performed with the patient in the dorsal posture with the feet toward the light.

Technic.—The examiner sits or stands facing the vulva and begins his inspection without disturbing the relation of the parts. He should first note the general appearance of the vulva, whether the labia are closed or in apposition, and whether the vulva is the seat of inflammation, ulcerations, warts, swelling, edema, varicosites, e tions, or excoriations, the latter a frequent accompaniment of a charge. If a discharge is present, its color, quantity, and o characteristics should be noted.

The labia are next separated with the fingers of the left hand, the entrance to the vagina is inspected (Fig. 803), noticing the (of the mucous membrane, the presence or absence of the hymen condition of the openings of the ducts of Bartholin and the orifi the urethra, and the presence or absence of lacerations, cysto or rectocele. By instructing the patient to bear down or st slightly, a prolapse of the anterior or posterior vaginal walls is n

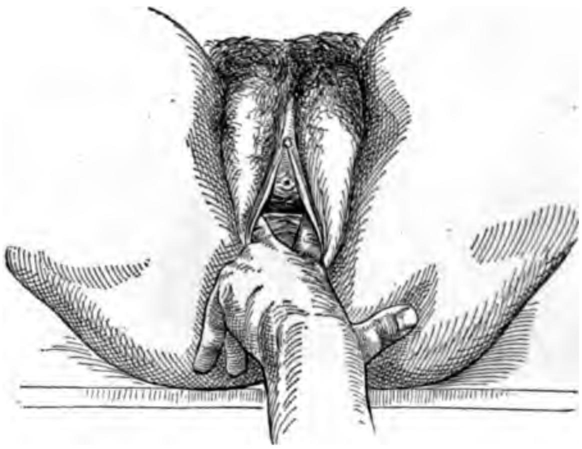


FIG. 804.—Method of exposing the anterior and posterior vaginal walls for inspe (Ashton.)

more evident. The hood of the clitoris should also be retracted an examination made for adhesions or concretions that may be cause of nervous symptoms. By retracting the perineum with fingers inserted in the vagina, as shown in Fig. 804, the lower po of the anterior and posterior vaginal walls may be brought to v

EXAMINATION OF DISCHARGES

If an abnormal discharge is present, specimens should be obta at this time for later microscopical or bacteriological examina The importance of such an examination cannot be too stro emphasized. The technic for collecting and preparing the s mens has been previously detailed at length in Chapter XI.

DIGITAL PALPATION

Palpation by means of the finger is employed to obtain more complete information as to abnormal conditions of the vulva or vaginal outlet discovered on inspection, and to determine the condition of the vagina, vaginal fornices, and the cervix. For a satisfactory examination of the other pelvic organs, bimanual palpation is necessary.

Asepsis.—All the aseptic precautions previously detailed (page 803) should be observed.

FIG. 805.—The diagnosis of a cystocele by the aid of a bladder sound. (Ashton.)

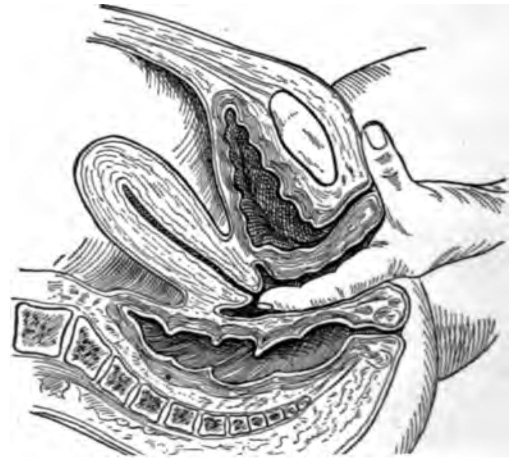
Position of Patient.—The dorsal position is ordinarily employed, but the erect posture will be found useful in estimating the degree of a uterine prolapse.

Preparations.—(See page 800.)

Technic.—The examiner first palpates between the thumb and forefinger of the right hand any abnormal conditions, such as swellings, new growths, etc., about the vulva and the vaginal outlet, and also the glands of Bartholin for signs of inflammation or thickening.

The labia are then separated between the thumb and index-finger of the right hand, and the index-finger of the left hand, well lubricated, is introduced into the vagina. The condition of the vagina is then investigated, noting the presence or absence of congenital malformations, its sensitiveness, its temperature, and whether the vaginal walls have their normal roughness or are smooth

FIG. 806.—Method of estimating the thickness of the perineum.



finger in the vagina (Fig. 805), a cystocele, if present, may be more readily recognized. The posterior vaginal wall is likewise examined by rotating the examining finger, palmar surface back, and, by placing the thumb of the same hand near the rectum, the perineum may be grasped between the two fingers and its firmness and thickness estimated (Fig. 806). The vaginal fornices on all sides of the cervix are next palpated, noting their depth, any rigidity, induration, or tenderness.

If the uterus is in a normal position, it will be possible to feel its body through the anterior fornix, while, if retroverted, the latter will be felt in the posterior fornix. The condition of the uterus is more satisfactorily made out, however, by bimanual palpation.

Finally, the cervix is palpated (Fig. 807), noting especially its size, whether closed or open, whether hard or soft, its mobility, and its position, that is, whether pointing backward toward the sacrum, as in retroflexion of the uterus, or pointing forward toward the symphysis, as is found when the uterus is retroverted or anteflexed. The presence or absence of lacerations, erosions, cysts, etc., should also be determined.

BIMANUAL PALPATION

Bimanual palpation by means of the fingers of one hand in the vagina or rectum and the fingers of the other hand making counterpressure above the symphysis is the most valuable method for investigating the condition of the pelvic organs. By it one may map out the size and shape of the uterus and determine its consistency, position, mobility, and the presence or absence of new growths. The tubes, ovaries, broad ligaments, etc., may likewise be palpated and their condition ascertained.

Vagino-abdominal palpation is the most satisfactory and the more generally employed method. It should be supplemented by recto-abdominal palpation, however, in any doubtful cases. The latter method is especially useful in exploring the posterior surface of the uterus and the appendages in cases of posterior displacement of the uterus, as these structures may then be more readily reached from the rectum than from the vagina. Recto-abdominal palpation is also indicated in children, in the unmarried, and in cases where the vagina is unduly sensitive or obstructed by tumors or an imperforate hymen.

To perform a successful bimanual examination it is necessary that the abdominal walls be thin, relaxed, and free from tenderness upon pressure, and that the vagina be sufficiently large to admit the fingers of the examining hand. In the case of individuals with very muscular, fat, or rigid abdominal walls or a small vagina the examination is usually unsatisfactory without an anesthetic. In any case, the examination must be performed with the utmost gentleness. Rough manipulations accomplish nothing and are capable of causing great harm, especially in cases where the pelvis contains a tube filled with pus, a thin-walled cyst, an ectopic pregnancy, etc.

Asepsis.—For the necessary precautions against infection see page 803.

Position of Patient.—Bimanual palpation is most satisfactorily performed with the patient in the dorsal position.

Preparations.—(See page 800.)

Anesthesia.—General anesthesia is not often required in individuals with thin and relaxed abdominal walls, but in muscular, fat, or nervous individuals or where the parts are tender and sensitive an anesthetic may be necessary to secure relaxation. A general anesthetic should also be employed if any doubt remains as to the conditions found after an ordinary bimanual examination, and in all cases where it is necessary to make a vaginal examination upon virgins.

Technic.—1. *Vagino-abdominal.*—The examiner stands facing the patient a little to one side or the other depending upon which hand he palpates with. The labia are then separated between the thumb and forefinger of one hand and the index-finger of the other hand, or the index- and middle fingers if the parts are sufficiently relaxed to admit them, are well lubricated and are inserted into the vagina, while the fingers of the free hand are placed on the abdomen above the pubes. The external hand is used to steady or depress the organs while the internal hand does the palpating. As a rule the left hand is employed to palpate with, being the smaller of the two and possessing greater tactile sensibility, but the examiner should be equally proficient with either hand. The last two fingers of the internal hand should be folded back upon the palm, as shown in Fig. 808, so as to invaginate the pelvic floor and thereby permit the greatest possible penetration. The palmar surfaces of the fingers of the internal hand are brought in contact with the cervix and its condition and position are first determined. With the internal fingers in contact with the cervix and exerting upward pressure the external hand locates the fundus of the uterus and makes gentle pressure from above. The length, sensitiveness, consistency, and position of the uterus are thus determined, and likewise the mobility by making a series of gentle pushes from above and below (Fig. 809).

FIG. 808.—Method of inserting the examining fingers in bimanual palpation. Small figure shows the method of holding the fingers.

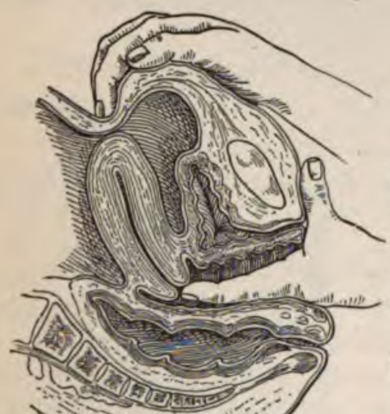


FIG. 809.—Method of determining the length and mobility of the uterus. (Ashton.)

FIG. 810.—Method of estimating the thickness of the uterus. (Ashton.)

By placing the internal fingers in front of the cervix and the fingers of the external hand behind the fundus the thickness of the uterus may be estimated (Fig. 810). If the fundus is pressed well forward by the external hand, the anterior and lateral surfaces may be palpated and any irregularity of the surfaces which might be caused by fibroids or other growths is noted. By carrying the fingers of the internal hand posterior to the cervix and pressing the fundus backward the posterior surface is in like manner explored. When the

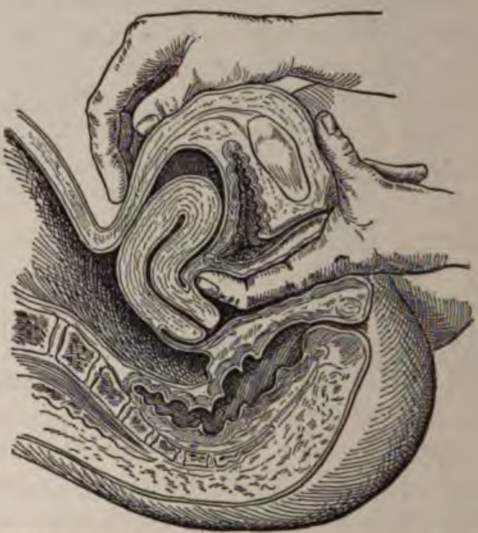


FIG. 811.—Diagnosis of an anteflexion of the uterus by bimanual palpation. (Ashton.)

FIG. 812.—Diagnosis of a posterior displacement of the uterus by bimanual palpation. (Ashton.)

FIG. 813.—Shows the method of palpating the body of the uterus in a posterior displacement. (Ashton.)

fundus is not found in its normal position, it should be sought for anteriorly near the symphysis, or posteriorly. To palpate for anterior displacements, the internal finger is carried up in front of the cervix into the anterior fornix, while the external hand exerts pressure downward behind the symphysis. If anteflexed, the fundus will be readily felt between the fingers of the external and internal hands (Fig. 811), while in posterior displacements the opposed fingers may be brought together as shown in Fig. 812. In such case the fundus should then be sought posteriorly by carrying the internal finger up into the posterior cul-de-sac while external pressure is made by the external hand from above (Fig. 813).

A posterior flexion will be readily differentiated from a version by the bend or angle on the posterior aspect of the uterus (Fig. 814).

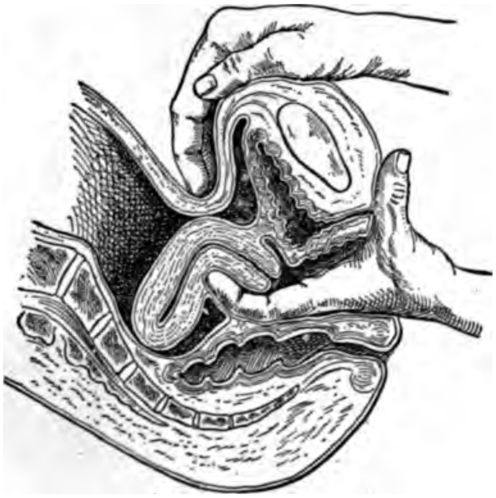


FIG. 814.—Diagnosis of a posterior flexion of the uterus by bimanual palpation. (Ashton.)

In the presence of a posterior displacement it should be determined whether the uterus is mobile or fixed through adhesions by passing the internal fingers high up posteriorly and by the aid of the external hand attempting to lift the uterus up.

After thoroughly examining the uterus the condition of the broad and uterosacral ligaments should be ascertained. By carrying the fingers up beside the cervix into the lateral fornices and making counter-pressure from above the condition of the broad ligaments may be determined, and any pain on pressure, thickening, or induration noted. Palpation of the uterosacral ligaments through the posterior fornix may be performed in like manner.

The tubes and ovaries should also be examined with reference to their size, shape, consistency, sensitiveness, position, and mobility.

It is of advantage to use the right hand in palpating the right side and the left hand for the left side. The examining fingers are inserted well up in the lateral fornix beside the cervix in an upward and backward direction, while the external hand makes deep pressure downward through the abdominal wall on the corresponding side. By altering the position of the fingers of the two hands from time to time the ovary and tube are finally grasped between the opposed fingers (Fig. 815). Except where the abdominal walls are extremely thin and the vagina is relaxed, the normal tube cannot be felt, but,

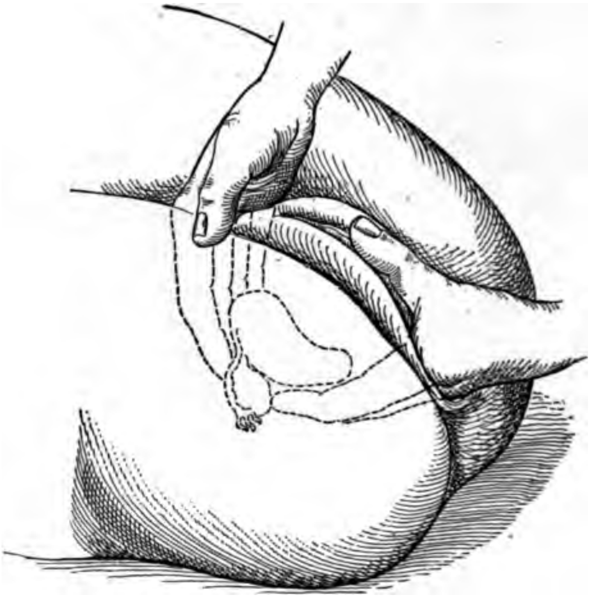


FIG. 815.—Examination of the uterine appendages by bimanual palpation. (Ashton.)

when enlarged, it may be readily recognized as a club-shaped mass gradually narrowing down as it approaches the uterus. The normal ovaries, however, are generally palpable as small, oval masses, somewhat tender upon pressure, on each side of the uterus. When, as the result of chronic inflammation, extensive adhesive formation has taken place the tubes and ovaries are often matted together into irregular masses, and it may not be possible to map them out separately. Having examined one side of the pelvis, the same procedure is repeated upon the other side.

2. *Recto-abdominal.*—The examiner stands facing the patient and inserts the well-lubricated index-finger of the left hand high into the rectum. At the same time the external hand placed on the abdomen

bove the symphysis makes counter-pressure, while the uterus and ppendages are carefully palpated (Fig. 816). Care must be taken,

FIG. 816.—Recto-abdominal palpation of the uterus. (Ashton.)

IG. 817.—Recto-abdominal palpation of the uterus with the latter drawn toward the vaginal outlet by means of a tenaculum. (Ashton.)

owever, not to exert too much force with the fingers in the rectum or fear of lacerating or otherwise injuring the bowel.

By drawing the uterus well down by means of a pair of bullet forceps caught in the cervix, and then performing recto-abdominal palpation, a much more complete examination is possible (Fig. 817). This method, however, should never be attempted when the uterus is fixed by adhesions or the appendages are inflamed. As a rule, general anesthesia is necessary. Care should always be taken to replace the uterus in its normal position at the completion of such an examination.

EXAMINATION BY SPECULA

By means of suitable specula the mucous membrane of the entire vagina and cervix may be directly inspected. The use of specula furnishes little information outside of the color and condition of the

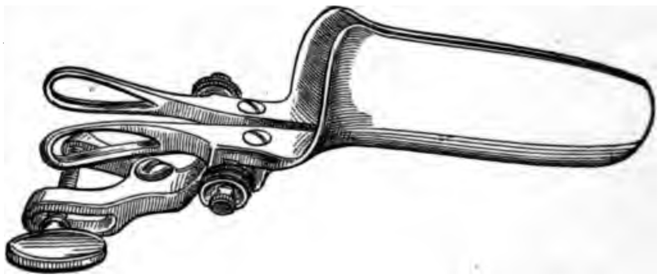


FIG. 818.—Goodell's vaginal speculum. (Ashton.)

mucous membrane and the origin of a discharge, which is not as readily obtainable by digital palpation. For gynecological treatment and operative procedures, however, specula are indispensable.

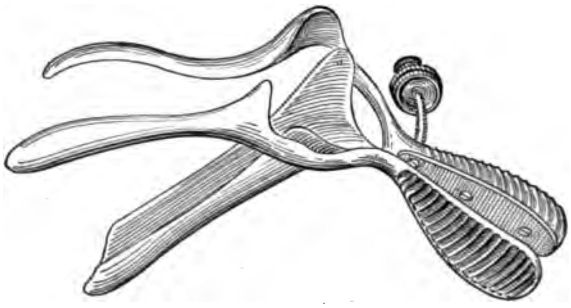


FIG. 819.—Trivalve vaginal speculum.

Instruments.—Numerous specula have been devised, such as the bivalve (Fig. 818), the trivalve (Fig. 819), the cylindrical, the Sims (Fig. 820), Simon's, the self-retaining weighted speculum, etc., etc.

For diagnostic purposes the bivalve and the Sims specula are probably most commonly employed. To prevent the anterior vaginal wall from obscuring the view when using the Sims speculum a vaginal depressor is also required (Fig. 821). A sponge holder (Fig.

FIG. 820.—Sims' vaginal speculum. (Ashton.)

822) and cotton wipes should be provided for removing secretions.

Asepsis.—The speculum should be sterilized by boiling for five minutes in a 1 per cent. soda solution and the operator's hands are sterilized in the usual way.

Position of Patient.—When the bivalve or trivalve speculum is

FIG. 821.—Vaginal depressor. (Ashton.)

employed the patient should be in the dorsal position. In using the perineal retractors, such as the Sims, the left lateral, or the knee-chest position may be employed.

Preparations of Patient.—(See page 800.)

FIG. 822.—Sponge holder and swab.

Technic.—1. *With the Bivalve Speculum.*—The examiner stands or sits facing the vulva. Then, with the labia well separated between the index- and middle fingers of the left hand, the speculum, warmed and well lubricated, is inserted into the vagina with its blades parallel to the vulva opening (Fig. 823). The speculum is introduced about 2 inches (5 cm.) and is then rotated so that the

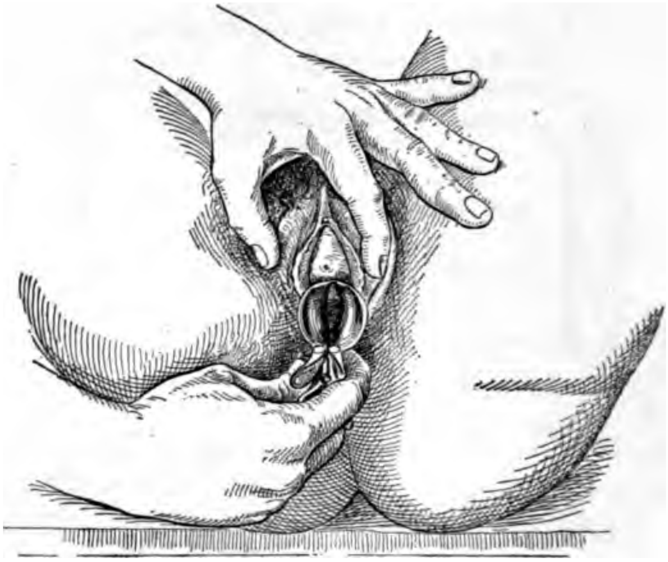


FIG. 823.—Method of inserting the bivalve speculum. (Ashton.)

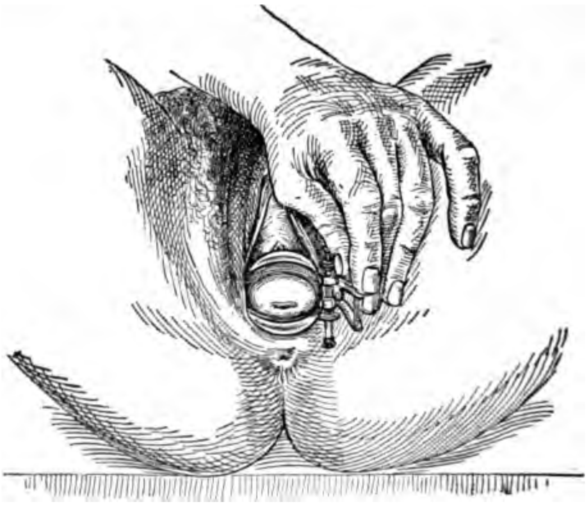


FIG. 824.—Method of exposing the lateral walls of the vagina by means of the bivalve speculum. (Ashton.)

blades lie parallel with the anterior and posterior vaginal walls. By widely separating the blades (Fig. 824) a view of the cervix and the lateral walls of the vagina is obtained. For inspection of the anterior and posterior vaginal walls the blades of the speculum are turned so that they lie parallel with the outlet of the vulva and they are then opened (Fig. 825). The condition of the entire vaginal mucous

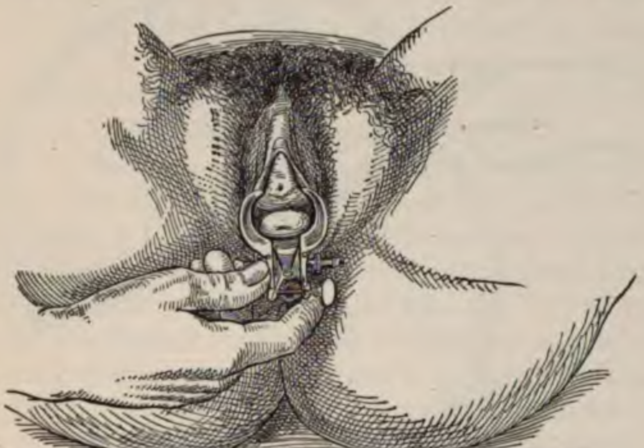


FIG. 825.—Method of exposing the anterior and posterior vaginal walls by means of a bivalve speculum. (Ashton.)

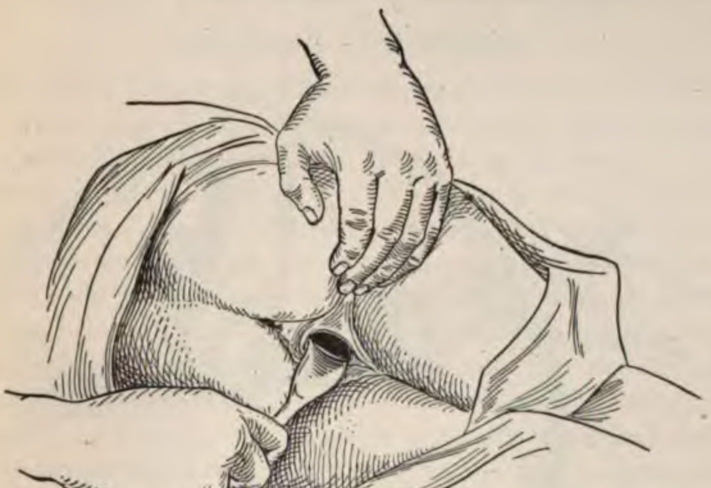


FIG. 826.—Shows the method of inserting Sims' speculum.

membrane may be thus ascertained, and inflammatory conditions, a fistulous opening, new growths, etc., will be readily recognized if present. If a discharge is present, its origin should be determined.

blades parallel to the vulva opening (Fig. 823). The speculum is introduced about 2 inches (5 cm.) and is then rotated so that the

FIG. 823.—Method of inserting the bivalve speculum. (Ashton.)

FIG. 824.—Method of exposing the lateral walls of the vagina by means of the bivalve speculum. (Ashton.)

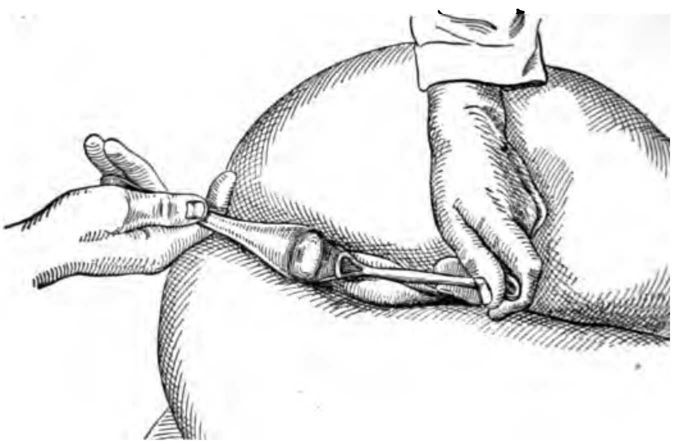
blades lie parallel with the anterior and posterior vaginal walls. By widely separating the blades (Fig. 824) a view of the cervix and the lateral walls of the vagina is obtained. For inspection of the anterior and posterior vaginal walls the blades of the speculum are turned so that they lie parallel with the outlet of the vulva and they are then opened (Fig. 825). The condition of the entire vaginal mucous

FIG. 825.—Method of exposing the anterior and posterior vaginal walls by means of a bivalve speculum. (Ashton.)

FIG. 826.—Shows the method of inserting Sims' speculum.

membrane may be thus ascertained, and inflammatory conditions, a fistulous opening, new growths, etc., will be readily recognized if present. If a discharge is present, its origin should be determined.

FIG. 827.—Showing the Sims speculum in place. (Ashton.)



The cervix is then inspected, noting its size and shape and whether it is lacerated or is the seat of inflammation, erosions, cysts, or new growths, and whether a discharge issues from the external os. If secretions obstruct the view, they should be carefully wiped away by means of cotton wipes held by a sponge holder. In some cases, where the vagina is very long and narrow, a clear view of the cervix can only be obtained by drawing it down into the vagina by means of a tenaculum or bullet forceps.

2. *With the Sims Speculum.*—The shaft of the speculum is grasped in the operator's right hand while with the left hand the upper buttock is raised so that the vulva is well separated. The blade of the speculum, which has been previously warmed and lubricated, is then inserted into the vagina parallel with the cleft of the vulva (Fig. 826). The blade is then rotated so that it lies parallel with the anterior and posterior vaginal walls and is further introduced until its distal end lies back of the cervix. By making traction backward and outward the perineum is retracted so that an excellent view of the anterior vaginal wall and cervix is obtained (Fig. 827). Should the anterior vaginal wall obstruct the view, it may be drawn out of the way by means of the vaginal retractor as shown in Fig. 828.

SOUNDING THE UTERUS

The uterine sound, which was formerly employed to a great extent in gynecological diagnosis is, now seldom used, as little information is gained by its use, ouside of determining the length, size, and consistency of the uterine cavity, that is not as readily obtainable by other and less dangerous means. The unskilled use of the uterine sound has often led to the introduction of septic material into the uterus carried from the vagina or cervix, as well as to the infliction of serious injury upon the uterine mucous membrane and even perforation of that organ. To avoid these risks the position of the uterus should be ascertained before an attempt is made to introduce the sound, and, during the attempt, only gentle manipulations of the instrument should be made; it should never be used as a means of righting a displaced uterus. The sound should never be introduced by touch alone, but always with the cervix clearly exposed by means of a speculum, and in every case the date of the last menstruation should be ascertained beforehand so as not to interrupt a possible pregnancy. Its use is contraindicated if the uterus is infected or is the seat of a malignant disease, or if the uterine appendages are involved in a suppurative disease.

Instruments.—The operator will require a vaginal speculum, a pair of bullet forceps, cotton wipes, a sponge holder, and a uterine sound (Fig. 829).

The sound is made of flexible metal, about 12 inches (30 cm.) long and from 1/12 to 1/8 inch (2 to 3 mm.) thick, with a bulbous tip. The shaft is marked off in inches, and 2 1/2 inches (6 cm.) from the distal end is a small protuberance to indicate the normal depth of the uterus.

Asepsis.—The introduction of a sound or any instrument into the uterus should be regarded as a surgical operation and should be carried out with every aseptic detail. All the instruments should be

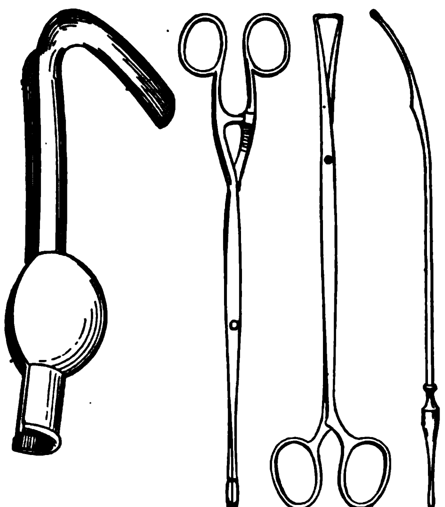


FIG. 829.—Instruments for sounding the uterus. 1, Garrigues' weighted speculum; 2, dressing forceps; 3, tenaculum; 4 uterine sound.

boiled for five minutes in a 1 per cent. soda solution. The external genitals should be thoroughly cleansed with soap and water followed by a 1 to 2000 bichlorid solution and the vagina should be douched with some antiseptic. The operator's hands are cleansed as thoroughly as for any operation.

Position of Patient.—The patient should be in the lithotomy position.

Technic.—The operator sits facing the vulva and, after separating the labia, introduces the speculum. The anterior lip of the cervix is then seized by means of bullet forceps and, after being pulled down into view, is thoroughly wiped off with a cotton swab soaked in a

1 to 2000 bichlorid solution. The sound with its distal 3 inches (7.5 cm.) bent in a slight forward curve is grasped lightly between the thumb and forefinger of the right hand and is introduced into the external os, being careful not to touch any portion of the vagina. By gently depressing its handle the sound should readily glide up the canal to the fundus. If the point is arrested by catching in a fold of mucous membrane or at the internal os, gentle manipulation will usually result in its passage—*force should never be employed.*

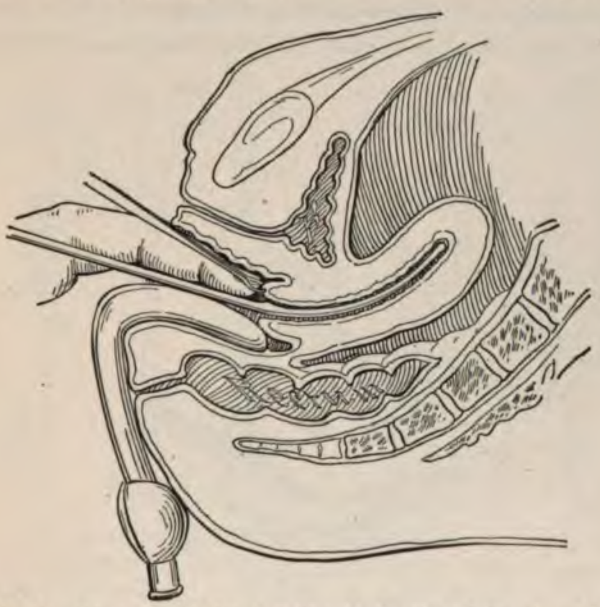


FIG. 830.—Showing the method of estimating the length of the uterus by means of the uterine sound.

Sometimes, when the cervix is bent forward, the sound may be more readily passed if it is started with the concavity of its curve turned backward and, as soon as it becomes arrested, rotating it forward. When the tip of the instrument reaches the fundus, the operator's right index-finger should be moved along the shaft of the instrument until it comes in contact with the cervix for the purpose of indicating the depth of the canal when the instrument is removed (Fig. 830).

DIGITAL PALPATION OF THE UTERINE CAVITY

Digital exploration of the interior of the uterus is occasionally required in the diagnosis of intrauterine growths or retained products of conception which are not revealed by other methods of examination. With the finger in the cavity of the uterus it is possible to determine whether the uterus is empty or not, the length and direction of the canal, and the thickness, consistency, and other characteristics of the endometrium.

Digital exploration necessitates a thorough preliminary dilatation of the cervix, except in puerperal cases, and should, therefore, be considered in the same light as a surgical operation. It should not be attempted until the possibility of pregnancy has been excluded by determining the date of the last menstruation and by a careful examination.

FIG. 831.—Digital exploration of the uterine cavity. (Ashton.)

Instruments.—Instruments for dilating the cervix are required. These include a vaginal speculum, a pair of dilators, sponge holders, and two bullet forceps. (See Fig. 883.)

Asepsis.—Strict aseptic precautions should be observed. The external genitals are washed with soap and water, followed by a 1 to 2000 bichlorid of mercury solution. The vagina is cleansed with soap and water by means of a sponge on a holder and is then douched with an antiseptic solution. The instruments are boiled for five minutes in a 1 per cent. soda solution and the operator's hands are prepared with the same care as for any operation.

Position of Patient.—The lithotomy position is employed.

Anesthesia.—General anesthesia is required except in postpartum cases.

Technic.—The cervix is first dilated sufficiently to admit the operator's finger (see page 864). The index-finger of the right hand or, where possible, as in postpartum cases, the index- and middle fingers are then passed into the uterus, while, with the left hand on the abdomen, the operator presses down upon the fundus uteri, so as to bring the uterus within reach of the internal fingers (Fig. 831). The interior of the uterus is then systematically explored by the internal fingers.

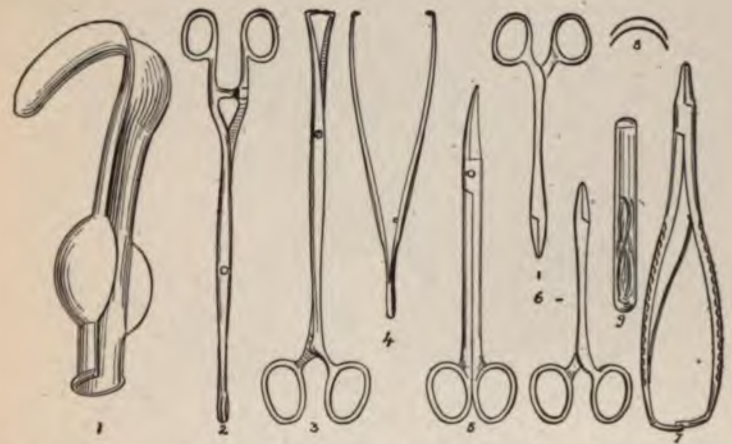


FIG. 832.—Instruments for an exploratory vaginal section 1, Garrigues' weighted speculum; 2, sponge holder; 3, tenaculum; 4, thumb forceps; 5, sharp-pointed scissors; 6, artery clamps; 7, needle holder; 8, needles; 9, No. 2 catgut.

THE EXAMINATION OF SECTIONS AND SCRAPINGS FROM THE UTERUS

To determine the nature of a suspicious growth a portion should be excised for examination. The method of doing this has already been described (page 307). Where the interior of the uterus is the seat of suspected disease, scrapings from the endometrium for examination should be collected by a thorough curettage (see page 868).

EXPLORATORY INCISION

Direct palpation of the pelvic structures is sometimes required in the diagnosis of obscure pelvic conditions. It may be accomplished by means of an abdominal incision or through a small opening made in the cul-de-sac of Douglas. The latter method is preferable, as it is not a dangerous operation, and the recovery of the patient is more rapid than when an abdominal section is performed. The operator should be prepared, however, to perform any operative procedures, such as draining a pus sac, removing suppurating tubes, or opening the abdomen, if the findings indicate it.

Instruments.—There will be required a weighted vaginal speculum, sponge holders, bullet forceps, toothed thumb forceps, sharp-

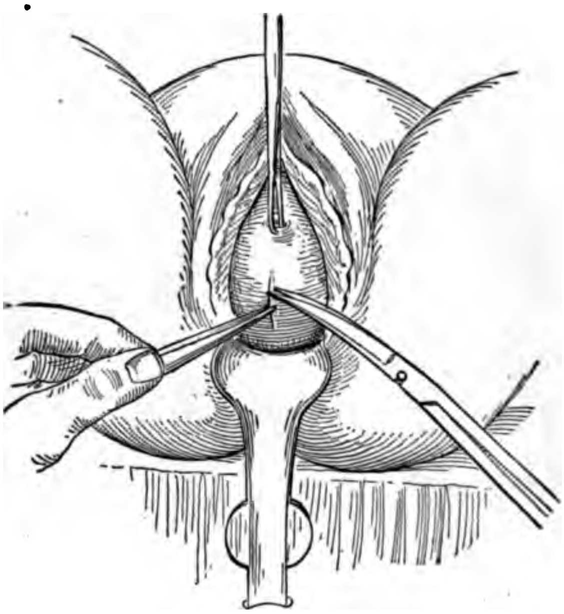


FIG. 833.—First step in performing a posterior vaginal section, opening into the posterior cul-de-sac.

pointed curved scissors, artery clamps, curved cutting-edged needles, a needle holder, and No. 2 catgut (Fig. 832).

Asepsis.—The instruments are boiled for five minutes in a 1 per cent. soda solution. The external genitals are scrubbed with soap and water followed by a 1 to 2000 bichlorid solution, and the vagina is cleansed by first washing with soap and water and then by means of an antiseptic douche. The operator's hands are sterilized in the usual way.

Position of Patient.—The patient should be in the lithotomy position.

Preparation of Patient.—The patient is prepared for general anesthesia (see page 18) and the bowels and bladder should be empty at the time of operation.

FIG. 834.—Shows the posterior cul-de-sac opened.

FIG. 835.—Shows the method of palpating a tumor through an incision into the posterior cul-de-sac.

Anesthesia.—General anesthesia is employed.

Technic.—The vaginal speculum is placed in the vagina and the posterior lip of the cervix is seized in bullet forceps which are given to an assistant to hold. The operator then picks up the posterior vaginal wall by means of thumb forceps at a point in the mid-line, just back of where it is reflected from the cervix, and with a pair of scissors makes a transverse incision about 1 inch (2.5 cm.) long through the vaginal wall (Fig. 833). The vaginal wall posterior to the incision is then separated by blunt dissection from the underlying peritoneum for a short space (Fig. 834). The peritoneum thus exposed is then picked up and a transverse opening, sufficiently large to admit the fingers, is made in it. Through this opening the pelvic structures may be thoroughly palpated by the finger (Fig. 835), and if desired the appendages may be brought down to view and inspected.

At the completion of the operation the opening in the peritoneum and that in the vaginal wall are closed by a few catgut sutures.

Therapeutic Measures

VAGINAL IRRIGATIONS

Vaginal irrigation, or douching, may be employed for simple cleansing purposes, as in leucorrhea or in preparation for operative procedures; for the purpose of bringing soothing, astringent, or antiseptic solutions in contact with diseased vaginal or cervical mucous membrane; and as a means of applying heat to the pelvic organs to relieve congestion or inflammation, to hasten involution after labor, to control uterine hemorrhage, etc. In pregnancy and during menstruation douches should be used with caution.

Apparatus.—There will be required a large glass irrigating jar or douche bag, a bath thermometer, 6 feet (180 cm.) of rubber tubing, 1/4 inch (6 mm.) in diameter, leading from the reservoir to the douche nozzle, a glass vaginal douche nozzle, and a douche pan with a spout to which is attached a piece of rubber tubing sufficiently long to convey the waste fluid to a slop pail (Fig. 836).

The douche nozzle should preferably be of glass *without any curve* and *having perforations on the sides*, but *with none at the end* (Fig. 837). With such an instrument there is little danger of the solution entering the uterus in cases of a patulous cervix.

Asepsis.—The greatest care should be taken against infection especially in puerperal cases. The apparatus should, therefore, be boiled for five minutes in plain water and the thermometer should be sterilized by immersion in a 1 to 500 bichlorid of mercury solution, after which it is rinsed in sterile water. The attendant's hands

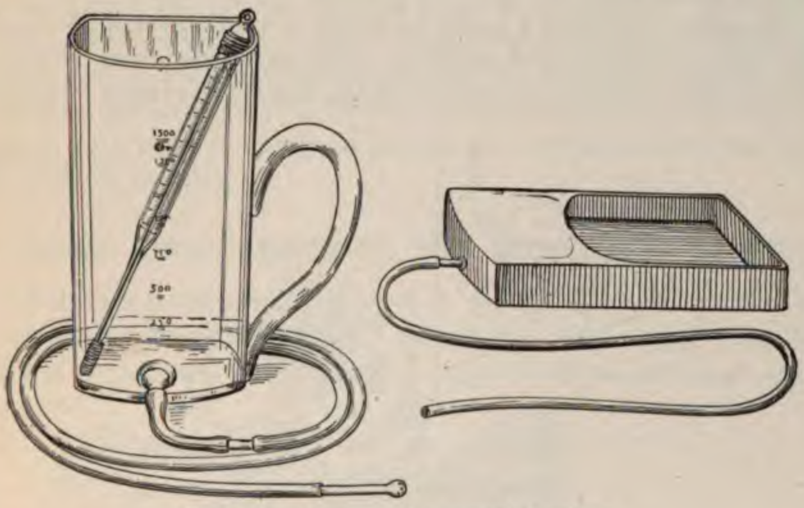


FIG. 836.—Apparatus for vaginal douching.

should be cleansed in the usual way and the external genitals should be washed with soap and water followed by a 1 to 2000 bichlorid solution. When the patient administers the douches herself, the dangers of infection and the proper means of avoiding it should be carefully explained to her.

FIG. 837.—Enlarged view of a glass vaginal douche nozzle.

Solutions Used.—Among the many solutions used for vaginal injection are the following: Plain sterile water; normal salt solution—salt ʒi (4 gm.) to the pint (500 c.c.) of boiled water; boric acid 2 per cent.; thymol 1 to 1000; lysol 1 per cent.; creolin 1 per cent.; tannic acid ʒi (4 gm.) to the quart (liter); alum acetate ʒi (4 gm.) to the quart (liter); permanganate of potash 1 to 2000; bichlorid of mercury 1 to 5000; carbolic acid 1 per cent., etc. *The* *use of poisonous drugs, such as the latter two, should be followed by a douche of sterile water or saline to avoid any danger of absorption.*

Temperature.—Ordinarily the irrigation is given at a temperature of 100° to 105° F. (38° to 41° C.). When the stimulating and vascular constricting effect of heat is desired, however, the temperature should be from 115° to 120° F. (46° to 49° C.).

Quantity.—At least 1 gallon (4 liters) of solution should be used at a time. If it is desired to obtain a prolonged effect from the heat, several gallons may be used over a period of fifteen to thirty minutes.

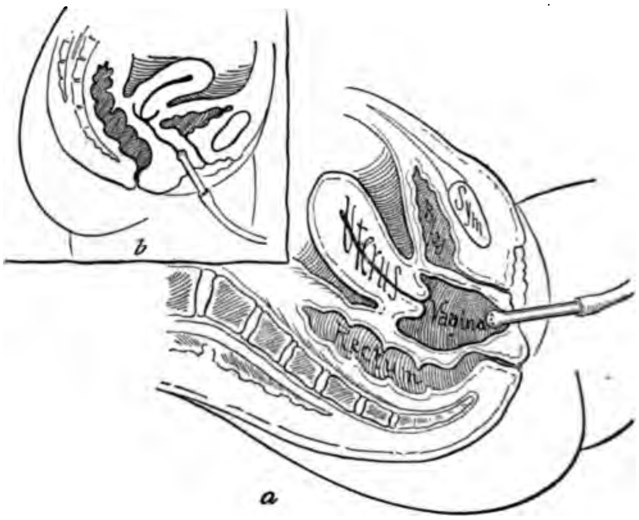


FIG. 838.—Showing the correct (*a*) and the incorrect (*b*) method of giving a vaginal douche. (Ashton.)

Height of Elevation.—This is important, since, if the reservoir is elevated too high, the pressure will be so great that solution may be forced into the uterus. An elevation of 2 to 3 feet (60 to 90 cm.) is amply sufficient.

Frequency.—This will depend upon the purposes of the douche from once a day to three or more times daily.

Position of Patient.—The patient lies in bed on a douche pan in the dorsal position, with the knees flexed, or else recumbent in a bath tub. *The douche should not be taken with the patient sitting on the toilet.*

Technic.—The labia are widely separated with the finger of the left hand and with the right hand the nozzle is introduced into the vagina, first, however, allowing the solution to flow in order to expel any air or cold fluid. The desired amount of solution is then permitted to enter the vagina which balloons up under the influence of the distention and thus allows the solution to come in contact with its entire surface (Fig. 838).

In cases of a relaxed vagina, it is necessary to compress the vaginal outlet about the douche tube in order to obtain this distention. This procedure should, however, be used with caution in puerperal cases, for, if the intravaginal pressure be too great, some of the solution will necessarily be forced into the uterus. During the irrigation care must be taken to protect the patient's body from cold by suitable covering.

LOCAL APPLICATIONS TO THE VAGINA AND CERVIX

Local applications are employed in treating inflammations of the vagina and the vaginal portion of the cervix. They may be made by means of cotton-tipped applicators or by tampons (see page 837).

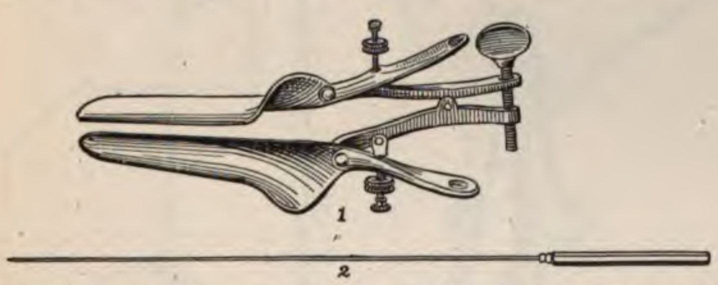


FIG. 839.—Instruments for making local applications to the vagina. 1, Bivalve speculum; 2, applicator.

The former method should be employed when it is desired to medicate localized areas of inflammation or ulceration or to employ strong solutions.

Instruments.—There will be required a bivalve vaginal speculum and a metal applicator or a pair of dressing forceps (Fig. 839).

Asepsis.—The instruments are boiled in a 1 per cent. soda solution for five minutes and the external genitals are cleansed with soap and water followed by a 1 to 2000 bichlorid of mercury solution. The operator's hands should likewise be clean.

Solutions Used.—Tincture of iodin, silver nitrate gr. xx to xxx (1.3 to 2 gm.) to the ounce (30 c.c.), argyrol 50 per cent., copper sulphate gr. v to xx (0.3 to 1.3 gm.) to the ounce (30 c.c.), zinc sulphate gr. v to xx (0.3 to 1.3 gm.) to the ounce (30 c.c.), etc., are among the solutions generally employed.

Frequency.—Applications may be made

Position of Patient.—The patient shoul the dorsal position.

Technic.—The diseased area is exposed and, after removing any mucus or secretior to medicate is wiped dry. An applicator or with cotton is then dipped in the solution a thoroughly rubbed over the diseased area. vaginal tampon is inserted and allowed to r twenty-four hours.

APPLICATION OF POWDERS T

Powders are sometimes employed with s in the treatment of chronic vaginitis, espec are present.

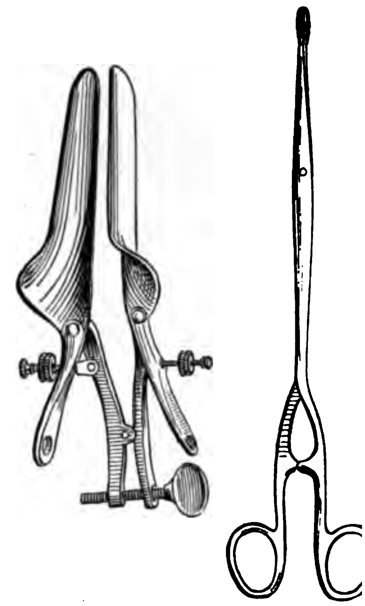


FIG. 840.—Instruments or the application of powde speculum; 2, dressing forceps; 3, pov

Instruments.—A vaginal speculum, c powder blower are required (Fig. 840).

Formulary.—Soothing or astringent pov zinc oxid, bismuth subnitrate, calomel, tanr nin, acetanilid, alone or in combination, ar

Position of Patient.—The patient should be in the dorsal posture.

Technic.—The vagina is first well cleansed with a douche. A speculum is then inserted and, by means of a cotton swab held in a dressing forceps, the mucous membrane is thoroughly dried. The entire inflamed surface is then coated with the desired powder applied by means of the powder blower. A light tampon is finally inserted and is left in place for twenty-four hours.

VAGINAL TAMPONS

Vaginal tampons are used for a variety of purposes, namely, to bring medication in contact with the vagina or the cervix in the treat-

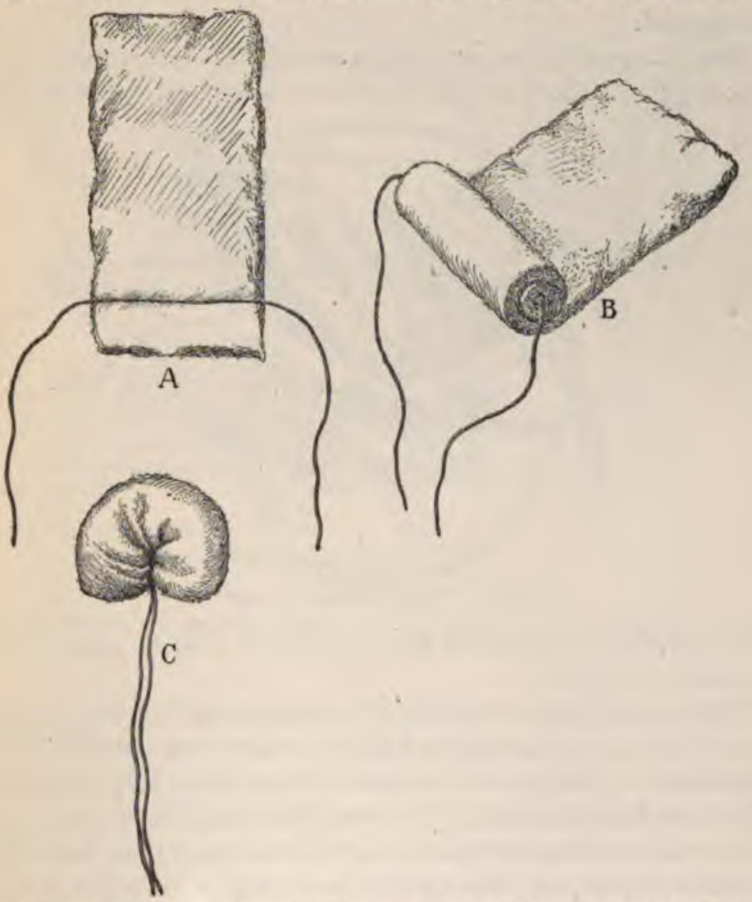


FIG. 841.—Showing the method of making a cotton vaginal tampon. (Kelly and Noble.)

ment of inflammations involving these structures, to protect and keep separated inflamed or ulcerated vaginal walls, to apply glycerin for its depleting effect upon the uterus and pelvic organs, to support a prolapsed ovary, for the purpose of stretching adhesions or supporting the uterus by distention of the vagina and fornices, and alone or in combination with the uterine pack to control hemorrhage from the uterus.

Tampons should not be left in place more than twenty-four hours, as they tend to become foul and offensive, and strings should aways be attached so that they may be removed by the patient. The patient should, of course, be informed of the exact number of tampons inserted.

Instruments.—Bivalve and Sims' specula and dressing forceps are required.

The Tampon.—Tampons are made of absorbent cotton, lambs' wool, or gauze. For carrying medication absorbent cotton is preferable, while for purposes of support lambs' wool or gauze, having more body, are best.

FIG. 842.—Vaginal tampons in position.

The cotton tampon is made by cutting a flat layer of absorbent cotton into an oblong shape, placing a heavy silk string about 14 inches (35 cm.) long, across one end as shown in Fig. 841, and rolling the cotton about the string. On tying the string the two ends of the cotton roll are brought together and, at the same time, the string is buried in and securely fastened to the cotton.

Lambs' wool tampons may be made in the same manner or a silk string may be simply tied to the center of a wad of the wool.

A gauze tampon should consist of a single piece of gauze 3 feet (90 cm.) or more long, depending on the capacity of the vagina and the firmness with which it is to be packed, and folded to a width of about 2 inches (5 cm.).

The Medicated Tampon.—The tampon is made as above described and is then saturated with the desired medication. For this purpose the following drugs are employed: Ichthyol and glycerin 25 per cent., boroglycerid, glycerite of tannic acid 20 per cent., argyrol 10 to 25 per cent., protargol 2 per cent., etc. When indicated, the tampon may be covered with some of the powders mentioned on page 836 in place of these solutions.

Asepsis.—The instruments should be boiled and the tampons thoroughly sterilized. The external genitals are washed with soap

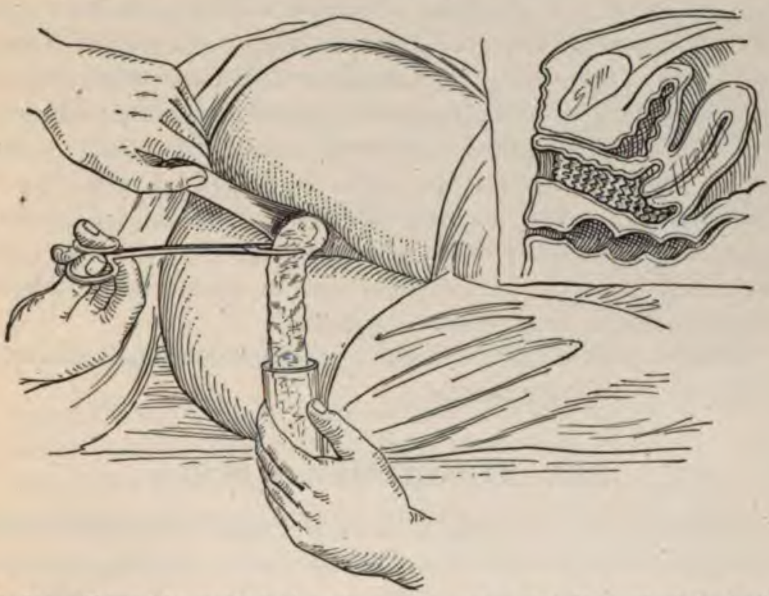


Fig 843.—Shows the method of packing the vagina with the patient in the Sims position.

and water followed by a 1 to 2000 bichlorid of mercury solution. The operator's hands are cleansed in the usual way.

Position of Patient.—For inserting the medicated tampon the patient may be in the dorsal posture, but, when it is desired to thoroughly pack the vaginal vault for the purposes of support and to control hemorrhage, the Sims or the knee-chest posture is preferable.

Preparations of Patient.—The bladder and bowels should be empty. Any clots or secretions are wiped from the vagina and the entire vagina is then swabbed out with a 1 to 2000 bichlorid of mercury solution.

Technic.—For applying a medicated tampon a bivalve speculum is inserted and the tampon, soaked in the medicament, is carried in dressing forceps to the desired spot. A wool tampon is then inserted to retain the first one in position and, while the tampons are held securely in place by means of the dressing forceps, the speculum is removed, care being taken that the strings attached to the tampons are left hanging from the vagina (Fig. 842).

The tampon is to be removed by the patient within twenty-four hours, at which time a cleansing douche should be taken.

To thoroughly pack the vagina, as is necessary, for example, for the control of hemorrhage, the patient being in the Sims or the knee-chest posture, a Sims speculum is inserted and the posterior vaginal wall is put upon the stretch. Then, by means of a pair of dressing forceps, the entire vagina is thoroughly tamponed with a strip of gauze, beginning with the posterior vaginal fornix, then filling the lateral and anterior fornices, and, as the rest of the vagina is packed, gradually withdrawing the speculum (Fig. 843). A T-bandage is then applied to retain the pack in place. Such a pack properly inserted will control any ordinary hemorrhage from a nonpuerperal uterus, but in severe hemorrhages and in postpartum cases the uterus also should be tamponed (page 847).

Removal of the packing in twelve or twenty-four hours should be followed by a cleansing douche.

THE INTRAUTERINE DOUCHE

Uterine douches are employed in the treatment of septic conditions affecting the uterus, to control hemorrhage, and for cleansing the uterus after curettage and other intrauterine operations. Certain precautions in their use are necessary. They should always be given by the physician himself and the same care and attention to cleanliness should be observed as in any operative procedure. It is absolutely essential that a free and unimpeded return of the solution be provided by having the cervix well dilated or by employing a return-flow irrigating nozzle, otherwise there is danger of overdistention of the uterus with resulting shock or of the fluid being forced into the tubes. Furthermore, *the use of poisonous drugs, such as carbolic acid or bichlorid of mercury, should always be followed by an intrauterine irrigation of sterile water or of normal salt solution.*

Apparatus.—There will be required a glass irrigating jar or a large douche bag, a thermometer, 6 feet (180 cm.) of rubber tubing, 1/4 inch (6 mm.) in diameter, connecting the reservoir and the douche nozzle, a douche pan with a spout to which is attached a piece of rubber tubing sufficiently long to convey the returning fluid to a waste pail (see Fig. 836).

There are several forms of intrauterine douche nozzles. When the cervix is widely dilated, as in postpartum cases, a curved glass

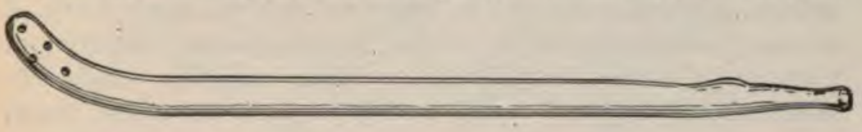


FIG. 844.—Glass intrauterine douche nozzle.

nozzle with the openings upon the sides, such as the Chamberlain tube (Fig. 844), is sufficient.

In other cases it is necessary to employ some form of return-flow nozzle. The Fritsch-Bozeman nozzle (Fig. 845) is the safest of these.

FIG. 845.—Fritsch-Bozeman return-flow uterine douche nozzle. (Bandler.)

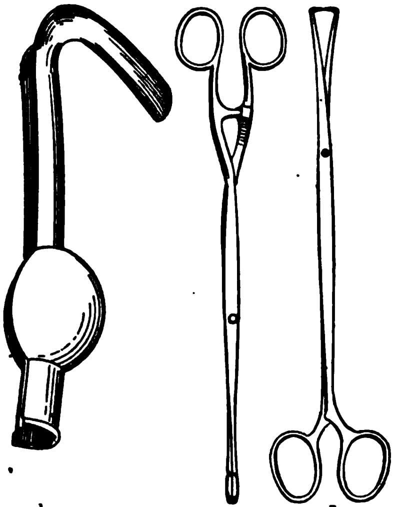
It consists of an outer tube fenestrated near the tip, with a second opening upon the under surface of the instrument near its lower end for the return flow. Inside this outer tube is a smaller inflow tube. This instrument requires some dilatation of the cervix, however,

FIG. 846.—Return-flow dilating catheter. (Ashton.)

before it can be introduced and where this is lacking a smaller instrument, such as Talley's intrauterine catheter (Fig. 846), may be employed. The latter consists of a curved metal catheter with two heavy wires on its under surface, which may be expanded or closed by turning a small thumb-screw. The catheter is introduced into the uterus with the wires lying close to the catheter and, when in the uterus, the wires are expanded, thereby dilating the cervix sufficiently to permit a return of the injected solution.

Instruments.—In addition to the above apparatus a vaginal speculum, a sponge holder, and a pair of bullet forceps are required (Fig. 847).

Asepsis.—The apparatus and instruments should be sterilized by boiling and the thermometer by immersion in a 1 to 500 bichlorid of mercury solution followed by rinsing in sterile water. The external genitals are first washed with soap and water and then with a 1 to 2000 bichlorid of mercury solution. The vagina is cleansed by means



1 2 3

FIG. 847.—Instruments for intrauterine douching. 1, Garrigues' weighted speculum; 2, sponge holder; 3, tenaculum.

of a 1 to 5000 bichlorid of mercury douche, followed by sterile water. The operator's hands are sterilized in the usual way.

Solutions Used.—Plain sterile water, normal salt solution—salt ʒi (4 gm.) to the pint (500 c.c.) of water, 1 to 10,000 to 1 to 5000 bichlorid of mercury, 50 per cent. alcohol, 0.5 per cent. solution of lysol, 0.5 per cent. solution of creolin, silver nitrate 1 to 1000, etc., etc., are among the solutions employed.

Temperatures.—Ordinarily the temperature of the solution is about 105° F. (41° C.). Where the stimulating and constricting effect of heat is desired, the temperature of the solution should be 115° to 120° F. (46° to 49° C.).

Quantity.—About 1 quart (1 liter) of solution is used at a time.

Rapidity of Flow.—The fluid should not be allowed to enter the uterus more rapidly than it can escape, otherwise there is danger of its

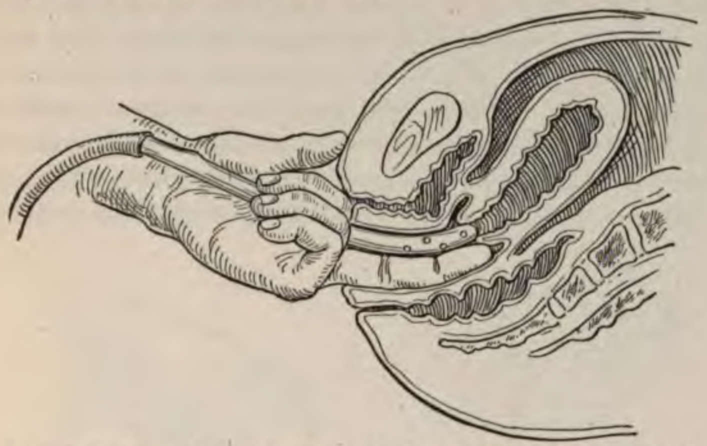


FIG. 848.—Inserting the douche nozzle when the cervix is well dilated.

being forced into the tubes. Therefore, the reservoir should not be elevated more than 2 feet (60 cm.).

Position of Patient.—The patient should be in the dorsal position.

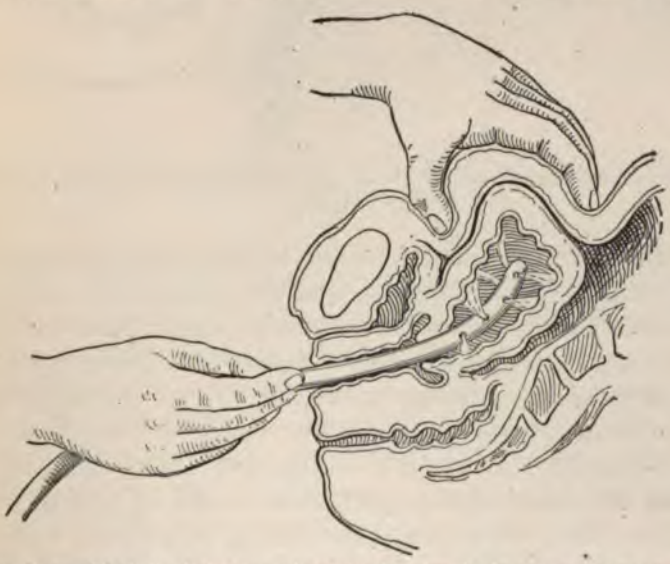


FIG. 849.—Method of giving an intrauterine douche in a postpartum case.

Tecnnic.—If the cervix is well dilated so that the entrance of the douche nozzle is not interfered with, the latter may be inserted by touch alone, as follows: One or two fingers of the left hand are passed into the vagina and the external os is thus located. The douche nozzle, with the solution flowing so as to avoid injecting any air, is then inserted into the uterus by the right hand, being guided through the cervix by the fingers of the left hand (Fig. 848). The nozzle is then gently passed to the fundus of the uterus and the cavity is thorougly irrigated. The return flow must be carefully watched to see that it is not obstructed, It is well to place the left hand externally over the fundus uteri in puerperal cases to prevent any possible over distention of the uterus and opening up of the sinuses (Fig. 849).

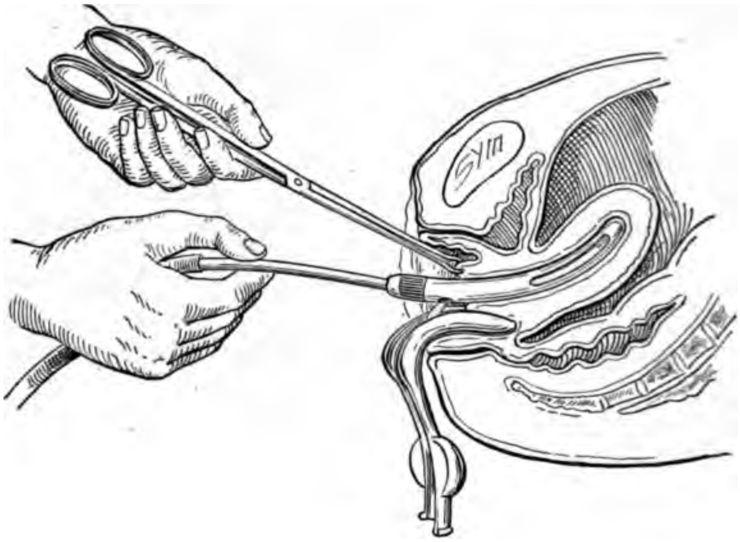


FIG. 850.—Shows the method of giving an intrauterine douche with a return-flow nozzle.

To introduce the douche nozzle by sight, the posterior vaginal wall is retracted by means of a speculum, and, if the cervix is not readily accessible, it is drawn down into the vagina by means of bullet forceps caught in its anterior lip. The cervix is then wiped off by means of a swab on a sponge holder wet with a 1 to 2000 bichlorid of mercury solution, and a return-flow nozzle is inserted by direct sight, taking care to have the solution first flowing (Fig. 850). In inserting the nozzle extreme gentleness should be used to avoid injuring the tissues or possibly perforating the uterus. The latter accident has happened frequently enough to warrant this caution.

INTRAUTERINE APPLICATIONS

The application of drugs with an astringent or caustic action to the mucous membrane of the uterus is employed in the treatment of endometritis alone or in conjunction with curettage. The best results are obtained, however, when intrauterine applications are used after a preliminary curettage.

The indiscriminate employment of intrauterine applications often do more harm than good. They should only be employed in cases where thorough asepsis can be obtained, and then only with the cervix sufficiently dilated to allow thorough subsequent drainage. The procedure, therefore, is one that rises to the dignity of an operation and should not be attempted as a part of the office treatment.

FIG. 851.—Instruments for making intrauterine applications. 1, Garrigues weighted speculum; 2, sponge holder; 3, tenaculum; 4, applicator.

The position and size of the uterus and the condition of the other pelvic organs must be determined by bimanual examination beforehand. In the presence of adnexal involvement or other complications intrauterine applications are contraindicated.

Instruments.—There should be provided a vaginal speculum, sponge holders, bullet forceps, and two uterine applicators (Fig. 851).

Asepsis.—The instruments are boiled for five minutes in a 1 per cent. soda solution. The external genitals are washed with soap and water followed by a 1 to 2000 bichlorid solution. The vagina is douched with a 1 to 5000 bichlorid of mercury solution followed by sterile water. The operator's hands are likewise sterilized as for any operation.

Solutions Used.—Sulphate of zinc 5 to 10 per cent., chlorid of zinc 5 to 10 per cent., silver nitrate 5 to 10 per cent., perchlorid of iron 5 per cent., ichthyol 5 to 10 per cent., tincture of iodin 50 per cent., Churchill's solution of iodin, pure carbolic acid, etc., etc., may be employed.

Position of Patient.—The patient is placed in the dorsal position.

Technic.—The vaginal speculum is inserted and the cervix is drawn down into view by means of bullet forceps which seize the anterior lip. Any secretion or collection of mucus is then wiped away

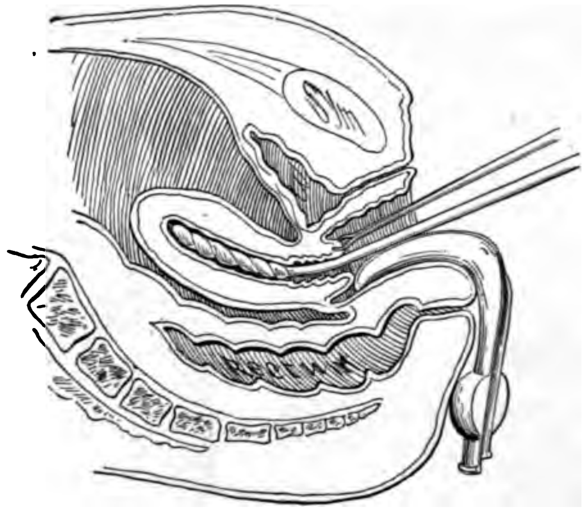


FIG. 852.—Shows the method of making an intrauterine application.

from the external os by means of a swab soaked in a 1 to 2000 bichlorid solution, and the cervix is dilated if necessary (see page 864). A small thin layer of dry cotton is then securely wound round an applicator, taking care that the tip of the instrument is well covered. The swab thus fashioned is to be of such size that it will readily pass the cervix. The applicator is curved to the shape of the canal and is passed into the uterus for the purpose of removing any secretions and thus allow the solution to come in contact with all portions of the mucous membrane. A second applicator, similarly wrapped with cotton, is dipped in the solution. Any excess of fluid is squeezed from the cotton and the application is then made to the interior of the uterus, carrying the cotton-tipped applicator well up to the fundus and moving the instrument about in the cavity (Fig. 852). A vaginal tampon is finally inserted, which is removed in twenty-four hours. The patient should remain quiet for a day or two, and, if a strong caustic has been employed, she should be warned that at first there will be an increased discharge.

TAMPONING THE UTERUS

Tamponage of the uterus may be required to control severe uterine hemorrhage, to secure dilatation of the cervix for the expulsion of the uterine contents or in preparation for intrauterine manipulations, and to aid in the separation of retained products of conception. The technic of tamponing the uterus for the control of hemorrhage is

FIG. 853.—Instruments for tamponing the uterus. 1, Garrigues' speculum; 2, sponge holder; 3, tenaculum; 4, uterine dressing forceps; 5, uterine packer.

something with which every physican should be familiar, as occasions may arise when the operation is demanded without delay as a life-saving measure; at the same time it should be regarded as a surgical procedure and one that should always be performed under thorough aseptic precautions. The position and size of the uterus should be ascertained by bimanual examination beforehand, otherwise the uterus may be injured in attempting to insert the packing.

Instruments.—A Simon or a Garrigues speculum, sponge holders, two bullet forceps, a pair of uterine dressing forceps, or a cannula and packer are required (Fig. 853). In the majority of cases a pair of curved dressing forceps may be employed for inserting the packing, but, where the cervix is not well dilated, a special packer, such as is shown in Fig. 854, by means of which the packing is pumped into the uterus through the cannula, is more convenient.

Packing Material.—The most satisfactory material to employ for packing is sterilized gauze. This should be folded into strips 2 inches (5 cm.) wide for use when the cervix is well dilated and into strips ½ inch (1 cm.) wide for an incompletely dilated cervix. Care should be taken to see that the strips are so folded that no

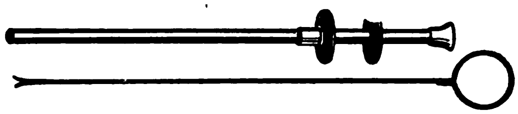


FIG. 854.—Showing the cannula and plunger of the uterine packer separated.

frayed edges are exposed. The gauze is best kept in long strips packed in sterile glass tubes.

Asepsis.—The instruments are boiled for five minutes in a 1 per cent. soda solution. The patient's external genitals are washed with

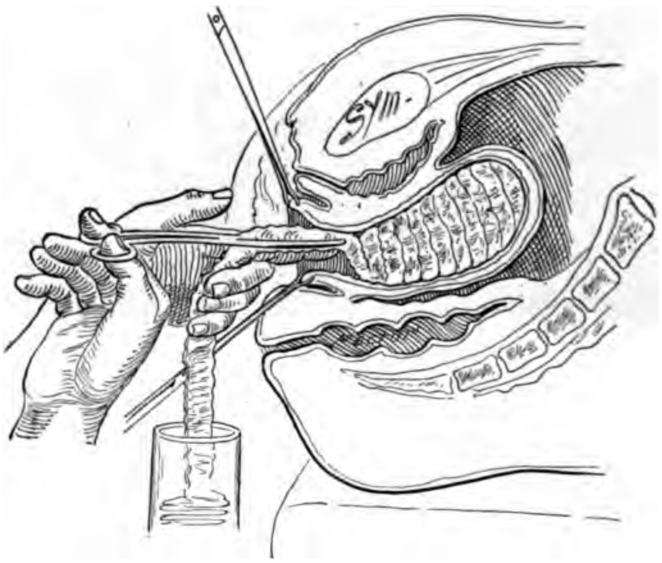


FIG. 855.—Method of tamponing the uterus with a long strip of gauze inserted by means of dressing forceps.

soap and water, followed by a 1 to 2000 bichlorid solution and the vagina is first cleansed with soap and water and then douched with a 1 to 5000 solution of bichlorid of mercury. The operator's hands are sterilized as for any operation.

Position of Patient.—The patient should be in the lithotomy position.

Preparations of Patient.—The patient's bladder and bowels should be empty.

Technic.—Any clots are first wiped out of the vagina. The cervix is exposed by means of the speculum and the anterior and posterior lips are seized in bullet forceps which are given to an assistant to hold. A strip of gauze is then seized in dressing forceps in such a way that the gauze falls over the end of the forceps so as to avoid inflicting any injury upon the tissues and is carried to the fundus. Successive sections of the gauze are inserted in the same manner until the cavity is filled (Fig. 855). Whenever possible, a *single strip of gauze* should be employed. While inserting the gauze the operator's

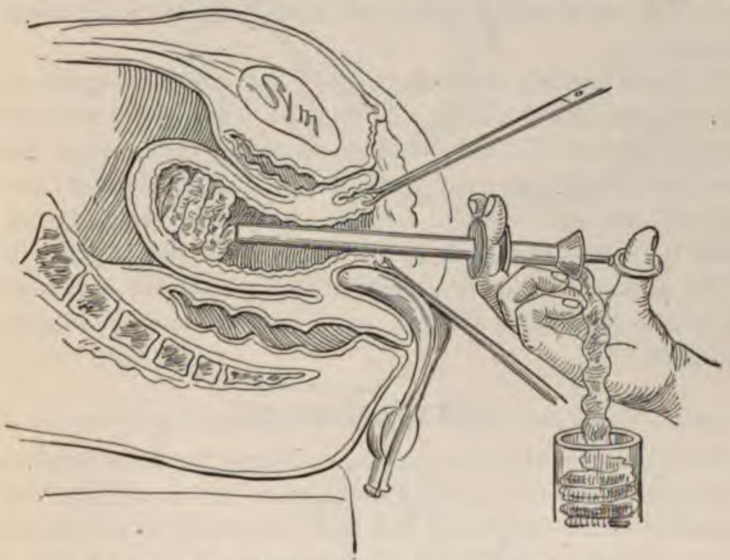


Fig. 856.—Method of using the uterine packer.

free hand should be kept upon the abdomen in order to control the uterus, and care should be taken that the gauze does not come in contact with anything that is not sterile. The end or ends of the gauze, if more than one strip is used, should be left projecting into the vagina, so that it may be easily found, when the gauze is to be removed, which should be within twenty-four hours of its insertion.

In cases of severe hemorrhage the vagina also should be packed (see page 837), taking care, however, to tie the vaginal strip to that within the uterus or else to bring the ends of both vaginal and uterine strips to the vaginal outlet. Upon removal of the gauze a vaginal douche should be given.

In tamponing the uterus by means of the special packer shown in Fig. 854, the cervix is exposed as before and is drawn down by means of bullet forceps. The cannula is then inserted into the uterus and a narrow strip of gauze is caught on the sharpened end of the piston and is carried into the uterus by a pumping motion of the piston (Fig. 856).

BIER'S HYPEREMIC TREATMENT IN GYNECOLOGY

Passive hyperemia by means of special forms of suction cups applied to the cervix uteri has been employed with good results in cases of puerperal and other forms of infection of the cervix and uterus, in ulcerations of the cervix, in chronic metritis, and in amenorrhea. The use of cups is contraindicated, however, if the adnexa are inflamed.

In dysmenorrhea there have been numerous favorable reports from the application of large suction cups to the breast once or twice a day for periods of fifteen to thirty minutes, beginning a few days before the date of expected menstruation and continuing the treatments till the end. Pelvic exudates have also been treated with success by means of hot-air boxes in which the pelvis and hips rest.

The apparatus for obtaining active and passive hyperemia, as well as the method of its use, have been previously described in Chapter X.

PELVIC MASSAGE

Pelvic massage after the method of Brandt has been employed for the purpose of hastening the absorption of pelvic exudates through stimulation of the circulation and lymph currents, to stretch or separate old adhesions, to stimulate contractions in the uterus, and to strengthen and tone up weakened or thickened pelvic ligaments. In certain selected cases this method of treatment has value. *Pelvic massage must never be employed, however, in the presence of acute inflammation or with pus collections in the tubes or pelvis*, so that the diagnosis must be carefully made in every case before it can be safely attempted, and then it should only be performed by the physician himself. In individuals with erotic tendencies it should be avoided.

Duration of Treatments.—The massage is performed for about ten minutes at a sitting.

Frequency.—Treatments are given daily.

Position of Patient.—The patient should be in the dorsal posture.

Preparations.—The bladder and bowels should be emptied beforehand and the clothing should be loosened from the abdomen

Technic.—Under all aseptic precautions two fingers of the left hand are introduced into the vagina and are carried up to the part to be massaged. Then, by means of the right hand placed on the abdomen, at first gentle circular movements and then deep pressure

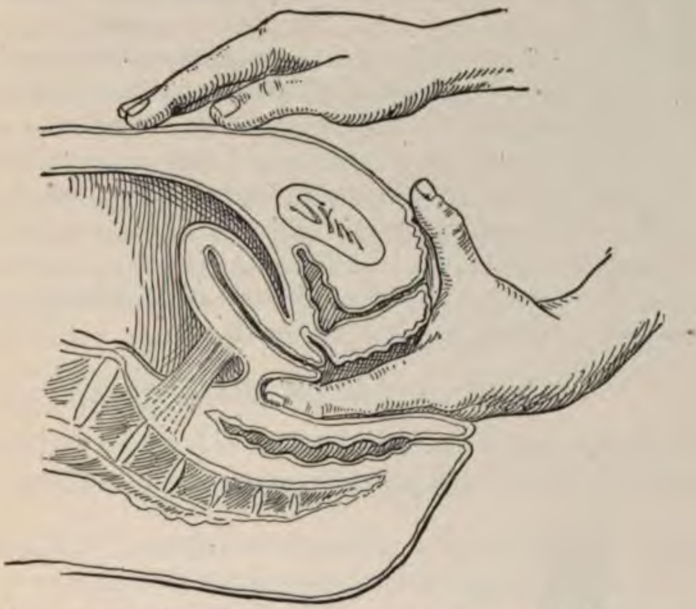


FIG. 857.—Showing the position of the hands in commencing pelvic massage.

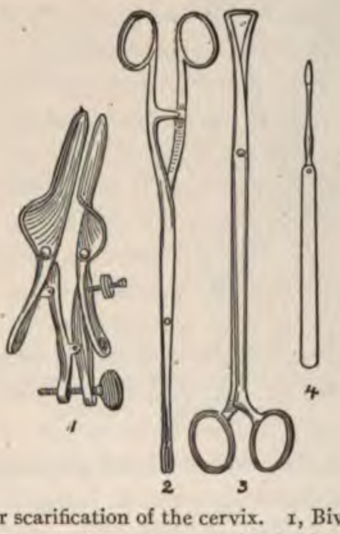


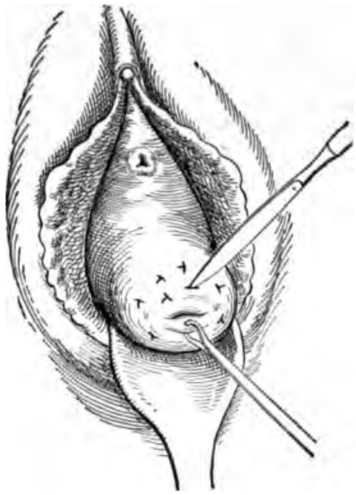
FIG. 858.—Instruments for scarification of the cervix. 1, Bivalve speculum; 2, sponge holder; 3, tenaculum; 4, narrow-bladed bistoury.

manipulations are made over the diseased part, which, at the same time, is raised and fixed within reach of the external hand by the internal fingers. The manipulations should be begun each time over the periphery of the diseased part and should always be made with the greatest care and with the absence of any approach to roughness.

When employed for the purpose of gradually stretching adhesions or contracted ligaments, gentle intermittent traction is applied to the uterus through the internal and external hands in a direction opposite to the point of the fixation (Fig. 857). By thus gradually stretching the adhesions and through the stimulating effect of the manipulations the fibrous tissue is gradually absorbed and the muscular and elastic tissues become regenerated. Such manipulations are especially useful when used in conjunction with hot douches and tampons in gradually replacing a uterus bound down by adhesions.

SCARIFICATION OF THE CERVIX

The withdrawal of blood from the cervix is a valuable therapeutic measure in cases of chronic congestion of the uterus and pelvic organs.



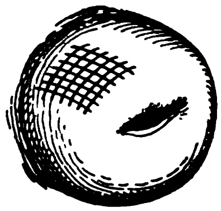


FIG. 859.—Method of scarifying the cervix by punctures. (Ashton.)
FIG. 860.—Scarification of the cervix, showing the method of making the superficial incisions. (Ashton.)

It is also employed with good results for the relief of the pain and colic of delayed menstruation due to pelvic congestion.

Instruments.—A vaginal speculum, sponge holders, bullet forceps, and a narrow-bladed bistoury are required (Fig. 858).

Asepsis.—All aseptic precautions should be observed. The instruments are to be boiled for five minutes in a 1 per cent. soda solution, and the hands of the operator are prepared as for any operation. The external genitals are cleansed with soap and water, followed by a 1 to 2000 bichlorid solution, and the vagina is douched.

Position of Patient.—The patient should be in the dorsal posture.

Technic.—The cervix is exposed by the speculum and, after being mopped off by means of a wipe moistened in a 1 to 2000 bichlorid solution, is seized by the bullet forceps and is drawn well down toward the vaginal outlet. Numerous punctures are then made by means of the point of the bistoury to the depth of ¼ to ½ inch (6 to 12 mm.) around the circumference of the cervix (Fig. 859), or, instead of punctures, cross cuts may be employed (Fig. 860). In this way from ½ ounce (15 c.c.) to 2 ounces (60 c.c.) of blood may be withdrawn. A tampon of ichthyol and glycerin or tannin and glycerin is then inserted into the upper portion of the vagina, to be removed within twleve hours.

PESSARY THERAPY

Pessaries are employed for the purpose of maintaining a retrodisplaced or prolapsed uterus in place and to support a cystocele. In the case of a prolapse of the uterus or a cystocele a pessary is only of value as a palliative measure where operative relief is refused or is undesirable on account of the age or condition of the patient. In a certain proportion of retrodisplacements, however, a properly fitted pessary will in time produce a cure, the most favorable cases being those in which the displacement is only of short duration as, for example, after confinement. The only cases of displacement in which pessary therapy is suitable are those where the pelvic floor has sufficient tonicity to give support to the pessary and where the displacement is not complicated by pelvic lesions. Their use is contraindicated in the presence of considerable enlargement or a prolapse of the ovary, hydrosalpinx, pyosalpinx, or new growths, and where the uterus is bound down by adhesions. Some cases of adhesions, however, under appropriate treatment by medicated tampons, hot douching, etc., may be so stretched, or even be made to disappear, that later a pessary may be satisfactorily employed.

Pessaries are not designed as a means of replacing a uterus, but simply to hold the organ suspended in proper position after it has been replaced. This it does by distending the vaginal walls, and not through any force exerted by the instrument upon the uterus itself. Every pessary should be fitted to the individual case, and it is here that the experience of the physician counts for much. When properly fitted, ***the pessary should never cause any pain or even make the patient conscious of its presence***, and it may be worn for years, with certain

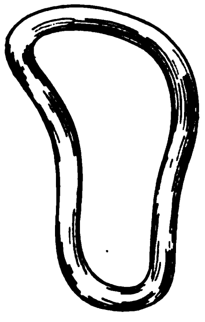


FIG. 861.—Hodge-Smith pessary.

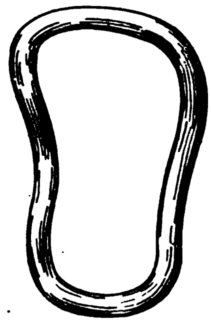


FIG. 862.—Hodge pessary.

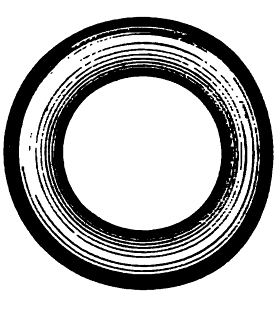


FIG. 863.—Ring pessary.

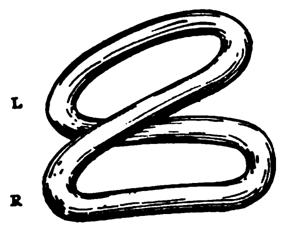


FIG. 864.—Gehrung's pessary.

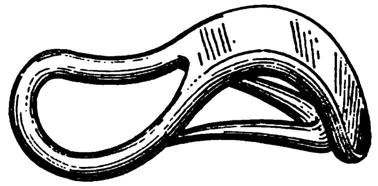


FIG. 865.—Skene's pessary.

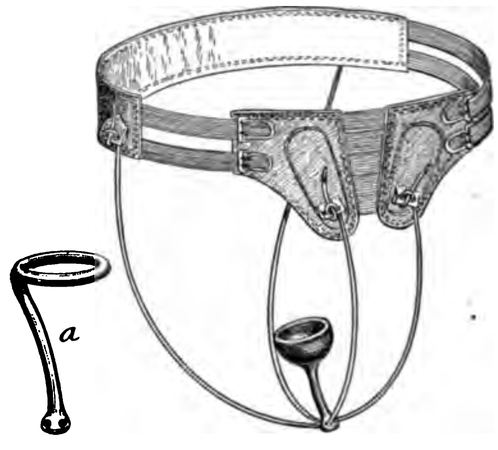


FIG. 866.—Cup or ring (*a*) pessary with external support. (Ashton.)

precautions as to cleanliness, to be mentioned later, without harm. On the other hand, an ill-fitting pessary or one employed in a case not suitable for such treatment is distinctly harmful. It should, therefore, always be impressed upon the patient that if the least pain or an undue amount of leucorrhea results from the insertion of the pessary, she should report to the physician immediately, or else remove the pessary herself.

Pessaries.—Pessaries are made of hard rubber in a great variety of shapes. For retrodisplacements the most commonly employed is the Hodge-Smith (Fig. 861). If, however, the pelvic floor is relaxed, a Hodge pessary (Fig. 862) is preferable, as its wide lower bar renders it less liable to slip out. This type of pessary acts in such a way that the force is exerted upon the posterior cul-de-sac and the uterosacral ligaments, so that the cervix is pulled backward and the uterus is thus tipped forward.

Ring pessaries (Fig. 863) are also employed in retrodisplacements where there is not sufficient support for the ordinary pessary. They act by so distending the vagina in all directions that the uterus is supported by the lower vaginal structures. The ring should be smooth and fairly thick, at least 1/4 inch (6 mm.), so as to avoid any danger of its eroding through the vaginal walls. The ring pessary is also employed for retaining a prolapsed uterus in place; but in many cases of prolapse, the perineum is so relaxed that the pessary immediately slips out, and some sort of pessary held in place by an abdominal support, such as is shown in Fig. 866, will be necessary.

For supporting a cystocele Gehrung's anteversion pessary (Fig. 864) or Skene's pessary (Fig. 865) is often used with success.

As previously stated the pessary should be fitted to each individual case. The shape of the pessary may be readily changed by first coating the instrument with oil or vaselin and then softening it by the heat of an alcohol lamp. When it has been moulded to the desired shape it is hardened again by immersion in cold water. The tendency is to employ too large a pessary, which is dangerous, as it may exert undue pressure upon the vaginal wall and produce excoriations, or in time even ulcerate through. On the other hand, if the pessary is too small, it will not remain in place. The safest plan is to measure the vagina in each case and shape the pessary accordingly. The depth of the vagina is determined by carrying two fingers as high as possible into the posterior cul-de-sac and measuring the distance from the inferior border of the symphysis, while the width is estimated by noting the distance to which the two fingers in the vagina may be separated. About 1/2 inch (1 cm.) should be deducted from the former measurement for the correct length of the pessary.

Asepsis.—The ring pessary may be sterilized by boiling, but the others, if so treated, lose their shape; prolonged immersion in some antiseptic solution, such as 1 to 500 bichlorid of mercury, should be employed instead. Instruments that may be required are boiled and the hands of the operator are sterilized in the usual manner.

Position of Patient.—For inserting the pessary the patient is ordi-

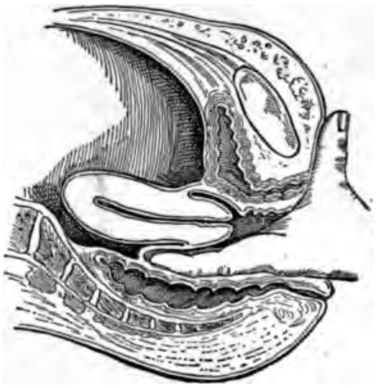


Fig. 867.—First step in replacing a retroverted uterus. (Ashton.)

narily placed in the dorsal posture, though in some cases the knee-chest position may be used to better advantage.

Preparations of Patient.—The bladder and bowels should be empty, and the clothing well loosened.

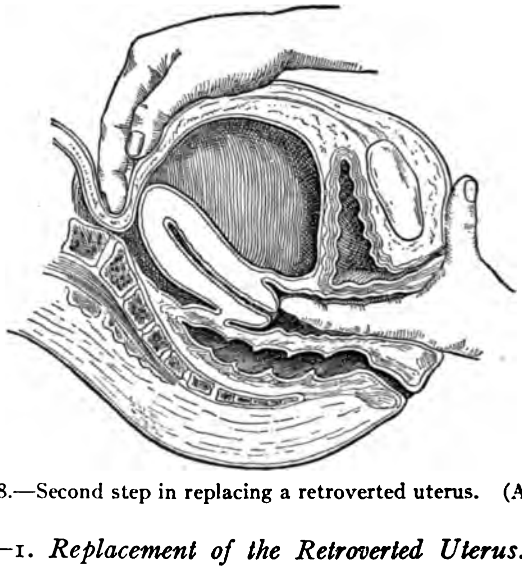


Fig. 868.—Second step in replacing a retroverted uterus. (Ashton.)

Technic.—1. *Replacement of the Retroverted Uterus.*—There are two methods of replacement: (1) By bimanual manipulation, and (2) with the patient in the knee-chest posture The former method is usually effective if the abdominal walls are not thick and rigid and the vagina is sufficiently roomy. It is performed as follows: Two fingers of the left hand are introduced into the vagina and are carried up into the posterior cul-de-sac where they exert pressure in an

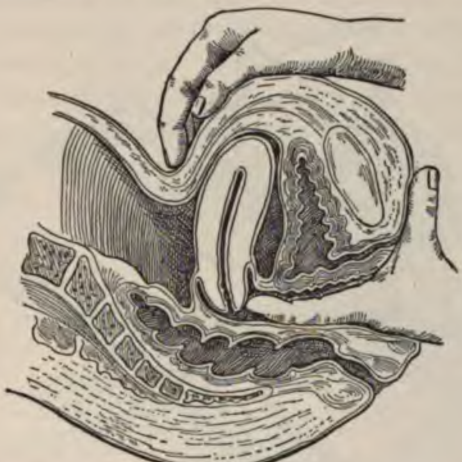


FIG. 869.—Third step in replacing a retroverted uterus. (Ashton.)

upward and forward direction upon the body of the uterus (Fig. 867). As the uterus is thus elevated, the right hand is placed upon the abdomen, and an attempt is made to hook the fingers behind the fun-

FIG. 870.—Second method of replacing a retroverted uterus. First step. (Kelly and Noble.)

dus (Fig. 868). The fundus is then pulled forward by the fingers of the external hand while the internal fingers are shifted to the anterior fornix, where they make backward pressure upon the cervix and the lower segment of the uterus (Fig. 869). Sometimes, however, it is not possible to raise the fundus past the promontory by this method. In such a case the anterior lip of the cervix should be

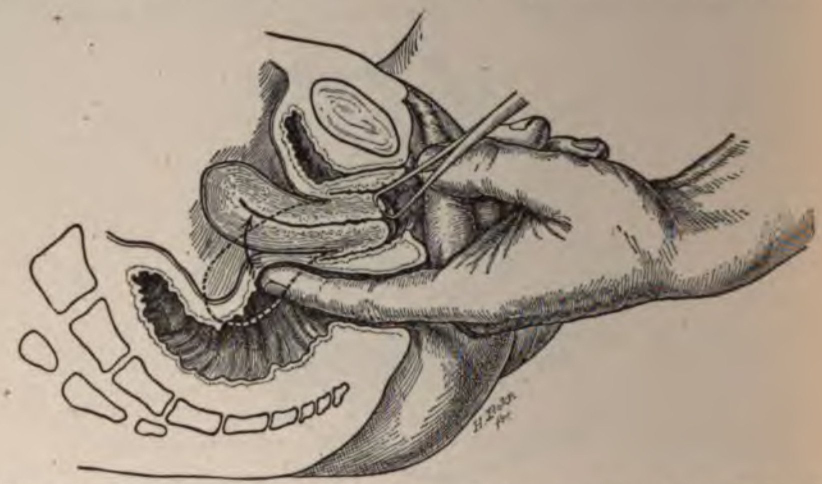


FIG. 871.—Second method of replacing a retroverted uterus. Second step. (Kelly and Noble.)

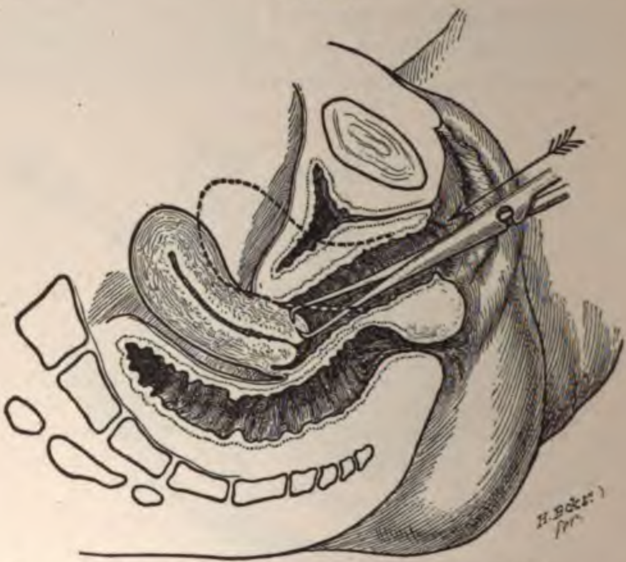


FIG. 872.—Second method of replacing a retroverted uterus. Third step.. (Kelly and Noble.)

grasped in bullet forceps, and the whole uterus is then pulled down toward the vaginal outlet (Fig. 870). At the same time the index-finger of the left hand covered with a glove is inserted into the rectum and the fundus is elevated past the promontory (Fig. 871). The cervix is then pushed backward (Fig. 872), the bullet forceps are removed, and reposition is completed bimanually as described above.

If these manipulations fail, the patient should be placed in the knee-chest posture and the posterior vaginal wall retracted by means of a Sims or Simon speculum. This frequently results in the uterus falling forward through the effect of gravity. If it does not, the cervix should be grasped with bullet forceps and pulled upward and outward toward the vaginal outlet, while the fundus is pushed forward by means of a pair of dressing forceps armed with a pledget of cotton carried up into the posterior cul-de-sac (Fig. 873). The

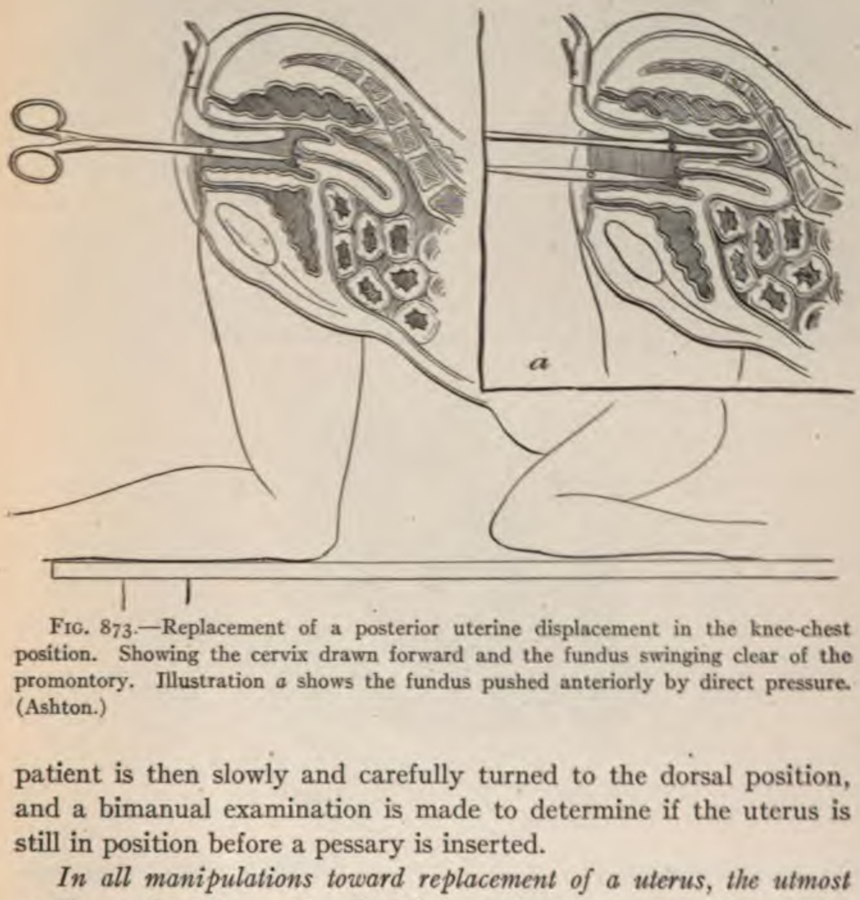


FIG. 873.—Replacement of a posterior uterine displacement in the knee-chest position. Showing the cervix drawn forward and the fundus swinging clear of the promontory. Illustration *a* shows the fundus pushed anteriorly by direct pressure. (Ashton.)

patient is then slowly and carefully turned to the dorsal position, and a bimanual examination is made to determine if the uterus is still in position before a pessary is inserted.

In all manipulations toward replacement of a uterus, the utmost gentleness should be employed. If the patient is very sensitive or the abdominal walls rigid, it is preferable to give a general anesthetic rather than employ force.

2. *Introduction of Pessaries.*—To insert the ordinary retroversion pessary, the left index-finger is carried into the vagina and the vaginal

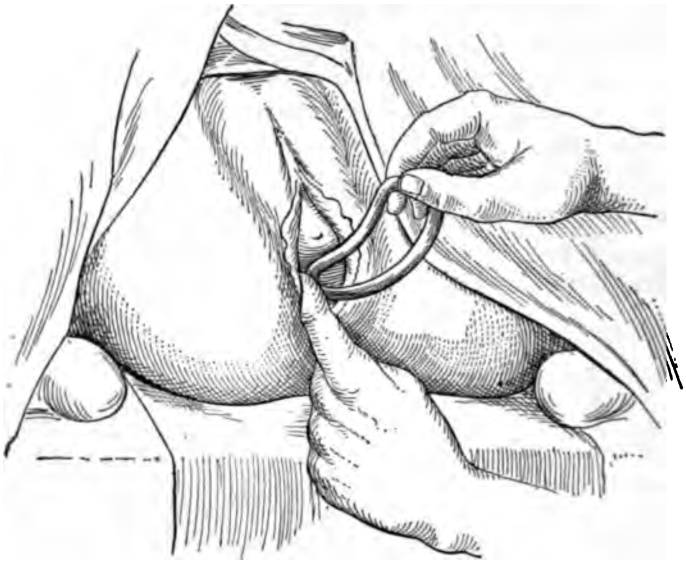


Fig. 874.—First step in introducing a retroversion pessary.

wall is retracted, while with the right hand, the pessary is introduced at first obliquely (Fig. 874), and then turned so that it lies transversely

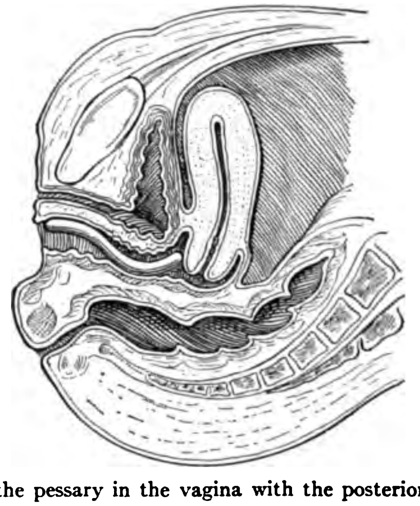


Fig. 875.—Showing the pessary in the vagina with the posterior bar in contact with the cervix. (Ashton.)

in the vagina (Fig. 875). The index-finger of the left hand is then shifted so that it lies under the anterior bar with its tip resting upon the posterior bar (Fig. 876). The posterior bar is then pressed downward and backward until it lies behind the cervix (Fig. 877). After the pessary has been introduced, the patient is examined while in the erect position to see if it fits properly. A properly fitting pessary

FIG 876.—Second step in introducing a retroversion pessary, depressing the posterior bar and inserting it behind the cervix. (Ashton.)
FIG. 877.—Showing the retroversion pessary in place. (Ashton.)

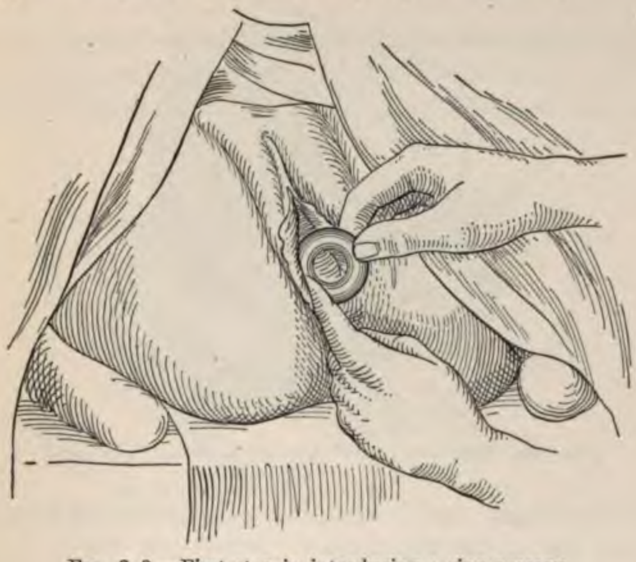


FIG. 878.—First step in introducing a ring pessary.

should hold the uterus in place and at the same time should not be so tight that the examining finger cannot be passed between the vaginal walls and the pessary on all sides.

The ring pessary is introduced in much the same way, that is, the left index-finger retracts the posterior vaginal wall while with the fingers of the right hand the pessary is introduced obliquely into the vagina (Fig. 878). It is then turned transversely and is manipulated

FIG. 879.—Shows the ring pessary in place.

FIG. 880.—Showing Skene's pessary in place. (Ashton.)

by the internal fingers until it lies in proper position with its opening surrounding the cervix (Fig. 879).

Skene's cystocele pessary is introduced into the vagina in the same manner as the retroversion pessary, with the posterior bar lying behind the cervix, and the broad anterior bar supporting the bladder (Fig. 880).

Gehrung's cystocele pessary is more difficult to introduce. The following method is employed: The pessary is placed upon a table in such away that it rests upon its inferior arch, with the two curves,

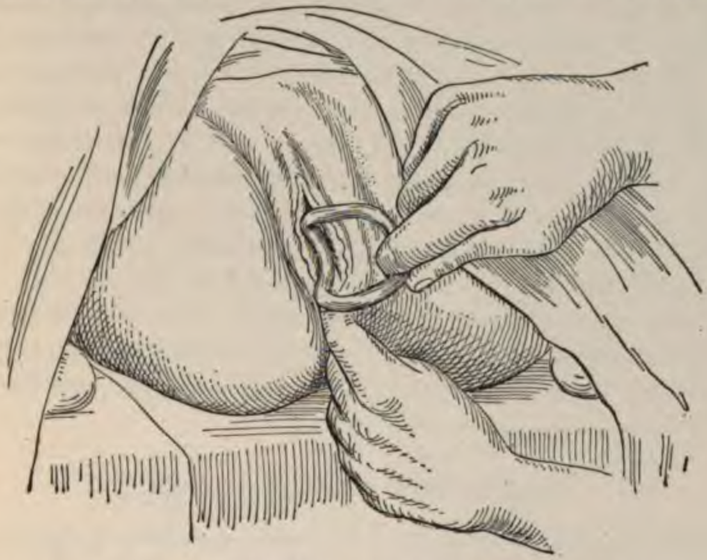


FIG. 881.—First step in introducing Gehrung's pessary.

right and left, facing toward the operator, who then grasps the curve L between the thumb and forefinger of the right hand, and inserts curve R into the right side of the vagina (Fig. 881) and then curve L

FIG. 882.—Gehrung's pessary in position.

into the left side. The pessary is then manipulated into such position, that the superior arch lies up in front of the uterus, the inferior arch under the pubic arch, and the two curves R and L on the posterior vaginal wall (Fig. 882).

After-care.—Within three or four days after introduction of the pessary, the vagina is inspected to determine whether there is any erosion from undue pressure of the pessary. The patient is then examined once every month or six weeks, at which time the pessary is removed and well cleansed before re-insertion and the vagina is examined for signs of ulceration, which, if present, necessitate the removal of the pessary and the substitution of medicated tampons until healing has been effected. Once a week and after each menstrual period the patient should take a warm boric acid or soapsuds douche for cleansing purposes, while, if there is irritation from the presence of the pessary, a daily douche should be administered. In cases where the displacement is accompanied by considerable uterine congestion and enlargement, a hot vaginal douche should be given night and morning (see page 832). In all cases the physician should impress upon the patient the necessity of reporting if at any time the pessary causes any pain or discomfort.

DILATATION OF THE CERVIX

Dilatation of the cervix, while a small operation, is one of considerable importance, as it forms a part of many gynecological pro-

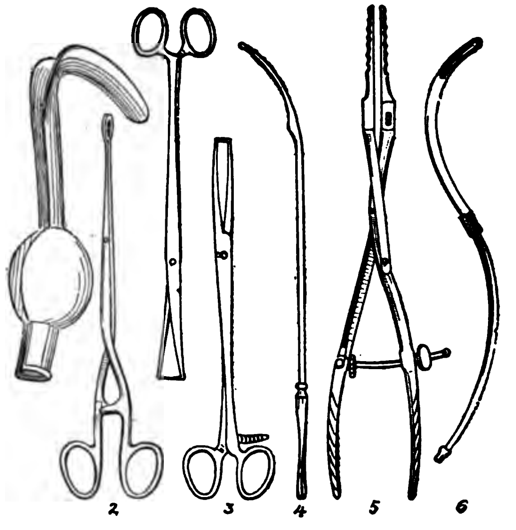


FIG. 883 —Instruments for dilating the cervix. 1, Garrigues' speculum; 2, sponge holder; 3, tenaculum; 4, uterine sound; 5, Goodell dilators; 6, Fritsch-Bozeman return-flow irrigator.

cedures. Thus it may be required as a preliminary to exploration of the interior of the uterus, intrauterine irrigations and applications, curettage, and to secure sufficient dilatation for the extraction of retained secundines following an incomplete abortion. Dilatation of the cervix is also employed for the cure of dysmenorrhea and sterility dependent upon cervical stenosis. The operation should always be performed under all aseptic precautions and after the position of the uterus and the condition of the appendages have been first determined by bimanual examination. Pelvic peritonitis, pelvic abscess, pyosalpinx, etc., are contraindications to dilatation, unless the procedure is to be immediately followed by operative treatment of these conditions.

There are two methods of performing dilatation: (1) Gradual dilatation by means of sponge, laminaria, or tupelo tents, and (2) rapid dilatation. The former method, besides being painful, is no longer looked upon with favor on account of the dangers of infection and will not be described.

FIG. 884.—Hegar's graduated dilators. (Bandler.)

Instruments.—A self-retaining speculum, a sponge holder, two bullet forceps, a uterine sound, two pairs of Goodell's dilators (a small and a large size), and a Fritsch-Bozeman return-flow irrigator are required (Fig. 883). Some operators prefer to employ graduated sound dilators, such as Hanks' or Hegar's (Fig. 884), in place of the glove stretcher form of dilator, as producing less laceration of the cervical tissue.

Asepsis.—The instruments are boiled in a 1 per cent. soda solution for five minutes and the operator's hands are thoroughly cleansed.

Position of Patient.—The patient should be in the lithotomy posture.

Anesthesia.—While the operation may be performed under local anesthesia by infiltrating the cervical tissue with a 0.2 per cent. solution of cocain or a 1 per cent. procain solution, and inserting a pledget of cotton saturated with a 4 per cent. solution of cocain into the cervical canal, general anesthesia will be found preferable in the majority of cases.

Preparations of Patient.—The bladder and bowels are to be empty. The hair is shaved or closely cut from the labia and the external genitals are washed with soap and water followed by a 1 to 2000 bichlorid solution. The vagina is then washed with soap and water by the aid of a swab on a sponge holder and this is followed by a douche of 1 to 5000 bichlorid.

Technic.—The speculum is introduced into the vagina and the anterior cervical lip is seized by bullet forceps and is drawn toward

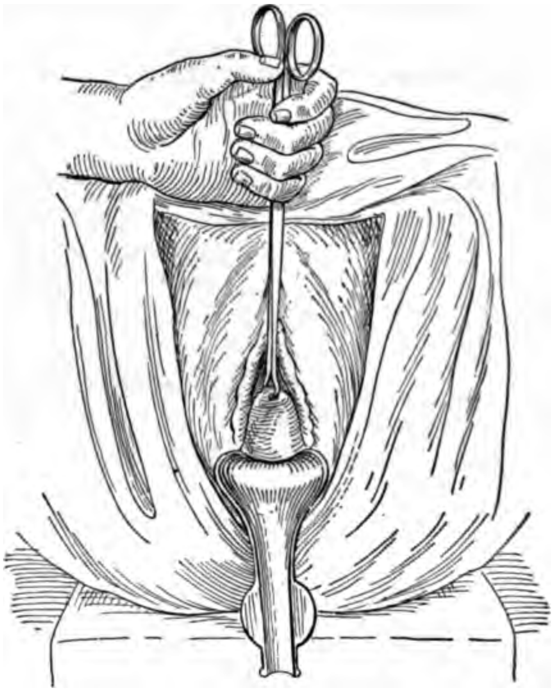


FIG. 885.—First step in dilatation of the cervix. The cervix exposed and drawn down by a tenaculum.

the vaginal orifice (Fig. 885). The cervix is then swabbed with a 1 to 2000 bichlorid solution. A sound is next introduced for the purpose of determining the direction of the uterine canal, and this is important in order to avoid perforating or otherwise injuring the uterus with the dilators in case of a retrodisplacement or a sharp anteflexion. The small size Goodell dilator is then inserted into the cervix, carefully manipulating it past any obstruction from the internal os, but above all *avoiding the use of any force.* With the instrument through the internal os the dilators are gradually expanded, first in one direction and then, after rotation of the instrument, in another, until a moderate amount of dilatation has been obtained, wnen the large size dilator may be substituted. The dilatation is thus continued, the operator being guided as to the force he may exert by the amount of resistance offered by the cervix, until the cervix has been sufficiently stretched for the purposes of the operation.

At the completion of the operation the uterus is irrigated through a Fritsch-Bozeman double-flow tube. Following the operation the patient should remain in bed three to four days during which time a

FIG. 886.—Second step in dilatation of the cervix. Shows the method of dilating by means of Goodell's dilators.

daily vaginal douche of warm 4 per cent. boracic acid solution or sterile water is given.

Dilatation by means of the Hegar style of dilator is comparatively simple. The cervix is exposed and drawn down as above, and then, beginning with the small ones, successive larger sizes of the dilators are inserted into the cervix (Fig. 887), lubricating each sound with sterile vaselin before its introduction. In using the smaller sized sound great care must be observed against making a false passage in case any obstruction is offered by the internal os.

When dilatation is performed for sterility due to stenosis, some operators follow the operation by introducing into the cervix a hard-rubber stem, such as is shown in Fig. 888, for the purpose of maintaining the dilatation. The stem is from 22 to 25 French in size and is

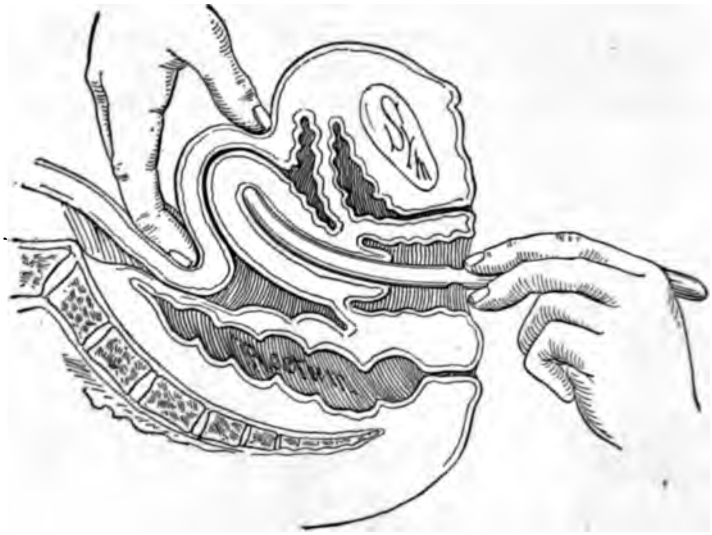


FIG. 887.—Showing the method of dilating the cervix by means of the graduated dilators of Hegar.

provided with a groove upon its lateral wall for the escape of discharges. It has this objection, however, that it is liable to irritate the cervical lining.

FIG. 888.—Intrauterine stem pessary. (Bandler.)

CURETTAGE

Curettage, or the scraping of the inner lining of the uterine cavity may be performed for the purpose of removing diseased mucosa in chronic endometritis, for the purpose of obtaining tissue for subsequent microscopic examination in suspected cancer of the uterus, and as a preliminary to repair of the cervix and operations upon the uterine appendages. In puerperal cases the operation is indicated for the removal of pieces of decidua or placenta retained after labor or following incomplete abortions.

The operation is contraindicated in cancer of the uterus except to obtain tissue for examination and as a preliminary to a radical operation and likewise in pelvic peritonitis, pyosalpinx, pelvic cellulitis, ectopic pregnancy, etc., unless as a preliminary to a laparotomy. Curettage is dangerous in the presence of submucous fibroids, as sloughing of the growths may result through injury from the curet. In streptococcus infections of the uterus, the operation, if performed at all, should be done with caution, as new channels for infection are

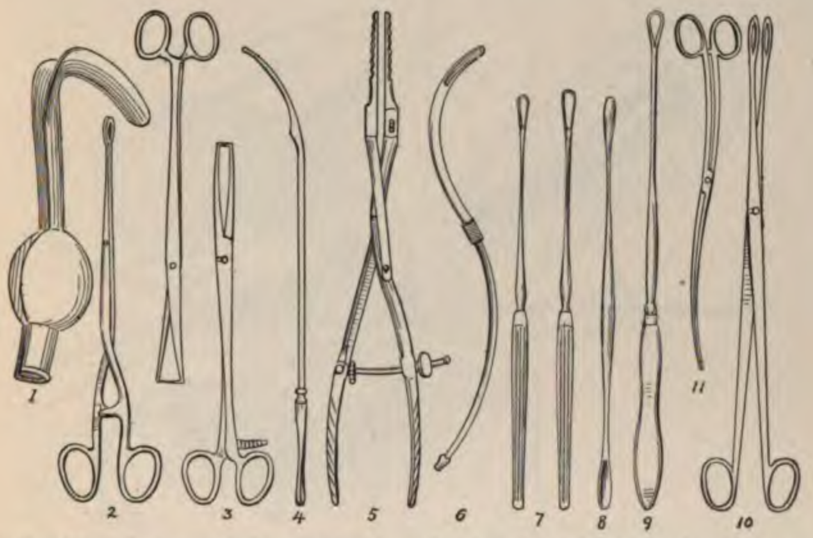


FIG. 889.—Instruments for curettage. 1, Garrigues' weighted speculum; 2 sponge holder; 3, tenacula; 4, uterine sound; 5, Goodell dilators; 6, Fritsch-Bozeman nozzle; 7, Sims' curets; 8, Martin's curet; 9, blunt curet; 10, placental forceps; 11, uterine dressing forceps.

opened up by the curet and extension of the process to the deeper tissues is liable to follow.

A curettage should always be performed under the strictest asepsis and with care and gentleness, as a false passage may easily be made through the wall of the uterus with the curet or dilator; especially is this liable to happen in septic conditions and in puerperal cases where the uterine wall is soft. The position of the uterus and the condition of the adnexa should be ascertained beforehand by means of a bimanual examination.

Instruments.—A Simon or a Garrigues self-retaining speculum, sponge holders, two bullet forceps, a uterine sound, a pair of large and small Goodell dilators, Sims' curets, a Martin curet, a large blunt curet, placental forceps, uterine dressing forceps, and a Fritsch-Bozeman return-flow irrigator will be required (Fig. 889).

Asepsis.—All the instruments are boiled for five minutes in a 1 per cent. soda solution, and the operator's hands are sterilized as for any operation.

Position of Patient.—The patient should be in the lithotomy posture.

Anesthesia.—General anesthesia is necessary.

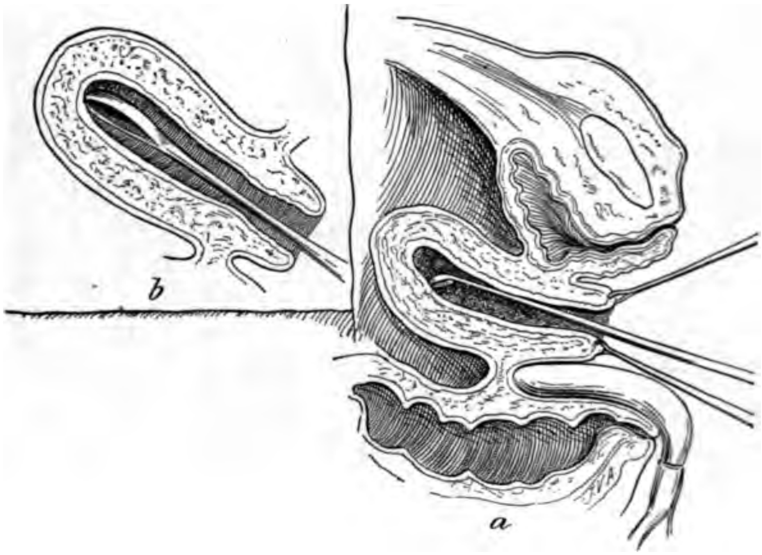


FIG. 890.—Dilatation and curettage of the uterus. Illustration *a* shows the endometrium being removed with Sims' curet; illustration *b* shows the mucous membrane on the fundus being removed with Martin's curet. (Ashton.)

Preparations of Patient.—The bladder and bowels are to be empty. The hair is shaved or cut from the labia and the external genitals are washed with soap and water followed by a 1 to 2000 bichlorid solution. The vagina is first thoroughly cleansed with soap and water by means of a swab on a sponge holder and is then thoroughly douched with a 1 to 5000 bichlorid of mercury solution.

Technic.—1. *Nonpuerperal Cases.*—The cervix is exposed by means of the speculum and the anterior or both the anterior and posterior lips are caught by means of bullet forceps and are drawn well down toward the vulva. The cervix is then wiped with a swab soaked in a 1 to 2000 bichlorid solution and, after first determining the direction of the canal, the cervix is dilated in the manner described on page 866. The entire uterus is then thoroughly scraped with a sharp curet of the largest size that will pass through the cervix. This should be done in a systematic manner—for example, beginning with the anterior wall, the curet is carried to the fundus and is then withdrawn along the front wall and out of the uterus in one sweep. Any adherent tissue is wiped off the curet and the instrument is reinserted and withdrawn over another section of the anterior wall. The process is repeated until the entire anterior wall has been scraped, and then the two side walls and the posterior wall are similarly dealt with. A Martin curet is then substituted for the

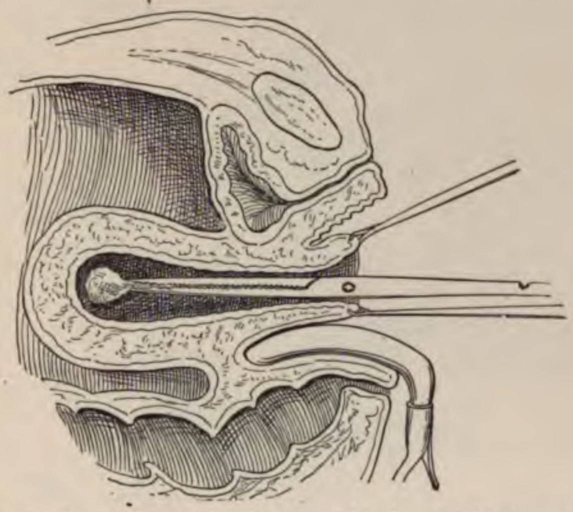


Fig. 891.—Shows the uterine cavity being swabbed out with pure carbolic acid. (Ashton.)

Sims instrument and the fundus is well scraped. The cavity is then irrigated with sterile water or normal salt solution by means of the return-flow catheter in order to remove any débris or loose shreds of tissue, and a light packing is inserted for a few moments to dry the cavity. The packing is then removed and the uterine cavity is swabbed with pure carbolic acid introduced by means of a cotton swab on dressing forceps (Fig. 891). In doing this care must be taken not to touch the vagina with the carbolic acid and to remove any excess of acid from the swab before inserting it in the cervix. The vagina is then cleansed, the bullet forceps are removed from the cervix, and a light vaginal tampon is placed in contact with the cervix. The vulva is finally covered with a gauze pad.

2. *Puerperal Cases.*—Unless the cervix is already dilated, it should be stretched sufficiently to admit one or, if possible, two fingers. The

operator then inserts the index- and middle-fingers or, if this is not possible, the index-finger of the right hand into the uterus and, while counter pressure is made over the fundus with the left hand, he thoroughly explores the cavity and separates any retained material by means of the internal fingers (Fig. 892). Large pieces of tissue thus loosened may be then removed by means of placental forceps. The cavity of the uterus is then irrigated with normal salt solution or with sterile water and is lightly scraped with a large dull curet. In doing this great care and gentleness are necessary to avoid perforating the

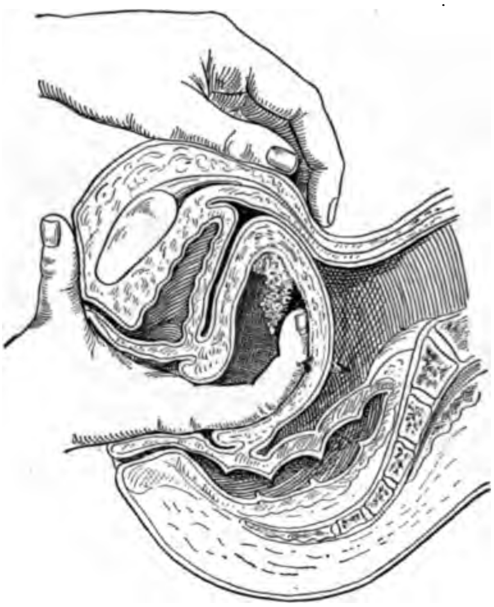


FIG. 892.—Digital currettage of the uterus. (Ashton.)

uterus. *Sharp curets should never be employed in puerperal cases.* After a final exploration with the finger, the cavity is again irrigated and the operation is concluded by cleansing the vagina and covering the vulva with a sterile gauze pad secured in place by a *T*-bandage. Only in cases where the operation is accompanied by severe bleeding or where it is desired to introduce contraction in a flabby organ is it necessary to pack the uterus (see page 847). If this is done, the packing should be removed in twenty-four hours.

After-care.—The vagina should be douched daily with a 1 to 5000 warm bichlorid solution followed by sterile water or normal salt solution. In cases of curettage for simple endometritis the patient may be allowed out of bed within a week, in other cases the duration of the stay in bed will depend upon the condition of the patient.

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