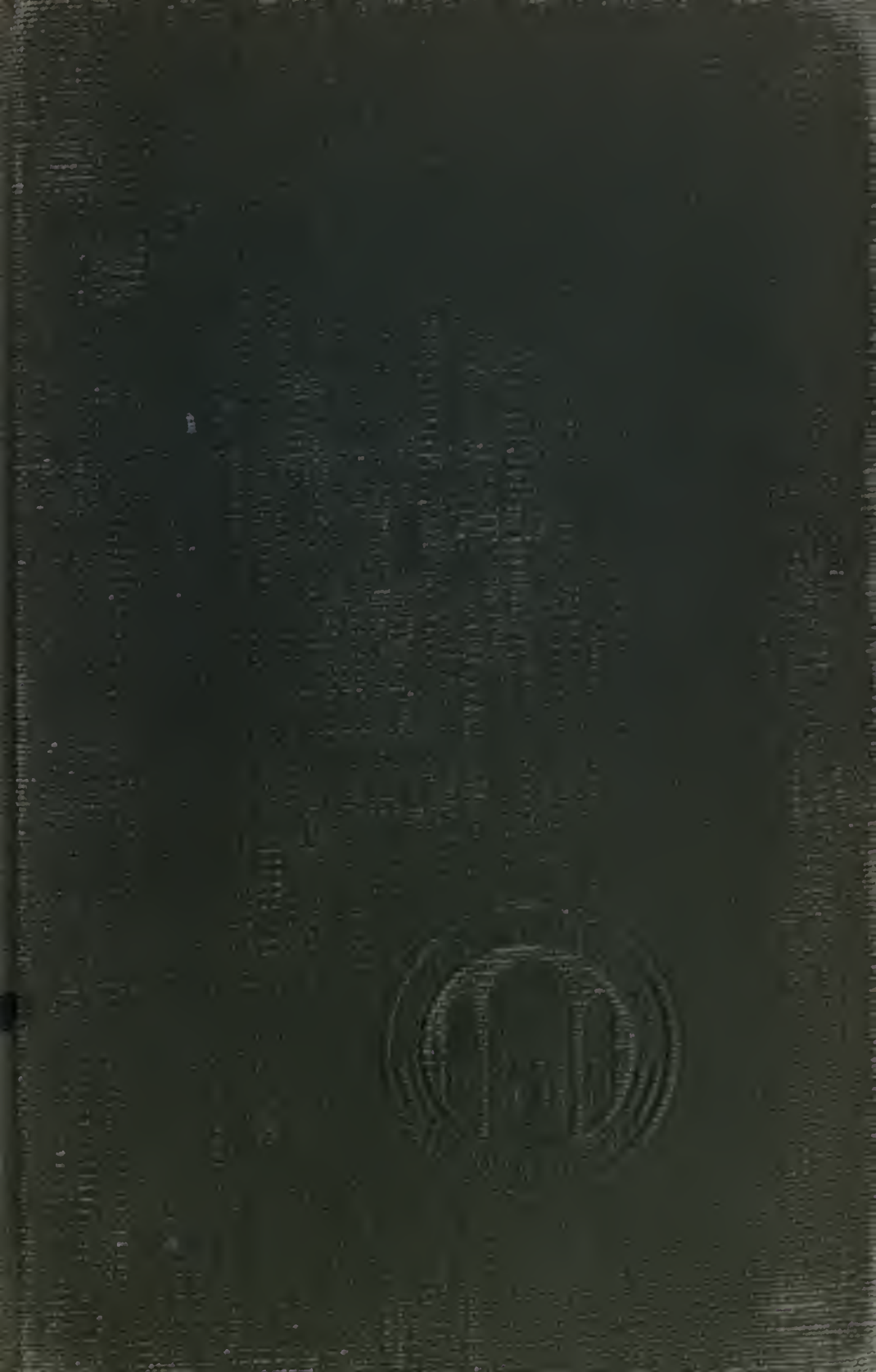

PHYSICAL RECONSTRUCTION AND ORTHOPEDICS

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By

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67 ORIGINAL ILLUSTRATIONS AND 2 DIAGRAMS

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PREFACE

Physical reconstruction is the watchword of the hour—and yet the picture brought to mind by this phrase is but a small part of a greater problem, the physical reconstruction of the race. That there is need for such reconstruction among us is evident from any study of the rejection from service for physical disability which the draft examinations brought forth. We have become a city-dwelling nation, and are subject to the innumerable deleterious influences which follow in the wake of city life and intense industrial competition. The meager beginnings of playground and physical education appropriations and infant welfare movements have as yet in no way compensated the child for his rapid loss of outdoor life and freedom. The physician must be deeply concerned with every effort to improve child hygiene. He is specifically concerned with the problem of prevention and cure of remedial physical defects. In this book concrete directions are given regarding spinal curvature, congenital defects, rickets and other orthopedic conditions. The question of competitive athletics and its relation to health in youth of both boys and girls is considered and certain definite rules for safeguards are laid down.

In the reconstruction of the wounded soldier, in which we and our allies are now engaged, much that is new and of great value has been learned. The new orthopedic

principles, appliances, and methods of treatment which have been evolved have been thoroughly tried out under exceptional conditions as regards amount of material, length of observation, and unlimited resources.

The application of the successful methods evolved in the treatment of war injuries to the treatment of industrial accidents is of the utmost importance to the general surgeon. Physiotherapy and vocational therapy have, by proper application and coördination, achieved such wonderful results that it is inconceivable that they can have other than a very prominent place in the general hospital in the future. Every physician and surgeon should be familiar with the indications for the various types of treatment, and their effects on the local and general condition of the patient, his morale, and his return to his former or new occupation. When one considers that the number of our wounded was approximately two hundred thousand, the importance of the viewpoint just mentioned is seen when we remember that we have in this country about seven hundred thousand industrial accidents yearly.

The author's experience in teaching and supervising reconstruction aides in physiotherapy has convinced him that a condensed manual, giving the directions for the various types of treatment as well as the theoretical considerations, would be of great assistance to them in the work in which they are now engaged. Since vocational reconstruction is being so largely applied for definite therapeutic indications, it is of the greatest importance that the workers in this corps understand the viewpoint

and treatment given in physiotherapy, which leads up to their work. The theory and treatment of congenital and functional defects other than those following war injuries should be useful to aides who plan to continue the same type of work in civil life.

In the teaching of normal-school students of physical education it has also been evident that they need, for their work in orthopedic and medical gymnastics, definite exercise programs for such conditions as faulty posture, spinal curvature, infantile paralysis, flat foot, etc.

It has been the author's object to present in condensed form the main principles of orthopedics in the treatment of the defects of childhood, war injuries, and industrial accidents, laying stress upon the treatment by massage, exercise, and other types of physiotherapy. It should, therefore, be of value to the physician, reconstruction aide, physical director, and orthopedic assistant, not only in their better understanding of the work, but in emphasizing the vital importance of this so long neglected field.

The author wishes to acknowledge the valuable aid given him by Miss Helen S. Willard, B.A., his chief Reconstruction Aide in Physiotherapy, and Captain G. W. Ramaker, Vocational Therapy Officer of the U. S. A. Base Hospital, Camp Meade, Maryland, in the collection of data for this book.

H. E. S.

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PHYSICAL RECONSTRUCTION AND ORTHOPEDICS

PART I
PHYSICAL RECONSTRUCTION

Chapter I

EXERCISE

The health of the body is, in the last analysis, absolutely dependent upon the health and tone of the muscular system. The condition of the heart muscle and the nonstriated fibers of the blood vessels and gastrointestinal tract, are profoundly influenced by the tone of the skeletal muscles. Many glands are stimulated both directly and indirectly as a result of proper muscular activity. These statements are obvious, almost trite, and yet they are constantly overlooked. The physician often treats first by drugs, then with attention to diet and sleep, and lastly, if at all, by exercise.

In modern business and industrial life the premium is placed upon nervous activity and very fine muscular coordination. This type of work is exhausting without any corresponding upbuilding of vigor. Physical work involving larger groups of muscles, while equally tiring,

tends to build up both the muscular structure and the general health. Years ago even the skilled artisan used to move about the plant selecting his materials, performing quite varied operations upon them, and perhaps carried the finished product to the shipping room. Therefore he was compelled to take a certain amount of general exercise. Modern efficiency has ruled that cheap labor shall bring in these materials, perform the easier operations, and remove the finished product, while the artisan's entire time is occupied in repeating, hundreds of times daily, some one or two specialized movements, which usually require prolonged, acute attention and delicate coördination. Thus only certain small muscle groups are apt to be used.

The same tendency is seen in modern business and professional life, where present appliances make it possible to conduct a whole day's business from the office chair.

The many occupations which require standing for hours subject those muscles which maintain the upright posture to strain, rather than exercise. The work of the heart, unassisted by alternating muscular compression and relaxation applied to the veins, is greatly increased, and the muscles and ligaments of the foot are subject to a distinct strain. It must be clear, then, since most occupations resemble more or less one or the other of the three types of occupations mentioned, that the average person under modern conditions does not have sufficient exercise for the maintenance of the best efficiency. That women, as a class, with the added handicap

of dress and social restrictions, take far too little exercise every one will recognize.

There is no escape from the tendency of modern life further and further to restrict normal exercise and increase the strain of professional and industrial life. I take it to be of the utmost importance that we should see to it that every child and youth be given the opportunity to lay by a surplus in his bank account of health, for these certain and severe strains which modern life makes it impossible for him to avoid. Since we have become a city-dwelling nation, with extremely limited play space, the youth is not so apt to be endowed with a vigorous muscular system at the beginning of his life work as were his father and grandfather. Until we have multiplied our playground, recreational center, and school gymnasium appropriations many times over, we shall suffer as a nation from this lack of muscular vigor.

That every child should have a thorough physical training is recognized by every physician. There are, however, problems closely associated with modern athletics which relate to possible overstrain of heart and disturbed blood pressure, which are not universally understood. During my experience in the physical education of both girls and boys, I was struck with the lack of definite knowledge in the profession of the results of vigorous athletic training on the heart and blood pressure.

The heart becomes stronger, the cardiovascular adjustment more perfect, and the blood pressure is not raised, by athletic training. Safeguards that the physi-

cian should insist upon in all athletic sports in both boys and girls are, first, preliminary medical examination; second, constant trained supervision; third, play only when in perfect health. I want to emphasize the fact that the delicate child can be built up, and should be encouraged to exercise when carefully watched; that the heart is a muscle, and as such can be increased in both size and strength when carefully kept from strain.

The physician's advice is often sought by parents in regard to the proper amount of physical training that should be taken by the normal child. Such advice can hardly be given without a knowledge of the circumstances surrounding the exercise, which may have a marked effect upon the benefits derived. The number and length of the periods per week, their time relation to meals and fatigue, temperature, ventilation, apparatus used, and the way the schedule is graded, all are important.

Nearly every normal boy goes in for athletics. His enthusiasm, and that of the coach who must produce a winning team, make it very easy to overstep the limits of safety. We must remember that the boy, as a rule, is carrying a heavy burden of growth, development, study, and extra-curriculum activity.

It must be constantly kept in mind that the growth of the heart and larger blood vessels is from one to two years behind the rest of the body, during adolescence. For this reason heart strain is more common than generally realized. Such games as basketball, football, and hockey should be broken up by frequent rest periods. I believe no secondary-school boy should run farther than

FIG. 1. ENTIRE SCAPULA, EXCEPT PART OF ACROMION, MISSING. (See FIG. 3.)

FIG. 2. GAIN FROM COMPLETE DISABILITY IN SIX WEEKS OF PHYSIOTHERAPY

the 220-yard dash. Cross-country running and distance runs should be reserved for college days. The marathon, or even modified marathon run, is fraught with the gravest danger to heart and kidneys, as shown by the work of W. L. Savage of New York.

No boy should be allowed to participate in more than one major sport at one time, and intervals between training seasons are desirable. Many breakdowns occur from indulging in athletics when suffering from slight illness, such as tonsillitis, or attempting to return to sport too soon after the cardiac muscle has been impaired by the toxins of disease.

The recent rapid growth of girls' athletics has brought us face to face with the same problems in regard to heart strain or overindulgence that we have found in athletic training for boys. My experimental study, "The Effect on the Heart Rate and Blood Pressure of Vigorous Athletics in Girls," *American Physical Education Review,* 1914, showed that even such violent sports as basketball and track athletics were extremely beneficial when properly safeguarded.

In regard to girls' athletics, the work of Dr. Clelia D. Mosher of Stanford University, and others, has modified greatly our ideas in regard to the proper relation between exercise and menstruation. It seems to be the unanimous belief that we may safely be much more liberal in our exercise allowance at that time; that marching tactics, calisthenics, and club swinging have a distinctly beneficial effect in lessening pain and disability. This is undoubtedly the result of a redistribution of the circulation

and improved mental attitude. In fact, it is emphasized that the psychical attitude is of great importance, and that the girl should be discouraged from thinking of this perfectly normal function in terms of illness. Among college women Dr. Mosher and others have succeeded in lessening the pain and disability to a very marked degree by exercise and treatment, the fundamental part of such a program being deep abdominal breathing with increased use of the diaphragm by training. This may be done with the patient lying supine and her effort directed toward raising and lowering, to as great an extent as possible, a moderately heavy book placed upon the abdomen. The more violent types of athletics, including jumping and running, should be interdicted for at least three days and longer, when necessary, in any individual case. I am convinced that we are only at the beginning of our knowledge of the possibilities of woman's physical development. Already in such a sport as track athletics, in spite of their very recent development and meager opportunities, girls are making records in the different events, which range from two-thirds to three-quarters of those records made by our Olympic champion athletes. Those invaluable traits of character, loyalty, unselfishness, self-control, and the team-work ideal, are developed by athletics as in no other way. I have not seen, in my experience, the slightest tendency for athletics, developed by coaches with the proper ideals, to make girls in any way less womanly.

The sudden secession from regular exercise, which usually comes at the end of school and college life, is

something which should not be allowed to occur. From the vigorous games of youth the transition should be made through the gymnasium, volley ball, and tennis to such sports as hiking and golf, which can be followed throughout life. This principle should be applied to both sexes. In general, it is well for the physician to keep in mind that, after a great deal of painstaking study, physical educators, as a rule, have come to the following conclusions: 1. That exercises of *speed,* those exercises in which a certain distance is covered in the shortest time, are not suited in their severe forms except to persons in good condition from eighteen to thirty-five. 2. That exercises of *strength,* which require all of one's energy to perform—for instance, weight throwing, weight lifting, and apparatus work—are suited to the ages of twenty to thirty-five. 3. That exercises of *endurance,* which constitute many and rhythmical repetitions of easy movements, such as distance running, walking, bicycle riding, etc., are suited to any age up to fifty (they are self-limited in childhood), the only exception being the period of accelerated growth, as regards games and distance running, before mentioned. 4. That exercises of *skill* such as golf, archery, quoits, etc., are suitable through all one's active life, and are invaluable, especially after fifty.

Many games, such as tennis, may partake of several or all of these types, and in advising in regard to them one should be guided by the other general principles already outlined.

I have appended a simple drill of "setting-up exer-

cises'' which will make for general development, and a set of exercises on the chest weights, which may be used in the same way, but which is mainly intended to exercise fully both actively and passively each possible joint. These chest-weight movements will greatly assist in the return of function after the disability following fracture, dislocation, or arthritis.

Therapeutic Exercise.—Turning from the value of exercise, as a means of upbuilding and retaining general health, to exercise as a purely therapeutic measure, there are several things to be considered. In the treatment of patients by exercise much more enters into the problem than the conditions relating to the involved group or groups of muscles. The inheritance of the patient, the environment in which he has been and that in which he must remain during the treatment, and the special effect of his stage of development must all be carefully considered. The importance of the last fact has been too often overlooked. For example, as E. H. Arnold of New Haven has emphasized, in the giving of corrective exercises to children during accelerated growth, more harm than good is often done by overload of work or by the superimposing of a strenuous exercise régime on the already too severe strain of growth, development, and school life, which the child is carrying. Furthermore, we must expect a far different reaction to exercise treatment on the part of a patient who has left the ''elastic age'' of youth and entered the ''connective tissue age'' of middle and late life. It is also the physiological and not the chronological age which it is essential to keep in

FIG. 3. SEVERE SHRAPNEL WOUND OF LEFT SHOULDER WITH COMPOUND COMMINUTED FRACTURE OF 6TH AND 7TH RIBS.

X-Ray shows entire body of scapula missing, glenoid, coracoid and acromion processes intact. Piercing fracture of ribs. Movements at shoulder limited to 40° of flexion and 20° of abduction. After four weeks of massage and exercise active flexion to 80°, abduction to 50°.

mind, as has been pointed out by C. W. Crampton of Battle Creek. We have found in the New Haven Orthopedic Dispensary many cases of children who had to be taken from home surroundings for the simple purpose of supplying them for a sufficient period of time with adequate nourishment before the special treatment outlined could be expected to achieve the desired result.

There are four main types of exercise used: (a) that done entirely by the operator (passive); (b) that done by the patient assisted in varying degrees by the operator (assistive); (c) that done wholly by the patient (active); (d) that done by the patient opposed by the operator—weights, friction, or the opposing group of muscles (resistive). The muscular contraction in the last type has been further divided into three varieties, according to the direction of the movement of the muscle's insertion in relation to its origin. For instance, in the contraction of the biceps when opposed by the action of the triceps (self-resistive exercise), the former may slowly overcome the pull of the latter and its origin and insertion be brought nearer together—concentric contraction; or the power of both may be equal, so that the distance between the origin and insertion remains unchanged—static contraction; or the pull of the triceps may be greater, bringing further apart the points of origin and insertion—eccentric contraction.

As we proceed in the development of the muscular system certain changes in structure take place. With increased bulk and tone developed by exercise there is a tendency for the entire body of the muscle to shorten,

bringing its points of origin and insertion nearer together. We make use of this property of well-developed muscle to shorten in the treatment of many orthopedic conditions—for instance, in a round-shouldered child we exercise particularly the muscles of the upper back, thereby retracting the shoulders. It might here be noted, as will be emphasized later, that disuse, such as would follow the application of a shoulder brace in this same group, has ultimately the opposite effect, namely, to stretch out and weaken the affected muscles and to increase the slump. This shortening of the stronger muscles is also seen where there is a lack of balance in the power between two muscles or muscle groups having antagonistic function as, for instance, following partial paralysis. The less affected tends to shorten at the expense of the more affected muscle or muscle groups.

Muscles, then, are elastic, and will shorten when given the opportunity. If this condition remains long enough, real structural shortening ensues. For example, the wearing of high heels for many years has a marked tendency to produce structural shortening of the calf muscle. This tendency to contraction is undoubtedly due to the property of muscle called tone, or tonus. Muscle tone is the result of a slight constant contraction of many of the fibers of any healthy muscle. (Tone is increased in vigorous bodily health and well-developed muscle and in response to mental stimulus.) It is decreased during mental depression, bodily weakness, and sleep, and practically lost under complete anesthesia or other complete loss of consciousness.

Fig. 4. Slanting Ladder, Use of Body Weight to Secure Passive Flexion of Stiff Knee Joint.

Fig. 5. Suspension Used to Stretch Adhesive Bands in Right Elbow.

Fatigue is a sluggish or subnormal response of a muscle to its stimulus. This may be due to either a weakening of the stimulus itself following injury or weakness of the neurone, or to a deadening of the sensitivity of the end-plate of the nerve in the muscle cell by the accumulation of fatigue products. The first fatigue products are stimulants to muscular activity, and this accounts for the fact that a muscle works better after a few contractions than at first. That is why we "warm up" a muscle before sevère exertion.

The early onset of fatigue must be carefully watched whenever the muscle is subnormal. In regard to general fatigue the point is often overlooked that it is cumulative in its effect. This means that a little more work done by a fatigued muscular system calls for the expenditure of a tremendous amount of nervous energy.

Remedial gymnastic programs for the various orthopedic conditions—infantile paralysis, kyphosis, lordosis, scoliosis, flat feet, etc., are fully given in the sections where each is discussed.

CHEST WEIGHT EXERCISES.

The position assumed for active flexion gives passive extension, and vice versa.

Unless otherwise stated, the use of the shoulder height weights is indicated.

1. Wrist.

A. Flexion.

Patient stands with back of hand toward weights, arms extended downward and flexes. (Passive extension.)

B. Extension.

Patient stands with palm of hand toward weights, arms extended downward and extends. (Passive flexion.)

2. Elbow.

A. Flexion.

1. Patient stands facing weights, arms extended forward. Flex, extend.
2. Overhead weights. Arms extended upward, hands encased in gloves and bound to handles if necessary. Flex, extend.

B. Extension.

1. Patient stands with back to weights, elbow flexed shoulder high and rope over shoulder. Extend, flex.
2. Overhead weights. With arms at side, let weights flex elbow. Extend, flex.

C. Pronation.

Patient stands affected side toward weights, elbow flexed, and fixed at side by other hand or by operator. Lower forearm across body and return.

D. Supination.

Patient stands unaffected side toward weights, elbow flexed and fixed at side by other hand or by operator. Draw forearm up and sideward and return.

3. Shoulder.

A. Flexion.

1. Floor or shoulder weights.

a. Patient stands facing weights, arms extended forward, supinated or pronated. Lower arms and raise.

b. Patient lying supine, head toward weights, arms extended upward. Lower arms fore—downward to sides and raise.

2. Overhead weights.

Arms extended upward, lower fore—downward and raise.

B. Extension.

1. Floor or shoulder weights.

a. Patient stands with back to weights, arms extended downward. Raise arms forward and return.

b. Patient lies supine, feet toward weights. Raise arms fore—upward and return.

C. Abduction.

1. Patient stands unaffected side toward weights, affected arm across body.

a. Abduction in a lateral plane, elbow flexed. Extend elbow. Keep at shoulder level. Return.

b. Carry straight arm forward and sideward at shoulder level. Return.

2. Floor weights.

Patient lies supine, feet to weights. Raise arm sideward, return.

D. Adduction.

1. Patient stands, affected side toward weights, arm extended, shoulder level. Carry arm forward across chest, keeping straight or flexing elbow, then adducting shoulder. Return.

2. Floor weights.

Patient lies supine, head to weights, arm extended upward. Lower sideward, raise.

3. Overhead weights.

a. From extended arm. Lower and raise.

(1) Carry arm obliquely fore—downward.

(2) Carry arm side—downward.

(3) Carry arm obliquely back—downward.

Combination of adduction and abduction.

Raise arm sideward to shoulder level, carry forward and return, carry backward and return.

4. Trunk.

Resistance to forward, backward, and lateral bending of the trunk is obtained by fixing the handle of the weights at given points in relation to the trunk. The higher the weight is fixed, the greater the resistance given. The weight may be fixed on abdomen, chest, head, or arms extended over the head.

5. Thigh. Foot bound to handle by special slipper or loop attached to shoe.

A. Flexion.

1. Floor attachment.

a. Patient supine, feet toward weights, knee flexed or straight. Flex, extend.

b. Patient lying on side, feet toward weights, knee flexed or straight. Flex, extend.

c. Patient standing, back to machine. Flex, extend.

B. Extension.

1. Floor attachment.

a. Patient supine, head toward weights, knee flexed or straight. Extend, flex.

b. Patient lying on side, head toward weights, knee flexed or straight. Extend, flex.

c. Patient standing, facing weights. Extend. flex.

C. Abduction.

1. Floor attachment.

Patient stands or lies supine, unaffected side toward weights. Abduct, return.

D. Adduction.

1. Floor attachment.

Patient stands or lies supine, affected side toward weights. Adduct, return.

E. Rotation.

1. Floor attachment.

Patient lies prone, knee flexed, side toward weights. (*a.* Unaffected side for inward rotation. *b.* Af-

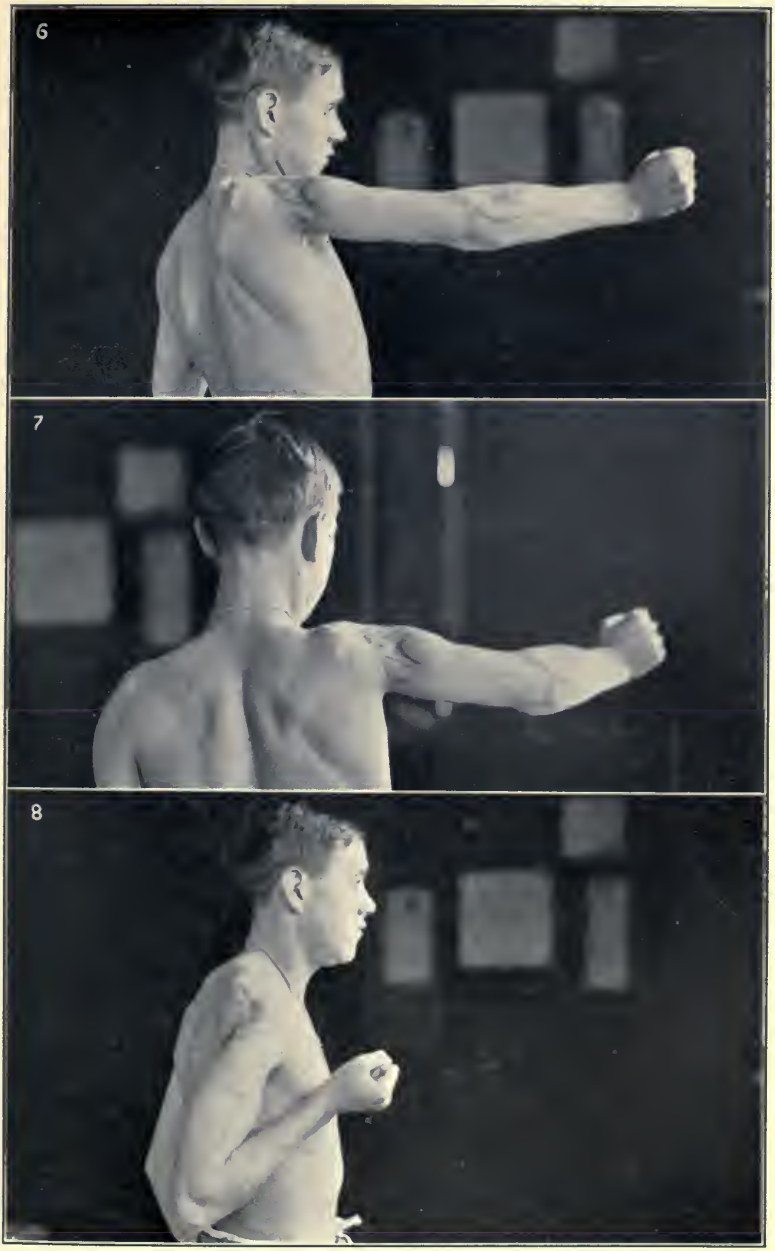


FIG. 6. CHIPPING OF HUMERAL HEAD AND EXTENSIVE WOUND OF SHOULDER. No active motion at first. Flexion after five weeks of massage and exercises.

FIG. 7. ABDUCTION ASSISTED LARGELY BY SCAPULAR ROTATION WELL CONTROLLED.

FIG. 8. HYPEREXTENSION LIMITED BY SCAR TISSUE AND ADHESIONS.

fected side for outward.) Rotate by swinging foot sideward.

6. Knee. Foot bound to handle.
   A. Flexion.
      1. Floor attachment.
         a. Patient stands facing weights. Flex, extend.
         b. Patient lies prone, feet toward weights. Flex, extend.
   B. Extension.
      1. Floor attachment.
         a. Patient stands back to weights, knee flexed. Extend, flex.
         b. Patient lies prone, head toward weights, knee flexed. Extend, flex.

Setting-up Exercises.

1. *a.* Arms to thrust raise, thrust forward, return, lower.
   b. Arms to thrust raise, thrust sideward, return, lower.
   c. Arms to thrust raise, thrust upward, return, lower.
2. Hands on hips.
   a. Heels raise, lower.
   b. Toes raise, lower.
   c. Heels raise, knees deep bend, knees straighten, heels lower.
3. Hands on hips.
   a. Trunk sideward right bend, raise, bend sideward left, raise.
   b. Trunk sideward right turn, return, turn sideward left, return.
   c. Trunk lower forward, raise, bend backward, raise.
4. *a.* Arms forward raise, carry sideward, carry forward, lower.
   b. Arms sideward raise, carry forward, carry sideward, lower.

c. Arms forward raise, carry upward, lower forward, lower downward.

d. Arms sideward raise, carry upward, lower sideward, lower downward.

5. Hands on hips.
   a. Raise right knee, lower.
   b. Raise left knee, lower.
   c. Raise right knee, extend leg forward, bend knee, lower.
   d. Raise left knee, extend leg forward, bend knee, lower.
6. Jump to stride stand, arms raise sideward.
   a. Trunk bending, alternating right and left.
   b. Trunk turning, alternating right and left.
   c. Hands behind head.
   Trunk bending alternately forward and backward.
7. Stationary running on toes with high knee raising.

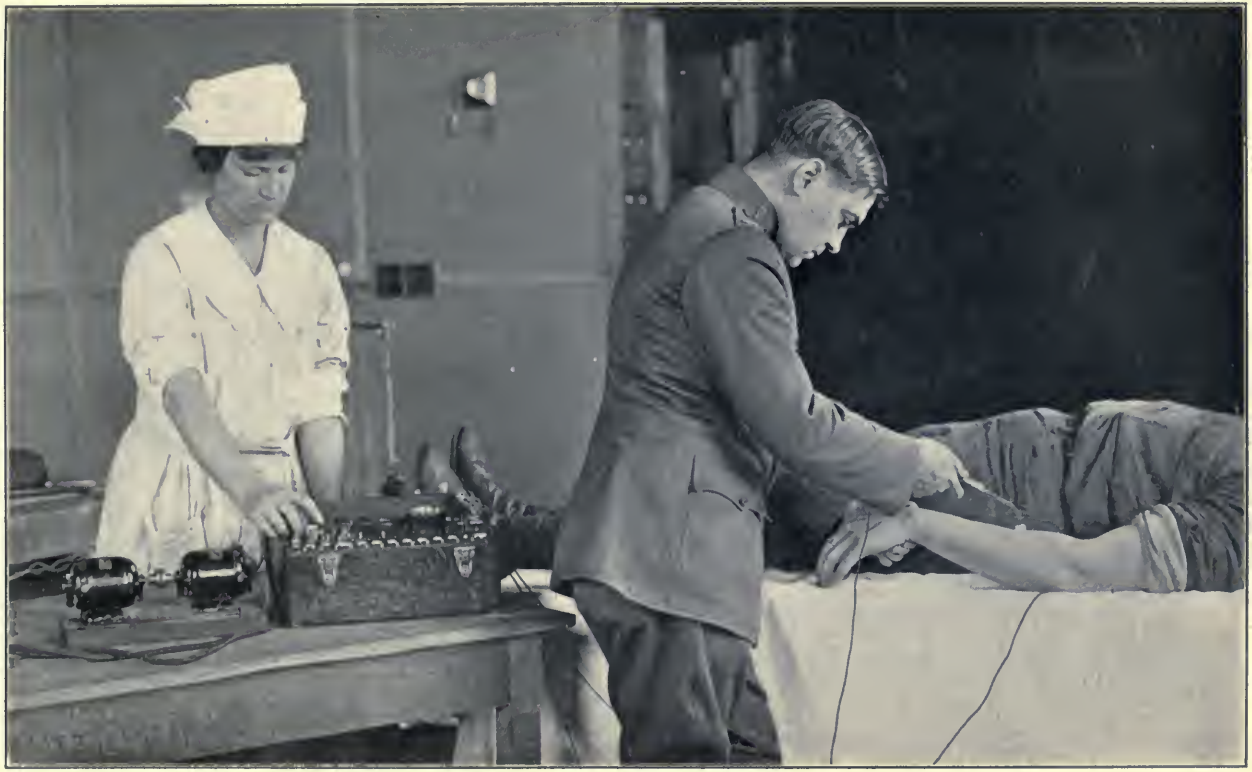


Fig. 9. Muscle Contraction Test for Nerve Injury. Faradic Battery and Generator.

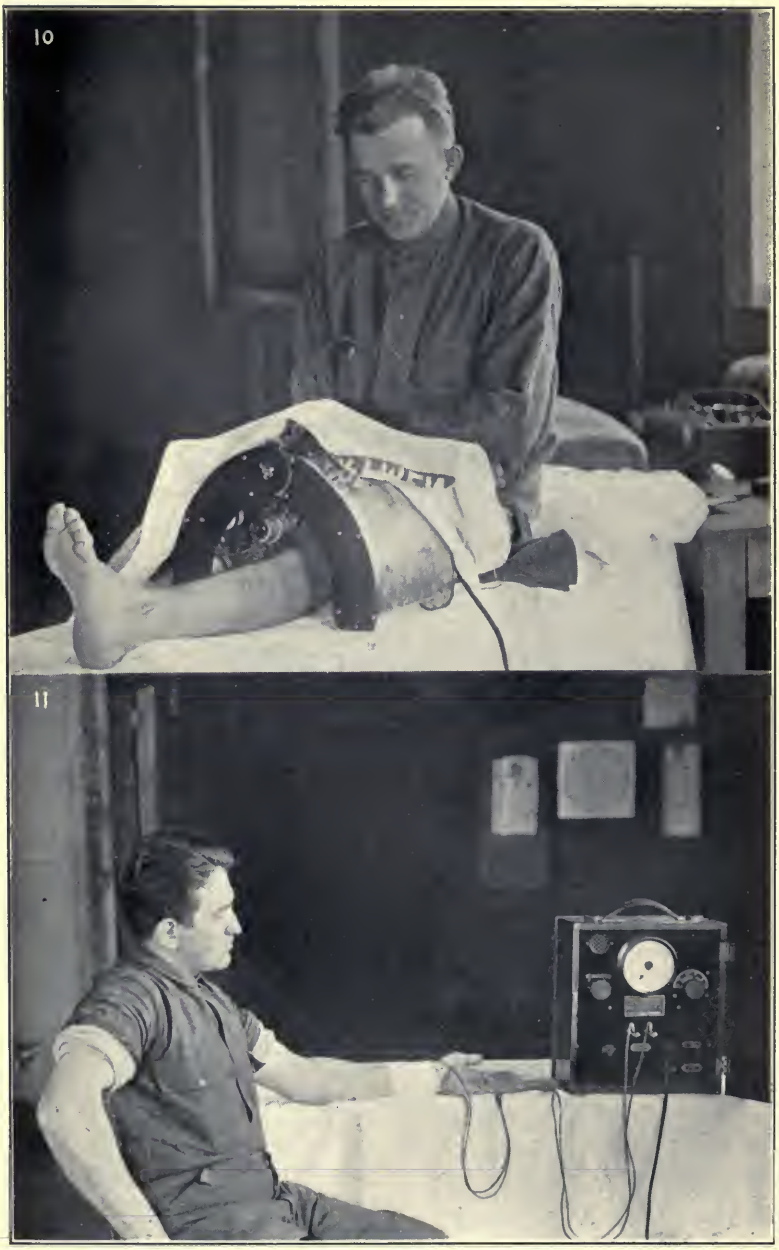


FIG. 10. BAKING. ELECTRIC LIGHT BATH OF KNEE.

FIG. 11. DIATHERMY. ELECTRICAL HEAT PENETRATION FOR DEEP HYPERÆMIA.

Chapter II

BAKING—HYDROTHERAPY—ELECTRO-THERAPY

BAKING

The result of the treatment of a part of the body by superheated dry air is to cause a local dilatation of the skin and subcutaneous capillaries, thereby thinning their cell walls and increasing the intercellular spaces. A greatly increased amount of blood serum with its contained food is thus permitted to pass out and supply the tissue cells. This, and the increased removal of waste brought about by the accompanying stimulation of the lymphatic circulation, are the two essential factors in shortening the period of tissue repair.

The common means employed to obtain this result are: First, electric lights with reflectors, such as the thermolight; second, the adjustable local electric light bath (Burdick); third, Kellogg's thermophore; fourth, the electric light body cabinet; and fifth, the various types of ovens heated by gas and alcohol, some of which are quite inexpensive. For the application of heat to the deeper tissues, machines for electric heat penetration are used. The average length of treatment is twenty minutes. In baking, the part must be well wrapped in a dry towel.

Watch for scars or anesthetic areas. The heat is given at 250 to 400 degrees.

Passive Hyperemia. This method of increasing local blood supply by means of the constriction band placed proximally to the part, tight enough to shut off the venous return but not to impede the arterial inflow, is usually referred to as the Bier treatment. This method should precede the other types of treatment indicated on the part and its duration should not exceed ten minutes. It is a valuable method of obtaining passive hyperemia, especially in selected cases where means of procuring active hyperemia are not available.

HYDROTHERAPY

Definition. Hydrotherapy is the application of water to the surface of or within the body for the relief of diseased condition.

History. The therapeutic value of this agent was known to the Egyptians, Chinese, Greeks, Romans and Arabs. Modern use of water for curative purposes began in the sixteenth century in Italy, France and England, as shown in the writings of Lanzani, Barra, Wesley, Cullen and Floyer. In the United States Rush, Lockette, Bell and others have added to our knowledge of this form of treatment. Among modern writers none have contributed more than Kellogg of Battle Creek.

At the present time the use of hydrotherapy is being greatly extended and its value more largely recognized. While our larger sanitaria and hospitals have expensive

equipments, it is possible to obtain most of the fundamental benefits from the various forms of treatment with very simple apparatus.

Properties. The physical properties of water are all made use of in our treatment. Its different forms—solid, liquid and gas—all have their places. Added value is derived from the ability of the water to hold certain salts and minerals in solution. Varying degrees of the temperature of the water used, and the force and amount in which it is applied, each affect the result of the treatment.

Effect. The main desired result is obtained through the thermal and mechanical effect of the application of water on the sensory nerve endings in the skin. Reflexly, changes are brought about in the circulation and nervous system.

Circulation. (a) Distribution of the blood. The application of hot water brings about a local hyperemia. Cold water induces vasomotor contraction in the skin and dilatation in the deeper tissues, followed later by cutaneous dilatation.

(b) Composition of the blood. A redistribution of the blood cells shows a marked increase in the red blood cell count in the circulation.

(c) Changes in blood pressure. By increasing the skin elimination of toxins and blood vessel dilatation, we are able to reduce high blood pressure. Hot and tepid baths are used. The stimulating effect of cold baths will improve capillary tone and raise the pressure when below normal.

Respiration. A tonic bath will induce deep breathing and raise the general body tone.

Nervous System. (a) Stimulation of the nervous system is secured by the various tonic baths. Vigorous rubbing and massage are helps in securing this result. Often a hot bath will act as a stimulant.

(b) Sedative effect on the nervous system is obtained by a long continued tepid bath.

Muscular System. The removal of local and the lessening of systemic fatigue is possible by means of the tonic bath.

Skin. The direct effect of water applied to the skin is that of a mechanical irritant. This action may be increased by the use of salt, etc. The circulatory effect has been described. The removal of waste matter is best accomplished by warm water. Cold water stimulates, closes the pores and protects against cold.

Body Temperature. Cold water is now used freely to lower body temperature in typhoid, heat stroke, etc. It may safely be repeated several times daily if necessary. It is a good general rule preceding every bath to heat the body. Methods in common use are the blanket pack, electric cabinet, electric cradle, or exercise.

Electric Cradle or Cabinet Bath. In using the cradle (which is a frame wired with lights fitting over the patient in bed) or the cabinet (lined with lights in which the patient sits) cover the head with ice cap or cold wet towel. Take the temperature often and discontinue the treatment when the temperature has reached 100 degrees or the patient perspires freely. *Indications*—All forms

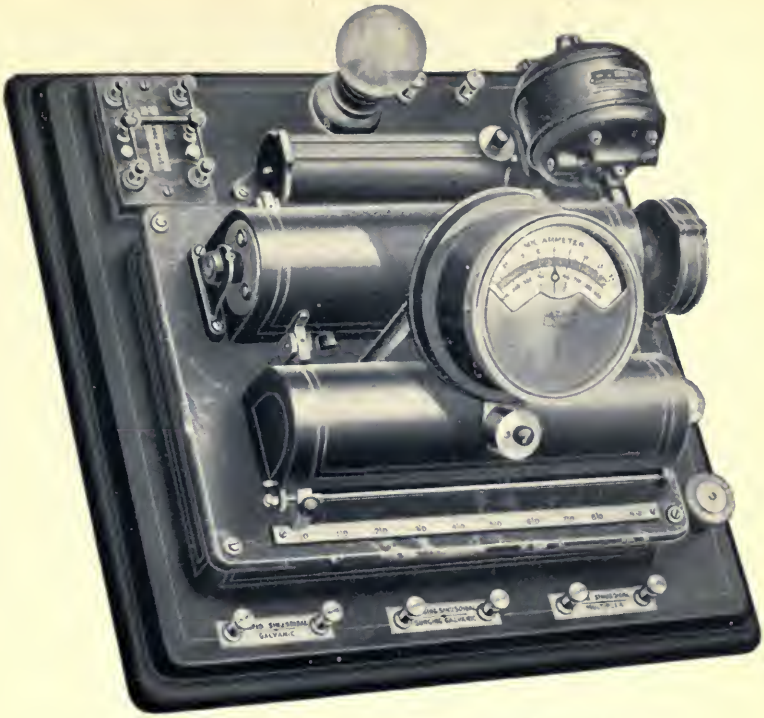


Fig. 11a. Multiplex Sinusoidal Machine.

Fig. 11b. High Frequency Machine.

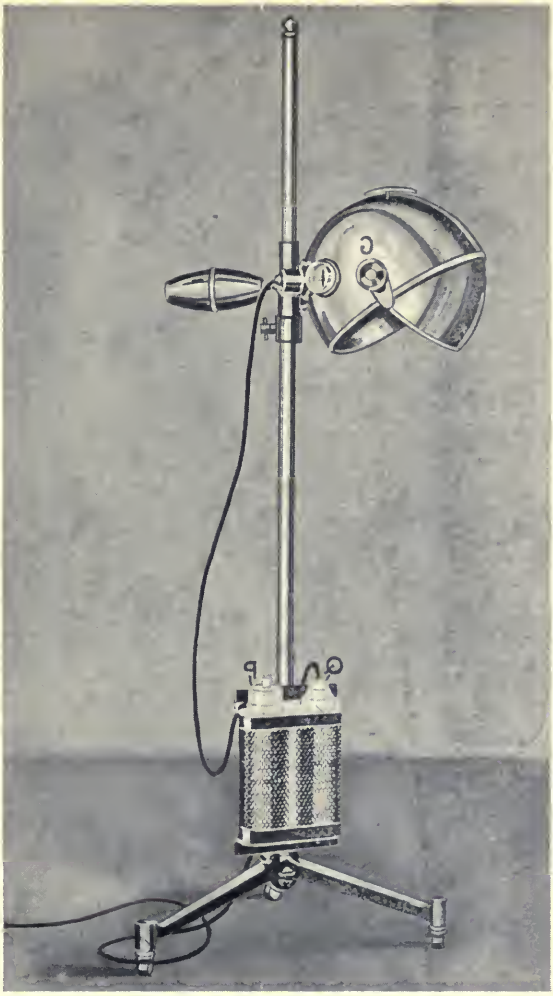


Fig. 11c. Alpine Sun Lamp, Ultra Violet Ray.

of intoxication, gout, nephritis and the relief of internal congestion.

Wet Pack. Wrap the patient in a wet sheet and then several blankets. Be careful not to have the surfaces of the body touching. Cold packs stimulate, warm ones soothe. Treatment should average about an hour or to desired physiological effect, and be followed by rest.

Evaporation Pack. This type of tonic treatment is given for fifteen or twenty minutes. Cover patient with wet sheet and one loose blanket. It may be given locally as a compress, or as a body pack. It is well to use a head compress also.

Neptune Girdle. Two sizes of binder 15″ by 60″ and 18″ by 72″ will serve. Wrap the patient's abdomen in the wet linen binder and cover with dry flannel one slightly larger, being careful to exclude the air. *Indications*—Nervousness, insomnia, nausea and digestive disturbances.

Abdominal Coil. Put on the linen binder, then the coil, then flannel binder. Run water through coil 120 degrees for 15 minutes; remain the rest of the hour.

Local compresses are used to relieve hyperemia.

Simple Tonic Bath. Sponge bath; apply water with slight friction with hand or cloth.

Half Bath. Tub half full of water at 85 degrees lower to 70 degrees or 65 degrees. Pour water over the patient and rub with the hand; sit three to five minutes, then apply the cooler water.

Drip Sheet. Stand in a tub of hot water. Hold the sheet so that one-third is in one hand and two-thirds in

the other. Dip in water; lift out and wrap around patient and pour on more water—duration three to five minutes.

Sitz Bath. Sit in sitz bath, place feet in bath tub. Apply water 80 degrees to 60 degrees. Keep rubbing the skin, the patient rubbing the thighs and the operator rubbing the shoulders and back. For bladder disturbances, pelvic congestion.

Use hot water for spasms, colic or chronic intestinal conditions. The body surface should be flushed with heat, followed by a cold shower to get a good reaction or the patient put to bed with the room at an even temperature till the vessels regain their equilibrium. For conditions following shell shock, irritable heart, hallucinations, fearful dreams, and neurasthenia, the bath at 94 degrees is kept up for an hour or more.

Douche. Treatment begins with water 90 degrees, rising to 115 degrees and ending with 60 degrees. Continue for two minutes.

Scottish Douche. Two jets, one 100 degrees, the other 60 degrees, applied alternately by a lateral sweep of the nozzle up and down the spine.

Whirl Bath. For sensitive stumps or masses of scar tissue, treatment by whirling water at 95-110 degrees, mixed or unmixed with air, leads to a very marked reduction of sensitiveness and to active hyperemia, and is an invaluable means of the preparation of the part for massage or exercise.

ELECTROTHERAPY

This important type of treatment is being rapidly developed and the scope of its usefulness greatly enlarged. It is essential that the student of electrotherapeutics have the elemental facts outlined for him in the simplest possible form.

The therapeutic effects of electricity are to produce surface or deep hyperemia; to induce muscular contraction, either by changes in the chemical reaction within the muscle or through its nerve supply; to soften scar tissue; to hasten the healing of open wounds; to soothe nerve irritation and to cause the direct absorption of drugs by ionization.

Electricity is produced by chemical action, induction or friction, all of which types are used in the treatment of patients.

The type of current produced by chemical action is generated in the galvanic cell as typified by the standard Daniell cell, which generates an electro-motive force of one volt. The simplest form of this cell is a quart jar two-thirds full of sulphuric acid, in which is placed a plate of zinc, the negative pole or cathode, and a plate of carbon, the positive pole or anode. If a wire is placed between the upper extremities the current will flow from the positive to the negative pole. In the solution there is a transfer of electricity from the zinc to the carbon. During this process bubbles of hydrogen form around the carbon. This is called polarization and may be great enough to block the current, in which case the carbon

should be removed and cleaned. In the dry cell a solid substance replaces the sulphuric acid, but the action is practically the same. Electric force may be either negative or positive in quality. Like types repel and unlike types attract each other.

The definition of a few electrical terms is here in order.

1. *Volt.* That unit of electro-motive force generated by the standard Daniell cell.

2. *Ohm.* The unit of resistance to the current offered by one thousand feet of one-tenth inch copper wire.

3. *Ampere.* The unit of quantity of current which the force of one volt will drive through one ohm in one second.

McKenzie, Strong and others illustrate the meaning of these terms by the comparison of electricity to water power. If one water container is placed above another, the force exerted by the water in the upper container in seeking the level of the lower is directly proportionate to the difference in height, and is comparable to the reaction between the positive and negative poles. The difference in height represents potential energy and this force corresponds to the voltage of an electric current. The amount of water allowed to flow from the upper to the lower container corresponds to the amperage of an electric current. Upon the size of the pipe used depends the amount and force of the stream of water. If a small pipe is used the resistance (number of ohms) is increased, the force of the flow (voltage) is high but the quantity of water (amperage) is small. On the other hand, if a

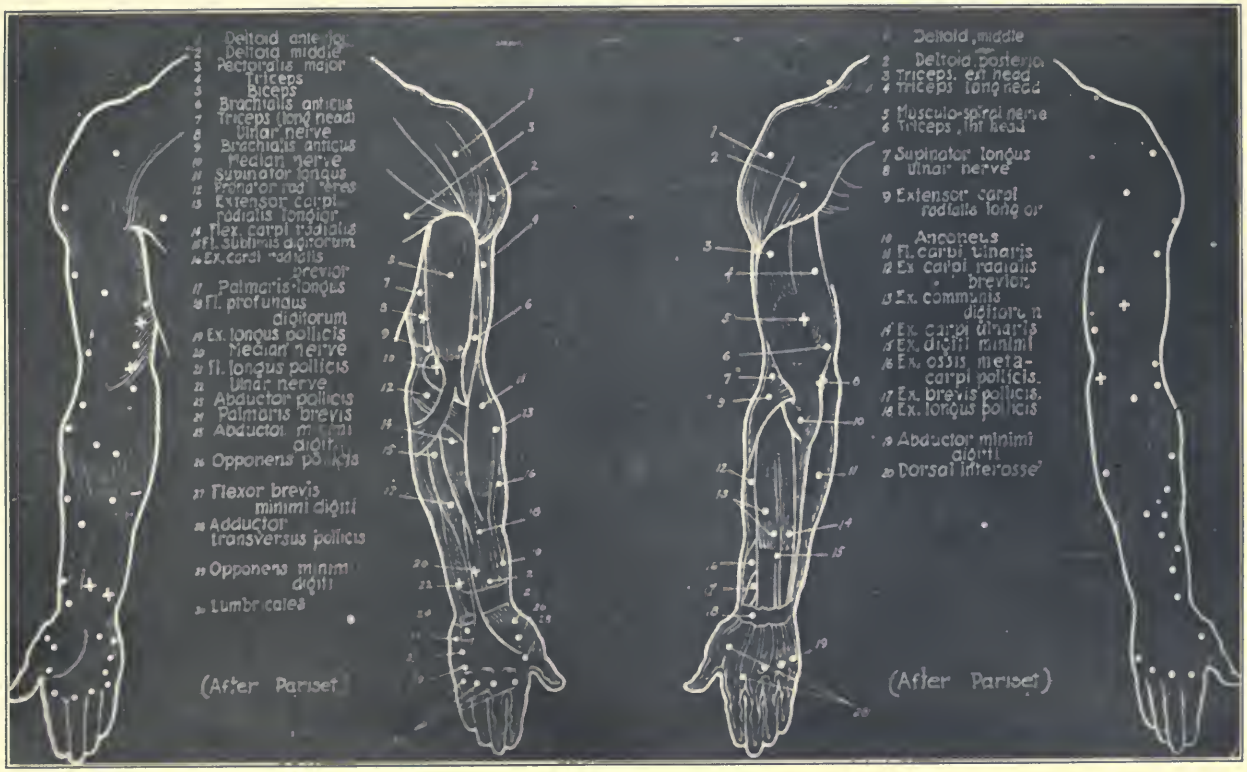


FIG. 12. ELECTRO-MOTOR POINTS, UPPER EXTREMITY.

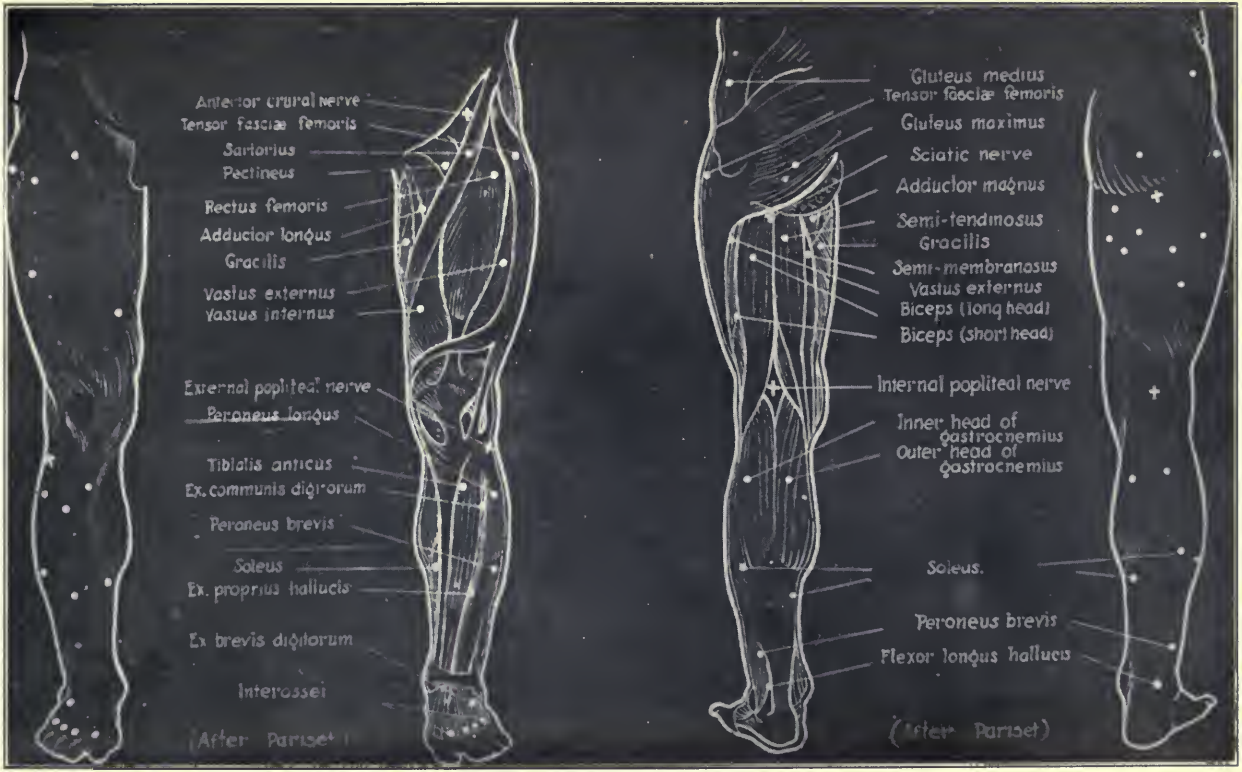


FIG. 13. ELECTRO-MOTOR POINTS, LOWER EXTREMITY.

large pipe is used the resistance is decreased and the force is lessened but the quantity of flow is increased.

In electrotherapy the type of current commonly used has relatively high voltage but very low amperage, which, for convenience, is measured in milliamperes.

Galvanism. The ordinary galvanic battery consists of a cabinet containing a series of cells joined to a switchboard with binding poles, to which are attached the cords and electrodes for applying the current to the patient. There are also appliances for measuring, interrupting or increasing the current.

The galvanic is a continuous current flowing steadily from positive to negative. It is used for the following physiological effects: stimulation, sedation, nutrition and chemical changes. Quite different effects are produced by the positive and negative poles. There are two simple tests for differentiating the poles. If the ends of the cords are placed on blue litmus paper the positive pole, because of its attraction of acids, will turn the paper pink. If the cords are dipped into salt solution bubbles will collect around the negative pole, which attracts alkalines. Where the anode or positive pole is used, circulation, muscular contraction and nervous irritability are reduced. At the point of application of the cathode there is greater muscular contraction, stimulation of circulation and increased nervous irritability. Having selected the proper electrodes for the desired effect, they should be applied smoothly and firmly to unabraded skin. It must be remembered that the electrodes should be covered with smooth felt or gauze thoroughly saturated in

warm salt solution and should be proportionate in size to the part treated. Burns are most likely to occur at the cathode and this point should be most carefully watched. The current should always be applied and decreased slowly. This type of current is also applied by local bath with one pole in the water, the other on the spine.

Ionization. Ionization is the induction of drugs into the tissues by electrolysis. These substances in solution may be driven in by the galvanic current. The ions of zinc, copper and lithium, being electro-positive, should be placed on the anode, by which they are repelled. The ions of chlorine, potassium and iodine are electro-negative and are repelled by the cathode. Weak solutions of two or three per cent are usually employed.

Interrupted Galvanic Current. The constant current has no effect on muscular contraction, but when it is suddenly shut off and again applied at both this break and make of the current a contraction is produced. The stronger contraction occurs when the current is made at the cathode. A device called a metronome, attached to the instrument, produces this effect.

A smoother type of galvanic current is the sinusoidal galvanic, a current which flows evenly on the positive and negative side alternately. It has a deeper effect on muscular nutrition.

Faradic Current. The faradic is an induced alternating current, produced by charging one coil, the primary, which then becomes an electro-magnet and when brought into contact with a secondary coil charges it also. By variation in the size of wire or the number of windings

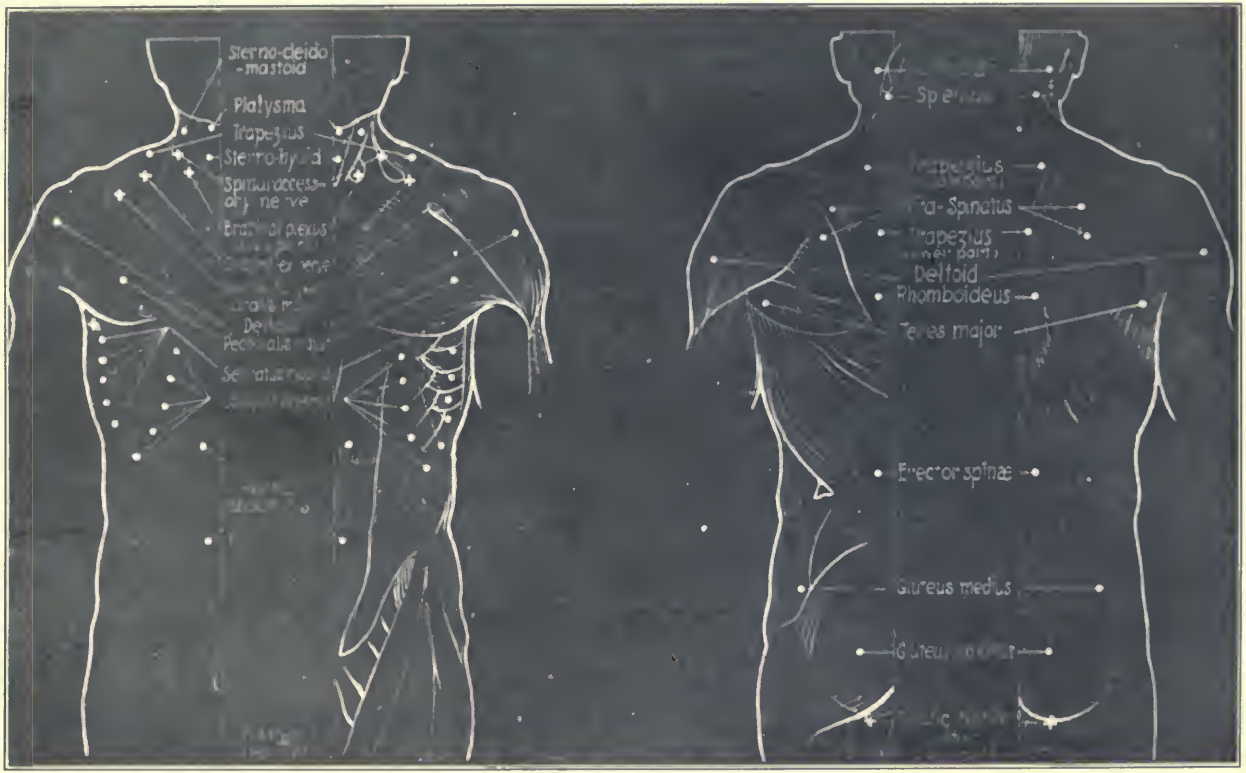


FIG. 14. ELECTRO-MOTOR POINTS, TRUNK.

on the secondary coil, the voltage of the current may be increased or "stepped up." This current may be made and broken by the withdrawal and reinsertion of one of the coils by hand, or may be rapidly done by mechanical interruption.

The faradic gives a harsher stimulus than the galvanic and acts directly through the nerves, producing a definite muscular contraction similar to that of a normal muscle. For that reason one electrode should be placed on a main nerve trunk proximately to the muscle to be stimulated and the other should be placed on the electromotor point. The difference in polarily is slight, therefore differentiation is unnecessary. The close similarity of this current to the normal nerve impulse makes it particularly valuable in keeping muscles in good tone when normal exercise is impossible.

Most machines for the therapeutic work combine the galvanic and faradic sinusoidal currents and they should therefore be used selectively.

Sinusoidal Current. The sinusoidal current is also induced and is therefore similar to the faradic, save that it passes in a wave from zero to the highest force on the positive side and then back through zero to the highest force on the negative side and then flows back from negative to positive. This surging effect produces complete muscular contraction, but is somewhat more gradual and therefore more pleasant than the harsh stimulus of the faradic.

High Frequency. This is an induced current oscillating from one-half to five million alternations a second,

with high voltage and low amperage. The different types —d'Arsonval, Oudin and Tesla—are all used. To obtain the current a resonator, coil (solenoid), adjustable spark-gap and Leyden jar condensers are used.

Application to the patient is made by means of vacuum electrodes or plates. Marked changes in metabolism are produced with little discomfort on the part of the patient.

Diathermy. Another common use for this type of current is the driving of heat deep into the tissues by means of two pliable, flat metal electrodes applied on opposite sides of the part to be treated. These electrodes should be smoothed out and then shaped carefully to the part and held firmly in place.

The resistance by the body increases the heat which in turn produces marked deep hyperemia. In this way we are able to drive heat deep into the tissue, as in the joint cavity, and to prepare a part for massage or exercise treatments.

Static Electricity. This current is produced by the friction of revolving glass plates, charging brushes. Holtz and Wimshurst machines have been varied for special uses. The high tension obtained requires insulation.

The types of current are Morton wave for general tonic, simple current for insomnia and "breeze," sedative effect on pain.

Sun Lamp. By means of the quartz lens light can be split into its component parts and all but a desired wave length excluded. The ultra-violet or actinic rays may

thus be used alone for the chemical effect. These rays have a marked bactericidal and healing action.

The patient's body, with the exception of the part to be treated, should be carefully covered. Operators much exposed should wear smoked glasses. An average exposure is three minutes at a distance of eighteen inches.

Very satisfactory results have been obtained in the quickened healing of open wounds by this means in a number of our base hospitals where these lamps are in use.

Chapter III

MASSAGE

Definition. Massage is the scientific manipulation of the soft parts of the living body for purposes of health. It is a mechanical interference with and modification of the physiological function of the different tissues.

History. Throughout the animal kingdom we find many instances of one animal massaging another or itself by rubbing, licking or biting the affected part. Among mankind it was known to the Chinese at least three thousand years B.C., and was used somewhat by the Egyptians and Greeks and by the Romans in their baths. Among the Greeks, Æsculapius and his followers, the Asclepiades, in their school of medicine on the Islands of Kos and Knidus, were the first to systematize massage. With the other arts and sciences it was submerged during the dark ages to reappear on the teaching of Paré, Ling and Metzger in modern history. It was first used extensively in this country by Dr. S. Weir Mitchell about 1877.

Types of Movements. There are four cardinal movements used:

1. Effleurage or stroking.
2. Pétrissage. Pinching or kneading.

Fig. 15. Massage. Effleurage or Stroking of Forearm.
Fig. 16. Massage. Petrissage or Kneading of Calf.

3. Tapôtement. Hacking, slapping or vibrating.
4. Frictions.

Objects:

1. To increase arterial, venous and lymphatic flow.
2. To improve skin function.
3. To soothe or stimulate the nerves.
4. To eliminate waste products.
5. To break down adhesions.
6. To reduce swollen tissue.
7. To improve nutrition.

General Considerations. Since by means of massage we are going to interfere with the physiologic function of tissue, a broad and thorough knowledge of physiology is an absolutely essential basis for scientific work. Not only the way tissues and organs act, but their structure and location must be exactly known; therefore a comprehensive knowledge of the anatomy, at least of the soft parts of the body, is of extreme importance. The too great neglect of this valuable means of treatment has been to a large extent due to the impression left on both the physician and the public through the ignorant and unscientific use of massage by a large proportion of those claiming to be able to treat by this means. Although one of the best contributions to this science was made by the Swedes, many valuable features have since been added to the theory and application of this form of physical therapy. It is a mistake, then, to follow the Swedish, or any other so-called system, to the exclusion of others.

The proven value of this form of treatment, and the fact that in so many serious conditions its use is indicated, make it a worthy branch of the medical science. No person can be truly successful in this work who does not approach it from the standpoint of service and who is unwilling to make the personal sacrifice necessary to gain a well-rounded knowledge of the entire subject. The high type of young women entering the work for the army will undoubtedly elevate the plane of this field of endeavor. Let us hope that in the mind of the general public the athletic "rubber" and the Turkish bath attendant will be hereafter clearly distinguished from the true masseur or masseuse.

The close personal contact with the patient makes it imperative that the operator remain constantly mindful of the fact that the feeling of confidence and trust on the part of the patient is an invaluable aid toward success. Dignity, reserve and high moral tone are prerequisites.

In an office practice it is desirable to have a couch or a padded table about three feet high and two feet wide. The best temperature is from 70° to 75°. Only the part should be exposed which is being manipulated. Both hands should be trained to equal skill and during a treatment are usually kept in contact with the skin. Powder is being increasingly used to lessen skin friction and is in many ways preferable to cocoa butter, cold cream or vaseline. The use of ichthyol or strong liniments to produce counter-irritation is unnecessary. The length of the average treatment depends upon the vigor and concentration of effort, the object desired, and the size

FIG. 17. PASSIVE STRETCHING OF A FLEXION CONTRACTURE AT THE ELBOW.

FIG. 18. MASSAGE. FRICTION HERE USED TO LOOSEN SCAR TISSUE.

of the surface to be covered, and varies from twenty to fifty minutes.

Venous Circulation. Venous circulation runs in the same direction as the lymphatic and is modified by the action of the valves scattered throughout the venous system.

Lymphatic Circulation. Its general course is from the extremities toward the heart and is modified by "stops," individual or groups of glands.

Arm. From the tips of the fingers to the axilla, especially on the flexor side. Gland in the elbow, middle of the arm and chain in the axilla.

Leg. Largest vessels on the dorsum of the foot, the back of the leg, popliteal space, inner side of the thigh to the front above. Glands between the tendo Achillis and external malleolus, the lower part of the thigh and the chain of inguinal glands in the groin.

Face. The upper vessels center at the root of the nose; the lower ones go toward the neck.

Neck. Down the front of the sterno-mastoid and in front of the edge of the trapezius, where most of the cervical glands are located.

Chest. Superficial glands from the inner third of the breast toward the sternum, outer two-thirds toward the axilla. Deep vessels toward the sternum.

Abdomen. Generally toward the inguinal glands.

Back. Superficial circulation of the upper part toward the axilla; deep circulation toward the spine; lower back toward the sacral notches.

Stroking is always done in the direction of the lym-

phatic and venous flow, the only exception being to remove secretions from an open wound.

MECHANICS AND PHYSIOLOGICAL EFFECT

Effleurage or Stroking. Stroking is done with one or both hands or any part thereof simultaneously, alternately or with one only and with varying degrees of force, rapidity and duration, depending upon the part massaged and the purpose in view. The object is to influence the blood and lymphatic circulations. The superficial circulation is always affected, the deeper only by added pressure. The direction is always toward the heart with the exception noted above.

The skin is mildly stimulated, but this effect is lessened with the use of lubrication.

Sensory nerve endings in the skin are stimulated by stroking and the sum total of the effect depends upon concentration of the nerve endings in the part, the amount of surface covered, and the number of strokes used. Since stimulation depends upon variation, and nerve endings soon become dulled to the same type and degree of stimulus, repeated light stroking is in its sum total effect soothing.

The circulation may be greatly modified by stroking. No measurable effect can be procured on the arterial flow. Capillaries are dilated by strong stroking and contracted by light stroking. Venous circulation can be markedly improved. The stroking should be deep enough to compress the vein, more rapid than the venous circulation, which

Fig. 19. Massage. Tapotement or Hacking of Muscle.

Fig. 20. (A) Posterior Half Cast to Prevent Foot Drop. (See Fig. 58 for X-Ray.)

is not more than five inches a second, and long enough to extend over the next proximal valve, which would be from six to eight inches. The lymphatic flow will be aided by slow, deep stroking, especially over the lymph glands.

The muscle can be directly relieved in fatigue through the removal of waste products by deep stroking.

Glands can be stimulated by the indirect effect of circulatory changes in the skin.

In such bones as the tibia the periosteal circulation and nutrition can be aided.

Several writers have called attention to the different effects produced on muscle tissue by the different types of massage. They consider light stroking to be both soothing and relaxing and therefore indicated in spastic contracture. Others do not massage spastic muscle at all.

Pétrissage. Pinching, Kneading. This type of massage is used mainly for its effect on muscle tissue. The amount of tissue grasped would then depend upon the part being massaged. Fine pinching is done between the thumb and first finger. Coarser pinching between the thumb and the side of the second phalanx of the first finger, or the thumb opposed by the tips of all the fingers, is good on a flat surface, such as the back; to this twisting may be added for more vigorous effect. The hands may be used effectively close together and alternately, one pinching while the other is re-grasping.

On the extremities the hands may be used on opposing sides, completely grasping the various muscle groups. The direction of the pinching should be at right angles

to the muscle fibers. On the abdominal wall, where we are unable to obtain selective action on the different layers of muscle, it is well to knead in concentric circles.

Pinching the muscle fibers brings about a partial contraction of those having their nerve supply intact. Some orthopedists believe a beneficial or a stimulating effect may follow even where we find that the nerve supply is entirely lacking. It is easier to obtain a partial contraction of a large number of fibers, or a complete contraction of a few by this means than by the use of electricity. Since only the stimulated part of the muscle reacts, we may by this means keep up the tone and health of muscles in the immediate neighborhood of inflamed joints, yet at no time cause an undesired movement of the joint. For this partial effect the different nerve supplies and the several heads of the various muscles must be kept in mind. A beginner should early learn to differentiate in infantile paralysis the thick, fat and connective tissue layer which so often overlies the muscle and upon which, without due care, the pétrissage may be directed from the muscle itself.

Tapôtement. Hacking, slapping, vibrating. This procedure is aimed at the skin and the muscles.

Skin slapping should be done with light, fast, alternate strokes. The wrist should be relaxed, each hand instantly rebounding from the skin. Superficial blood vessels and later the deeper vessels are quickly dilated in this manner.

Over groups of muscle the strokes are made alternately with the ulnar sides of the hands. Here, too, the wrists

Fig. 21. High Explosive Wound of Left Hand.

Loss of third and fourth fingers and part of hand. Function good following exercise and massage. (X-ray Fig. 22.)

Fig. 22. Loss of 3rd and 4th Metacarpals.

should remain relaxed, the hand nearly open, the fingers slightly separated. In this manner the fourth finger strikes the part first, the others following in turn. For harder striking, to relax a knotted muscle, for instance, the hand may be held rigidly extended and the strokes given more heavily, only the ulnar side of the hand and little finger striking the part.

Another method is by the use of the partially clenched hand, palm down, striking flat with the second phalanges of the fingers.

Vibrating can be done by keeping the finger tip or other parts of the hand in contact with the patient, the wrist relaxed, and performing a shaking motion of the whole arm.

The stimulation resulting from this method depends upon the number and force of the strokes and the amount of surface covered.

Frictions. Frictions are seldom used except on adventitious tissue in a number of pathological conditions. The breaking up of scars and adhesions forms an important part of its usefulness. We generally approach such tissue by concentric circles starting well out at the periphery. Frictions of the spine are sometimes used to stimulate the nerve roots. This manipulation is also valuable in the reduction of callus.

THERAPEUTIC USES AND CONTRAINDICATIONS

Skin. Where the skin is dry, harsh and cold, slapping will dilate peripheral capillaries, warm the skin and induce perspiration. Cold, clammy, moist skin can be

aided by frequent light stroking centrally above the part to aid the venous circulation.

Glands. Inactivity of the sebaceous glands, followed by the formation of blackheads and pimples, often occurs where the skin is normally rather immobile. Massage will improve the circulation, mechanically squeeze out the inspissated secretion and restore normal gland activity.

Dandruff is the result of hypersecretion of these glands in the scalp. The oil not being fluid enough, instead of supplying the hair it collects in layers around the gland openings and flakes off. The hair not being properly oiled, tends to dry and break off or split. Massage of the scalp will stimulate gland activity and the return of the sebaceum to its normal fluidity.

After chronic inflammation of the skin, for instance, as caused by boils or carbuncles, scar tissue may be reduced.

Scars. It must be remembered that scars are composed of connective tissues only and contain no sweat or sebaceous glands and no touch, pain, or heat corpuscles and are the result of wounds not healing by first intention. Frictions over and around scars will reduce the amount of tissue in duration and the size of the scar itself. Massage will prevent tissue contraction.

Atrophy. This condition is commonly seen after the wearing of casts or on the soles of the feet after prolonged rest in bed. Massage is extremely useful here in restoring skin function and hardening the soles of the feet preparatory to walking.

Contraindications. 1. Hypersensitivity of the touch corpuscles, which may, however, reflect the same state of the mind, contraindicates massage. Parts covered by hair must be well lubricated or shaved. This shaving does not stimulate the growth of hair as much as does the repeated irritation caused by the pulling of the massage itself.

2. Pimples or skin infection are not massaged. In case it is necessary to stroke a skin covered with blackheads and pimples, clean thoroughly before and again after the treatment with alcohol or soap and water.

CARDIO-VASCULAR SYSTEM

The Heart. The heart can at times be stimulated by tapôtement directly over its location, or this procedure over the stomach may greatly relieve cardiac embarrassment caused by gas formation there.

Pericarditis. Here the heart laboring under mechanical difficulties which retard its action can be relieved by stroking of the extremities, thus removing some of its normal work.

Myocarditis. In the same way a weakened or inflamed heart muscle can be relieved of some of its load. This very obvious fact in therapeutic indications for massage has been almost entirely overlooked by the general profession. Graded muscular exercise should, if possible, be given in conjunction with massage.

Endocarditis. This condition can be aided in the same way and, since cardiac dilatation is sometimes due to back

pressure from the venous system, this mechanical aid should never be withheld.

Contraindications. Tapôtement and the more vigorous types of massage may often be useless, but gentle stroking in the direction of the venous return will always aid a heart working under a handicap. Acute endocarditis and purulent myo- or pericarditis and angina pectoris contraindicate massage.

Veins. Dilatation of the veins may be treated by elevation and stroking, which may, especially in the veins of the lower leg, prevent them from becoming varicose. Varicose veins cause a great deal of extra work to be thrown on the heart through venous stagnation. Massage by gentle stroking above and below. When the dilatation is not marked or any sign of ulceration present, slow, gentle stroking may be done directly over them.

Phlebitis. Here the walls thicken, a sign of inflammation in the vein, which may greatly enlarge, become adherent to the surrounding tissue or break down and ulcerate. Later joint contractures may form in the knee or elbow. Elevation and rest should be given in the active stage. Later on gentle frictions and stroking at the sides over the non-inflamed veins and above and below the inflamed part, to aid in removing the swelling, is of value. *Contraindications.* In varicose veins any procedure except stroking is to be avoided and even this is not done when the walls are thin or ulcers have formed.

In phlebitis, during the active stage, or at any time directly over the vein, avoid massage for fear of freeing a thrombus.

Lymphatics. Dilated lymph capillaries and spaces may be massaged with stroking and deep pressure centrally, with light friction added over the lymph nodes. Elevation is helpful. *Contraindications.* Active inflammation contraindicates all direct massage.

Arteries. No disease of the larger arteries is amenable to massage treatment. The compensatory circulation may be improved in obliterating endarteritis. Arteriosclerosis usually begins in the capillaries and arterioles in the distal extremities, the left leg being often the first point of onset. The X-ray may show this condition. Tortuous temporal arteries, arcus senilis, palpation of the radial artery and high blood pressure are other means of determining its presence. A general massage continued for years and well done on the extremities and the veins of the surface will often arrest the progress of this disease and may give partial recovery. The mental attitude of these patients is greatly helped and this is a most desirable and important element in the treatment. *Contraindications.* Tapôtement, when the condition is at all advanced, and in aneurism, should not be used.

MUSCULAR SYSTEM

Myositis. Muscle soreness follows the insufficient removal of fatigue products. Stroke centrally above the muscle to open up the lymph channels and then stroke over the muscle.

Knotted muscle, which occurs in athletes, especially track, after severe exertion, is the next stage of the same process, but includes as a rule the tearing of a few fibers

with some serous exudate into the muscle tissue. Proceed as in muscle soreness just described but the stroking of the muscle itself should be deeper and of greater duration with some friction added.

Muscle Bruise. Here, in addition, occurs hemorrhage into the muscle with discoloration. If treated at once, it is dealt with as in knotted muscle. Later the fibrin glues the muscle fibers together and deep frictions must be used to break it up. Work in concentric circles. If neglected for some time the blood clot may become organized and a great deal of exertion must be put into the massage and a longer time given to the treatment. Vigorous tapôtement should be added. Occasionally it may be necessary to make the muscle "black and blue" again by this means before the organized mass can be broken up and the free play of the bundles restored.

Torn Muscle. This is usually associated with severe bruising and is followed by true scar formation within the muscle. This scar must if possible be reduced and broken up in the same manner as for a bruise, but the part should be immobilized between the treatments. The bandaging should start above and below and work toward the tear, thus keeping the fibers approximated. It is evident that tight bandaging started directly over the lesion would force the fibers apart and increase the amount of scar formation.

"Charley Horse" is a subperiosteal hematoma which follows deep bruising that involves the periosteum, tearing some of its blood vessels. Frictions and stroking will prevent organization and hasten reabsorption. This is

a common football injury of the front of the thigh and its presence is indicated when, with knee raised forward, the patient is unable to extend the leg. *Contraindications:* Purulent myositis, trichinosis, and muscle wounds should not be massaged.

Atrophic Muscle. The commonest condition we deal with here is infantile paralysis. The lesion is primarily in the motor and trophic nerves; occasionally the sensory are involved. While massage is aimed at aiding nutrition and stimulating any muscle cells and nerve endings that may be alive, we must remember in children how dependent we are for growth upon contact stimuli. These are usually lacking, but can to some extent be supplied by massage. Slapping and light tapôtement with open fingers are useful, and fine pinching, which must penetrate the layer of fat and connective tissue and be directed on the muscle fibers, is of great value. The intrinsic power of all muscle tissue to contract is thus stimulated even in the absence of motor impulses. *Contraindications:* In the active stage of infantile paralysis no massage should be used, and in advanced atrophy of old age or convalescence only stroking is indicated.

Spastic Muscle. Stimulating massage of the physiological opponent is good and on the muscle itself gentle stroking, which is now believed to be relaxing, aids the condition. Some authors, however, call all massage contraindicated in spastic muscle.

Sarcolemma or Muscle Sheath Inflammation. This structure is often inflamed in places where a large number of muscles lie close together and considerable friction de-

velops during their overuse, as in the neck, forearm and calf. The "spike soreness" of track men is of this type in the opinion of some writers; others class it as a neuritis. Rest, baking and elevation are invaluable adjuncts to massage stroking. Try to get between the muscles with the tips of the fingers. In chronic cases where there may be organized deposits, use deep friction followed by stroking.

Tendon Sheath Inflammation. Tendons themselves seldom are inflamed or injured. The sheath acts as a delicate insulation within which the tendon moves. This movement requires constant lubrication by a fluid secreted by cells in the inner layer of the sheath. Overuse will exhaust this fluid and set up an inflammation (tenosynovitis). Overproduction of fluid then takes place, distending the sheath with pressure on adjoining structures. Fibrin may coagulate within the sheath and form a painful, semi-solid swelling. In the wrist and ankle the annular ligaments may partially shut off a portion of the tendon sheath and, aided by gravity, hasten coagulation. Occasionally the fluid may enter a joint cavity and float the bones apart with a tendency to sprain and dislocate. Any mechanical interference in the absorption of the excess fluid, unless it be a snugly fitting bandage from the extreme distal part completely over the entire swelling, may be injurious; hence wrist and ankle supporters often do more harm than good. The tight lacing of high shoes is a common cause or an aggravation of this condition.

Treat by heat, rest, removal of constrictions and effleurage, with frictions if any coagulation is present.

Contraindications. Wounds and purulent inflammations should not be massaged.

BONES

Periosteum. Chronic periostitis may be greatly aided by deep stroking, especially in bones, like the tibia, which are practically subcutaneous.

Scar formation following tears may be lessened by friction and stroking.

Hemorrhage beneath the periosteum has been described under diseases of the muscle.

Fractures. The large callus that usually follows fracture repair may be reduced by frictions. These calluses may include some of the soft parts which must first be liberated. Deep frictions working circularly from the periphery to the center are best.

The action of the muscles may be greatly hindered by having to work over such an enlargement. Occasionally there may be great pain and discomfort from this condition. Even a small callus may cause trouble if situated near the joint. Fractures involving joints, which have been so common in the European war, have proven the indispensability of massage treatment to reduce callus and to break up foreign bodies and adhesions. Callus formation interfering with joint movement may be too soft to be disclosed by the X-ray and yet demands attention.

Faulty Metabolism. Such conditions as rickets may be greatly aided by massage aimed at the circulation. General body massage is often indicated and improved

nutrition of the bones leads to increased formation of red blood corpuscles. *Contraindications.* Immediately after fracture and in acute inflammations, osteitis, osteomyelitis and periostitis, massage is not used.

JOINTS

Dislocations. Gentle friction and stroking will aid the healing of the torn ligaments. In certain joints, for example, the shoulder, there is a tendency for the dislocation to recur and here the treatment should be delayed.

Sprains. These should be massaged at once in spite of pain. Deep strokes and frictions aid in the removal of extravasated blood and help to prevent its clotting. If the case is not seen until the clot has organized it must be broken up by deep frictions followed by stroking. If this is not done the ligaments heal over the clot, which, when it is finally absorbed, leaves the ligaments elongated and relaxed with a tendency to frequent recurrence. As I have before emphasized, there is no treatment available superior to this, coupled with a support to prevent resprain.

Synovial membrane is always involved in joint injuries. There is an increased secretion of synovia by means of which nature attempts to float apart the two inflamed surfaces. This results in lateral insecurity of the joint and this is where support is indicated. In the case of the knee a posterior splint, which is commonly used, is not the preferred treatment but a lateral hinged brace, which prevents twisting and lateral strain, but allows normal hinge movement, is indicated. Because of the relatively

poor blood supply, such injuries heal rather slowly, but a week should suffice in the ordinary case. When repair is delayed much beyond this time suspicion of the presence of toxins should lead to careful examination of the teeth, gastro-intestinal tract, etc. Baking and counter-irritation are of value. Massage should consist of effleurage above and over the sprain. In the chronic or subacute stage the excess of fluid is absorbed, leaving a gelatinous residue containing fibrin, which tends to coagulate. Hard frictions, getting as deeply into the joint as possible, are then indicated. If coagulation has taken place, small particles may be broken off and become loose in the joint. In the knee the so-called "rice kernels" are of this type. Here the joint should be fully flexed to open it up and moved several times during the treatment to shift the particles under the fingers. The next stage in untreated cases, or in repeated sprain, is a thickening of the synovial membrane which may not be apparent for two or three weeks. Here, too, the joint becomes insecure with tendency to subluxation and reinjury. The synovial membrane becomes thick and spongy and rolls between the bones like dough before a rolling-pin and a fold or crease in front or rear may limit joint movement. Normal movement, well protected, still tends toward cure, but as a rule heat and massage must be continued for months before permanent recovery takes place. *Contraindications.* Infective inflammations, toxic inflammations when most acute, and dislocation while unreduced should not be massaged.

NERVOUS SYSTEM

Brain Diseases. The quieting effect of stroking, especially of the back, may be of service in mild states of mental agitation. After a prolonged agitation, system exhaustion may be lessened by complete massage treatments. The persistent chronic constipation associated with many of these disorders may be relieved by abdominal massage of the type to be described.

"Softening of the brain" resulting from faulty circulation in localized areas cannot directly be affected. When it involves motor areas, however, the affected muscle should be treated by reëducational gymnastics and "muscle massage."

Apoplexy. Downward stroking of the veins of the neck relieves congestion. Treat the paralyzed muscle by "muscle massage." This has not only a distinct local beneficial effect but a pronounced sedative influence upon the patient's mental condition. *Contraindications.* In acute inflammations of the brain, meningitis and hypersusceptibility massage should not be used.

SPINAL DISEASES

Injuries. The spine cannot be directly stimulated because of its location.

Infantile Paralysis. Stroking of the back may be beneficial in the subacute stage. Local massage of the affected muscle should not be begun until tenderness has entirely disappeared, but thereafter it must be continued

until recovery or for a number of years. *Contraindications.* The acute stage contraindicates massage.

Functional Diseases. Improvement in diagnosis and recent researches are bringing us more and more to the point of view that pure functional neuroses are extremely rare, and that there is usually an organic or functional lesion somewhere. This should be diligently sought and if found removed.

Neurasthenia. The nervous and bodily weakness accompanying this condition is more efficiently treated by regular and complete massage than by almost any other method at our command. Both mentally and physically great benefit is usually obtained. The muscles are kept in good health and tone without the expenditure on the part of the patient of the energy which exercise would require. Later on massage should be supplemented by graded exercise.

Hysteria. General massage is indicated here when possible for its general tonic effect. *Contraindications.* Violent hysteria should not be treated by massage.

Peripheral Nerves. Thickening of the nerve sheath following injury can sometimes be relieved by light stroking. The nerves are often caught in scars following fractures or extensive tissue destruction. They must be loosened up and relieved from the pressure by passive movements, friction and stroking.

Neuralgia. This is a symptom, not a disease. Massage may help to remove the cause. It is contraindicated on the affected part.

Neuritis. This is commonly a result of some constitu-

tional poison and the massage is directed toward helping the body eliminate the causative agent. The muscular atrophy which usually accompanies severe neuritis can be retarded. *Contraindications.* Massage over the affected nerve is contraindicated.

ABDOMINAL VISCERA

Stomach. Vigorous tapôtement directly over the stomach will often assist in the elimination of gas which may, beside causing local distress, be embarrassing the action of the heart.

Intestines. Chronic Constipation. This is one of the most common distressing and truly important conditions with which we are concerned. Among the common causes are enteroptosis with stretched mesentery, partially occluding the blood vessels and resulting in atonic musculature. The mechanical stimulation to proper peristalsis is dependent upon the presence of a fairly large bolus within the intestine and then a period of rest. This means regular meals and not the constant nagging of small amounts of contents without rest periods. It also requires that we eat a reasonable amount of indigestible residue, largely cellulose, to maintain the required bulk. Lack of normal secretion within the gastro-intestinal tract, adhesions and lack of the formation of regular habits of attempt at evacuation may also be important causes. Long dependence on drugging is unwise. We must first not only eliminate, if possible, the cause but bring to our assistance every factor that will aid in the return of the normal function. Bodily exercise and espe-

cially abdominal exercise of the type outlined for lordosis is very efficacious. By massage we may increase the tone of the abdominal muscles, thereby lessening ptosis, and in most cases we may directly stimulate intestinal muscle coats. Deep pressure with the heel of the hand or the fist should begin over the cecum and follow the course of the large intestine. Circular stroking should follow the same course. Deep frictions should be thorough at the hepatic and splenic flexure, where deep stroking from back to front between the lower ribs and the pelvis should be vigorously applied. On the left side the ulnar surface of the hand in many cases may follow the sigmoid flexure for quite a distance downward and forward.

Liver. Tapôtement over the ribs covering the liver, circular frictions over its free edge and gentle depression of the movable ribs will stimulate hepatic activity.

Pancreas, kidneys and bladder are not treated by massage.

Hernia may be aided indirectly by bettering the nutrition of the abdominal wall muscles, especially where a truss is worn. *Contraindications.* Any abdominal tenderness, pregnancy, and all acute infectious diseases contraindicate massage.

Scalp. The scalp is often rather tight and its circulation somewhat impaired. It can be loosened by finger tip friction with considerable benefit to the circulation and the growth of hair.

Limb Stumps. In all its range of usefulness massage gives no more gratifying results than in the preparation of stumps for artificial limbs. In a great number of cases

at the Walter Reed Hospital in Washington careful massage has worked wonders.

During the war many of the stumps were, under stress of circumstances, operated on in such a way as to make it extremely difficult to prepare them for weight bearing. The chief pressure from an artificial limb is lateral, but the soft tissue must be drawn down to form a cushion over the end of the bone. Massage should be begun at the earliest possible moment regardless of whether or not the wound is healed. If effleurage is used great care should be taken to prevent drawing up of the muscles. The stroking should be mostly downward. Vibration and friction are used concentrically from above downward, loosening the scar and working to the very edge of the new formed tissue over and around the end of the bone. Where this technique is followed very few of the blue, cold stumps, such as were common earlier in the war, result and the whirl bath for their relief is unnecessary.

Summary. I would again emphasize the fact that it is necessary to know thoroughly anatomy and physiology and the reaction of the various tissues to strain, injury, under-nourishment, etc. With this knowledge, and a general idea of the technique of the main movements, the masseur is at liberty to develop his own special technique and method of procedure. One so equipped is in a far better position to perform successful and helpful work than one working merely from the mechanical standpoint, be he ever so efficient in any given system or school of massage.

FIG. 23. BASKET-MAKING.

Can be begun while the patient is still bedridden. It passes time pleasantly and has therapeutic value in hand and wrist injuries.

FIG. 24. TELEGRAPHY.

Instruction begins at the bedside and is carried on through the shop to field work.

FIG. 25. CLAY MODELING.

One of the most valuable therapeutic measures for joint mobility in the fingers and hand. It can be used very early in cases where more complicated work is impossible.

FIG. 26. CHAIR CANING.

A trade of great vocational value with many varied movements of the hand and arm which aid in restoring function.

FIG. 27. WOOD TOY MAKING.

Psychologically most patients become like children for a time. They are then easily interested in toy making. Later this interest and incentive to work is transferred to other things.

Chapter IV

VOCATIONAL THERAPY

This branch of physical reconstruction is growing most rapidly in its breadth of application to war injuries. The problems met and overcome so successfully are those which must in the future be met by the surgeon in civil practice. The work done and the lessons learned will be of the greatest value to the compensation insurance companies whose interest in the men crippled in industrial life closely parallels the economic interest of the government in the soldiers. Insurance companies have of late recognized that treatment of the insured by physiotherapy in many cases is a paying investment, the men being returned to partial or complete efficiency at a much earlier date than would otherwise have been possible. It is certain that vocational therapy will in the future play an increasing rôle in the treatment of convalescent employees. The larger manufacturing concerns which take care of their own compensation cases would in like manner gain much from a careful consideration of these modern methods of treatment, which have proven their efficiency in far too large a group of cases to ever be considered fads. The facts are that we have as yet exhausted but a small part of the possibilities which these methods of treatment hold forth.

Specifically, the objects of vocational therapy are therapeutic, economic, occupational and to improve morale. In the early treatment of men in the army the therapeutic indications control to a large extent the type and amount, or dosage, of work outlined for a patient. For example, a man with scar tissue contracture or fibrous adhesions in the elbow joint, allowing only limited motion in semi-flexion, may be put at planing in the carpenter shop. This treatment is given the man as far as possible on the prescription of the surgeon, as shown on page 59. Such a prescription is given as soon as the man has sufficient strength, motion and muscular control to make some movement possible, this beginning usually having been obtained by the preliminary application of physiotherapy. For some time the man may be treated by the suitable physiotherapy methods together with this simple occupational work. With the lessening of his disability the problems of his future value to himself and society are taken up. The patient is either given training in work which he has done before or takes up new work which will bring him reasonable financial return and in which his interest has been already aroused. If his disability is such that he is unable to return to any occupation comparable to the one in which he was engaged in civil life after the best surgical and vocational expert advice and treatment, he is then trained in some line in which his injury handicaps him little. His degree of disability in its relation to his future earning power is calculated and the difference made up to him.

Certain types of vocational training have as their main

object the arousing of the patient from the mental and physical lethargy into which he is so apt to fall. For this purpose basketry or any simple creative work which occupies his time and interest has proven of great value. Study with a teacher of the simple branches of learning is also used to good advantage.

Interwoven throughout a man's entire treatment is the inspirational idea. The personality of the teacher is, of course, of prime importance. These men are so often left with the belief that their disability has permanently unfitted them for their place in society that the time allowed them for introspection may be more destructive to their future efficiency than the wound itself. That these men do not lack courage their glorious record has proven. The problem lies in properly arousing their grit and stamina, which, during their stay in the hospital, has become gradually inert. The man must be made to realize that the noblest of all courage is the conquering of physical handicaps by patient endeavor and that both the instructor and the government realize the quality of manhood which such a successful fight requires through weeks and months of persistent effort. Too much cannot be said in praise of the splendid corps of aides who are carrying their own discouragements in addition to lifting, to the best of their ability, those of the men whom they serve. Their work will live in the years to come through the increased efficiency with which these men will carry on.

For the proper attainment of the man's rehabilitation a close and active coöperation must be obtained between

the surgical, physiotherapy and occupational departments. It is essential that each understand and appreciate the scope of the others. Between the man's vocational training and his final status in civil life stands a most important and efficient organization, the Federal Board for Vocational Training. This organization is prepared to give expert advice on the selection of future work. It also aids the man financially to obtain better training even to the extent of paying his tuition in vocational training schools or colleges until he has reached the best preparation of which he is capable. This done, the government's debt of honor to the wounded man is met and he is returned to civil life and self-support. Let us hope that never again the old pension system with its paternalism and attendant evils will have a place in the government's care of its veteran soldiers.

In such a book as this no detailed description of the methods used in the some two hundred and fifty occupations taught to convalescent soldiers can be undertaken. I will, however, briefly state a few of the most useful methods employed. At the bedsides are taught basketry, clay modeling, wood carving, leather and bead work, making of simple toys and the beginning of the studies of English, mathematics, stenography, telegraphy, etc. In the shops are taught carpentry, photography, automobile repairing, vulcanizing, modern machine shop practice, pattern making and a wide variety of other trades. In the class rooms stenography and typewriting, wireless and the common branches of language and mathematics are a few of the subjects taken up. This is further de-

FIG. 28. TEACHING THE BEGINNINGS OF MECHANICAL PRINCIPLES.
Toys are here being made from tin cans.

veloped, where possible, by field work in electrical construction, surveying and other outdoor occupations.

Of special interest to the general hospitals wishing to add vocational training to their equipment is the curative workshop. This is an attempt to combine the simple forms of vocational work requiring only inexpensive equipment and limited space. The therapeutic indication is the leading motive for treatment. In such a workshop we would find clay modeling, which has proven invaluable in the treatment of stiff fingers and wrist. The scroll saw and various lathe machines with adjustable pedals offer unlimited possibilities for increasing mobility of hip, knee and ankle. A simple kit of tools suffices for mechanical drawing, wood working, shoe making and similar occupations.

The talent of an artist is not destroyed nor his means of expression lost when a physical disability interferes with the particular method of drawing, painting, or playing which he had formerly used. There are several cases on record for artists following injury of the right hand have quickly learned to work equally well with the left. In the same way musical talent can be utilized. Professional musicians are used in an advisory capacity to aid men to choose that instrument or mode of musical expression which is not interfered with by his disability. There is another value to this type of treatment which must not be lost sight of and that is the inspirational effect of the music itself. Many a man will spend happy and beneficial hours in the music studio instead of giving

way to the mental depression and discontent of the invalid.

In the early spring of 1919 there were already over fifty thousand patients in this country under treatment by a corps of something over three thousand aides who are teaching, as before mentioned, between two and three hundred subjects. Vocational therapy will see increasing growth and development, and must necessarily be one of the last to be discontinued when this big chapter of our country's history is closed. I wish again to emphasize that the medical profession owes the same intelligent care to our great industrial army which the government has so efficiently given to its veterans of the Great War.

FIG. 29. ADJUSTABLE FOOT APPLIANCES.
Any desired degree of flexion and extension of knee, hip or ankle is obtainable. Mechanical drawing for partial drop wrist.

FIG. 30. MUSICAL KNOWLEDGE REAPPLIED TO AN INSTRUMENT THE MAN'S DISABILITY WILL ALLOW HIM TO PLAY.

Pleasure and higher emotional tone are derived from the production of good music.

FIG. 31. AUTOMOBILE REPAIR SHOP.

This is one of the most practical, valuable and popular forms of vocatio therapy.

FIG. 32. WOOD WORKING.

Gives many possibilities for self expression, arouses the creative interest and exercises almost innumerable muscle groups.

(Orthopedists have found the following simplified form useful in briefly outlining the reconstruction treatment which they considered best suited to the needs of the patient.)

EDUCATIONAL SERVICE

U. S. Army Base Hospital

Camp Meade, Md.

MEDICAL OFFICER'S PRESCRIPTION

Name .....

Ward .....191.....

Diagnosis .....

.....

.....

.....

Probable length of stay in hospital.....weeks.

Probable condition after completion of hospital treatment

.....

.....

Functional result to be attained.....

.....

.....

In orthopedic cases check below:

..Abduction	..Thumb	..R....L
..Adduction	..Finger	
..Flexion	..Wrist	
..Extension	..Elbow	
..Pronation	..Shoulder	
..Supination	..Back	
..Circumduction	..Toes	
	..Mid-Tarsus	
	..Ankle	
	..Knee	
	..Hip	

Remarks .....

.....

.....

.....

PRESCRIPTION BLANK FOR VOCATIONAL THERAPY

Please check below the general class to which this man's disability belongs, using double check for major disability and single check for minor.

MEDICAL CONDITIONS	SURGICAL CONDITIONS
Cardio-vascular	Orthopedic
Pulmonary Tuberculosis	Amputation
Functional Neurosis	Eye, Ear, Nose
Insanity	Throat Disease or Wound
Nephritis	Nervous System
Gastro-intestinal	Blindness
Skin Disease	Deafness
Gassed	Speech Defect
Convalescent	Severe Injury to Face or Jaw
Other general medical	Venereal Disease or Sequelæ
	Surgical Condition of G.-U. System
	Venereal
	Non-Venereal
	Other surgical conditions
	Convalescent

This man is ready for assignments checked below (please include all of which he is capable):

Work in wards: Mental.....Physical.....

Classroom work not to exceed.....hours and.....minutes daily.

Shop or farm work....

Hours per day....

Light.....Heavy.....

Outdoor.....Indoor.....

To be avoided.....

.....

.....

.....

.....

Medical Officer's Signature

(This prescription will be filed in the Surgeon General's Office as a part of the Physical Reconstruction Register.)

PART II
ORTHOPEDICS

Chapter V

CONGENITAL DEFECTS

Club Foot. As this common condition is much more often congenital than acquired, the congenital type only will be considered. There are four types. The deformed foot (talipes) may be, 1. Extended and everted, equino valgus. 2. Extended and inverted, equino varus. 3. Flexed and everted, calcaneo valgus. 4. Flexed and inverted, calcaxeo varus. Simple talipes equinus is discussed under muscle-bound foot.

These deformities vary greatly in their resistance to corrective measures. Resistance in any given case increases with age, therefore treatment should be begun as early as possible. In very slight cases manual correction alone may suffice. In the more marked types a series of casts must be used. In the commonest type, equino varus, emphasis must first be placed upon straightening the foot, flexion being easily obtained later on if necessary by tenotomy. The series of casts should be as nearly continuous as possible and each should remain on about two weeks.

Hip Dislocation. This condition is more common than is generally realized and the difficulty of reading X-ray

plates makes it necessary to use the utmost care in diagnosis. A neglected hip means an undeveloped or shallow acetabulum into which it may be impossible to place the head of the femur later on. It interferes with the development of the bones and tends to an asymmetrical pelvis. The table devised by Hibbs of New York has been used very successfully in difficult cases. Care must be taken not to overreduce and create a dislocation in the opposite direction, as has often been done.

RICKETS

Cause. We find rickets most prevalent among negro and Italian children of the first generation. It is caused by a lack of sufficient lime salts in the bone, primarily because they are not supplied in proper amount in the diet. The prolonged nursing of children to the fifteenth or even eighteenth month is perhaps the commonest cause. The dependence upon macaroni as the staple Italian diet accounts for a good deal of it.

Diagnosis. The large, square head with overhanging forehead and delayed closing of the fontanelles; enlarged epiphyses of the long bones; the beading of the sternal end of the ribs, so called rachitic rosary; the prominent, hard abdomen, and a tendency to draw up the legs, are the main early symptoms of the disease. Later on, bowing of the legs or knock knees develop.

Treatment. Improved hygiene, especially in regard to diet, fruit juices, particularly orange, green vegetables, fresh milk, eggs, etc., is essential. Massage is a valuable adjunct of the treatment. Braces are usually

needed and must be faithfully worn. Even in rather severe types of bow leg one brace will often suffice. If not it can be changed over or an additional brace made for the other leg. Anterior and very severe lateral bowing often call for surgical interference. A careful study of the epiphyses by the X-ray is very essential in order to determine the optimum time to operate when true bone has just begun to be rapidly deposited. Knock knee as well may call for surgical intervention guided by the same principles. It must be emphasized that permanent injury may be done to the knee joint rather early in neglected cases and that, with each additional degree of deviation from the normal line of weight transmission, a very great amount of additional strain is thrown upon the structures of the knee.

Coxa Vara. This is a decrease in the angle between the surgical neck and the shaft of the femur with consequent shortening of the affected leg and change in the normal line of weight transmission. Its effect is similar to but not usually as pronounced as that described as resulting from congenital hip dislocations. It calls for a long stilt brace on the affected leg to transmit the weight of the body from the pelvis to the ground, the weight of the leg giving some extension. The shoe on the unaffected side should be built up.

Spastic Paralysis. Central motor neurone lesions most often found in prolonged labor or instrumental delivery result in spastic paralysis. The only immediate relief of this condition is decompression, as performed with considerable success by Dr. Sharpe of New York, but even

under most favorable conditions a happy result is not certain. The associated retardation of mental development greatly complicates the problem of neuro-muscular education. Treatment by effleurage and passive stretching should precede exercises for coördination and balance. To bring lasting results these must be extended over a span of years. Every case can be improved and should be a challenge to us to obtain the greatest improvement possible, even when complete recovery is hopeless.

Fig. 33. Carriage which Reduces Friction and on a Smooth Surface Allows Wide Range of Movement with Slight Effort.

Fig. 34. Wire Cockup Splint for Wrist Drop, Light in Weight, and Requires No Bandaging.

Chapter VI

INFANTILE PARALYSIS

In infantile paralysis the lesion is a destructive one of the anterior horn cells of the cord and the lower motor neurones and almost always the resulting paralysis is a flaccid one. The trophic nerves are likewise affected and the part tends to decrease in bulk as well as in power. During the active stage, and while any tenderness persists, the patient should be kept immobile. This is best done by means of a cast or splint, but immediately thereafter for an extended period of time, daily treatment consisting of massage, exercise, support and sometimes heat, should be instituted. Massage should be mainly fine, deep pétrissage for stimulative effect. The operator must be sure that he is getting direct action on the few fibers that may remain alive under the usual thick coating of connective tissue and fat.

Exercises. In general, small and often repeated doses bring the best results. Like the burning out of a weak motor, lasting harm may be caused by overdoing. Many devices for counter-weighting the limb have been used, thereby giving the patient the early and stimulating effect of being able to move the limb actively. We have used a small carriage, consisting of a grooved platform mounted on casters and with a retaining strap.

This is easily made, and by overcoming to a large degree the friction of even a smooth table surface, will allow great amplitude of active movement very early in the treatment.

Let us consider as a typical case a paralyzed arm in which the adductor muscle group is partially affected, the abductors of the arm, especially the deltoid, the trapezius and the supraspinatus have regained their strength but slightly, the flexors and extensors of the elbow have very little power remaining, and the muscles of the forearm and hand are practically powerless.

The following three programs of exercise, preceded by the application of massage and heat, are suggested as giving, when used in rotation, a variety, which is of value in retaining the patient's interest.

PROGRAM I

The patient sitting, affected side toward table, hand strapped on carriage.

1. Wide sweep of arm forward and backward.
2. Flexion and extension of the elbow to the side.
3. Wide sweep of arm with one or more attempts to stop and start again at definite points.
4. Small hand circles, elbow free, done a few times in each direction.
5. Flexion and extension of the elbow, fixed.
6. Patient leaning far forward, wide sweeps of the arm. (The plane of the movement of the arm in relation to the body is thus changed from horizontal to vertical and valuable help is given in stretching the adductors.)
7. Forearm fixed, abduction and adduction of the wrist.

8. Hand turned, ulnar side down, flexion and extension of the wrist.

9. Patient prone on the table, wide sweep of the arm from side to side overhead. (On a narrow table use as wide a movement as possible directly above the head.)

PROGRAM II. FREE EXERCISES

Patient supine on the table. These exercises may be done by the affected arm only, by both together or alternately. Greater variety of neuro-muscular training may be secured by these different combinations.

1. Raise arm fore upward, carry above head and return.
2. Place hand on hip and return.
3. Carry arm sideward up to head and return.
4. Carry arm across body to opposite side of waist and return.
5. Snap hand to shoulder and return, aided by lifting elbow sideward if necessary.
6. Carry arm sideward, flex elbow, bringing hand to axilla, straighten sideward and return.
7. Flex elbow, bringing hand to opposite shoulder and return.
8. Supinate and pronate the forearm. (In this position this may be a shoulder exercise.)
9. Flex elbow to right angle, supported if necessary and pronate. (This position eliminates shoulder assistance.)
10. Flex elbow, hand on neck to shorten leverage, extend shoulder upward and return several times, return hand to side.

PROGRAM III. RESISTIVE EXERCISES

Fingers. 1. A well-fitting kid glove with small rings at the finger tips, to which are attached very light weights by means of strings, and used for flexion of fingers singly or together with the hand supine, the strings running over a wrist roller

or a row of spools. Pronate the hand for finger extension in similar manner.

2. Finger flexion machine—finger tread-mill.

Wrist. 1. Wrist roller.

2. Supination and pronation machine.

3. Abduction and adduction machine (McKenzie).

With overhead chest weights.

Elbow. 1. With hand encased in glove, if necessary, and attached to overhead pulley handle, flex elbow.

2. With arm at side allow weights to flex elbow as far as the control of the patient will allow, and extend downward.

Shoulder. 1. From extended arm, carry arm obliquely fore downward.

2. From extended arm, carry arm side downward.

3. From extended arm, carry arm obliquely back downward.

4. Arm raised sideward at shoulder level, carry forward and return, carry backward and return.

Without Chest Weights. Patient seated in chair, back to operator. Operator places hands on tips of shoulders while patient (1) pulls the shoulder forward, (2) lifts it up, (3) pushes it backward.

Most of the above exercises can be worked out with the shoulder or low chest weight, especially with the patient lying supine, head toward the weights. The overhead pulley, however, gives the additional advantage of passive stretching of the stronger, and frequently shortened, adductor groups. The other, and still more common, result of infantile paralysis is a partially paralyzed leg. We will take as our basis a leg in which all the muscles of the thigh have a fair amount of power present, the extensors of the foot are considerably weakened, and the flexors are almost powerless.

PROGRAM I

Patient lying supine.

1. a. Operator grasps the fore part of the foot with one hand, the heel with the other and passively flexes the toes and the fore part of the foot.

b. With the right hand grasping the fore part of the foot, the thumb on the ball, the left hand grasping behind the heel, the operator vigorously flexes the foot with an attempt at stretching the gastrocnemius and the calf muscles and, if necessary, slightly assists the extension. With the left hand working in the opposite direction, he overcomes the patient's movement at the hip, because, in attempting to extend the foot, the patient will press down with the whole leg, and vice versa.

2. The operator, supporting under the knee with the right hand, and the left under the ankle, is able to give any needed amount of assistance to the extension of the leg.

3. Grasping behind the ankle and giving support over the knee, if necessary, he assists the flexion of the hip with straight leg.

4. From the same starting position abduction and adduction are given, the operator carrying the weight of the leg.

5. Deep flexion of the thigh is done with the same assistance.

6. The carriage is placed under the ankle for active abduction and adduction.

Patient lying on affected side.

1. a. Place the affected ankle on carriage, knee fixed, for active flexion and extension.

b. With knee bending, flex the thigh acutely.

Patient lying prone.

1. The knee is flexed at right angles and held by operator or patient for rotation of the thigh.

2. Flexion and extension of the knee.

3. Overextension of the thigh by backward and upward pull of the operator.

4. Knee flexed, circling of the foot both ways, which is a combination of 1 and 2.

There are various tread mills and extension weight machines, which are of value. Machines for flexion, extension and circumduction of the ankle all have their place, if available.

It is taken for granted that the operator will vary and adjust his exercises exactly in relation to the strength of each group of the patient's muscles, following the general rule that the movements often have to be entirely passive at first, with a slowly increasing amount of assistance by the patient, and final development into active or even resistive movement. Again I would caution against too much work. An average of four to eight repetitions of each exercise in the program selected are sufficient for each treatment.

Support, especially a brace in the case of the leg, is almost always essential and when needed should be worn constantly. The deformities we fear, overextension of the knee and drop foot, are generally the result of the neglect of this needed support. Parents often need the truth driven home to them that it is the brace which carries the child, when to them it appears that the child is lugging around a heavy extra weight. A late complication, coming from two to four or even six years after the disease, is scoliosis, and this must be watched for from time to time. Indeed, Doctors Hibbs, Farrell and

Humphries, from their work in the New York Orthopedic Hospital, have come to the conclusion that infantile paralysis is the most common single factor in the causation of scoliosis. Late sequelæ in unfavorable or neglected cases may demand tenotomy or muscle transplantation, but these operative procedures are not as early resorted to as heretofore. They should only follow several years of patient endeavor to secure the fullest results that may be hoped for from exercise, and, if done, must in turn be followed by reëducation. Recent rather brilliant results in apparently hopeless cases have been achieved by baking for a considerable time in moderate temperature. One must avoid allowing the monotony of the work to get one into a rut and to make one overlook the individual problem incident to each case. Nothing in our field of work brings richer reward than patient, intelligent work with this distressing condition.

Drop Wrist. This is another common type of paralysis, which may follow fractures of the humerus, or lead poisoning. It is the paralysis of the extensors of the wrist and exercises as outlined above are applicable. Splinting in extension must be maintained constantly.

NERVE INJURIES IN WAR

Injuries to the peripheral nerves are very common in modern warfare because of the extensive lacerations of the soft tissue caused by many types of projectiles. In fact the high velocity bullet at mid-range and gas shells are about the only missiles that do not make this kind of wound. "The Orthopedic Treatment of Gunshot In-

juries," by Leo Mayer, covers this field in a very satisfactory manner.

Neurological examinations were made at the Field or Evacuation Hospital when possible and splints supplied if the injuries were extensive. It is important to remember that all wounds of the soft parts are now splinted where practicable. I will attempt only briefly to outline the diagnosis and treatment of injuries of the most common type.

Upper Extremity. 1. Brachial plexus injuries are occasioned by axillary or supraclavicular wounds. 2. Circumflex. The teres minor and deltoid are affected, so that full abduction of the arm is impossible. 3. Musculocutaneous. Weakness of elbow flexion without areas of anesthesia occur. 4. Musculospiral. This very common injury makes it impossible to extend the wrist or thumb and the proximal phalanges of the fingers are also affected. The distal phalanges can be extended, supination and the action of the triceps are weak, and small areas of anesthesia may be present on the base of the thumb. 5. Median. Flexion of the fingers and thumb is absent and there is anesthesia over the first two fingers and the outer half of the third. To test paralysis of pronation have the elbow fixed. 6. Ulnar. Fourth and fifth finger flexion is weak and there is inability to spread the fingers to the normal extent. The fifth finger and the inner side of the fourth is anesthetic.

Lower Extremity. 1. Sciatic. There is weakness of knee flexors and complete paralysis of the foot with nearly total anesthesia. 2. External popliteal. Dorsal

flexion and eversion are absent and the dorsum of the foot and toes is anesthetic. 3. Internal popliteal. Plantar flexion is weak or absent with anesthesia of the sole of the foot. 4. Musculocutaneous. Foot eversion is weak and there is anesthesia over dorsum of foot. 5. Anterior tibial. Dorsal flexion is absent with anesthesia of the big toe and part of the second toe. 6. Posterior tibial. Adduction is weakened and toe flexion is absent.

Treatment. Early treatment by splinting in such a way as to relax the fibers of the affected muscles is essential. This general rule may be accepted in the case of ulnar nerve injury because of the danger of contracture, hence the fingers should be kept straight. Attempt to bring the severed ends of the nerve into as close approximation as possible. Plaster, leather or metal may be used for splinting. In injury to the musculospiral nerve keep the hand extended. It is well to abduct the thumb also. The proximal phalanges of the fingers must be kept extended by the cockup splint.

Chapter VII

THE SPINE—DISEASES AND INJURIES

Anatomy. The spine is a flexible column made up of a series of block-like bones, the vertebræ. There are thirty-three in the entire column, seven neck or cervical, twelve dorsal or thoracic, five lower back or lumbar—five fused together for the sacrum and four fused to form the coccyx. In general, the vertebræ consist of two essential portions, the heavy solid body in the front and the neural arch formed by the two pedicles and two laminæ, with their processes, two transverse, four articular and one spinous. The bone structure is more dense in the neural arch than in the body.

The bodies, with their intervertebral, cartilaginous pads are able to rotate slightly, one upon the other in what more or less closely approximates the horizontal plane. The articular processes, however, are placed in an oblique plane, the superior backward and upward, the inferior forward and downward in direction. With the spine erect these articulations act as a check to rotation between the bodies. The anterior common ligament, binding the front of the bodies together, is not nearly as strong as the combined interspinous and supraspinous ligaments. There is a great difference in the mobility of the various parts of the spine. We find the most mo-

bility between atlas and axis; flexion forward is least in the dorsal, then cervical, most in lumbar; extension backward, the same; rotation is most in the cervical.

Tuberculosis of the Spine. ("Pott's disease.") The spine is one of the most common regions at which the tubercle bacillus attacks the bony skeleton. One or more vertebræ may be involved either as a primary or a secondary focus of infection. The bodies of the vertebræ are usually the parts first invaded. Points of lowered resistance caused by trauma are often affected or such a trauma may bring to light a slowly developing and heretofore unsuspected infection and cause its rapid spread. The cancellous nature of the bones permit early destruction with crushing in wherever the infection is extensive. The collapse of the body of one or more vertebræ makes more prominent the spinous process and forms on the back the distinctive angular deformity known as a gibbus. Complete paraplegia from pressure on the cord may occur. Spinal caries is more frequently found from the fourth to the fifteenth year.

Symptoms. Knowledge of tuberculosis in the patient or his family should make us use extreme care to rule out this condition in the presence of any obscure symptoms pointing to the back. Usually they are pain, protective spasm with resulting rigidity, angular deformity and the general signs of a chronic infection, although in early stages this may not be present. Rigidity alone is a symptom of great significance and sometimes a sufficient basis for a positive diagnosis. The X-ray should always be used and will often confirm the diagnosis. It

is of the utmost importance to differentiate this condition from scoliosis and kyphosis since the treatment for tuberculous spine by exercise would do certain injury. I have seen them exist together, with the postural defects the more obvious.

Treatment. Pott's disease demands the same constitutional treatment as tuberculous manifestations elsewhere in the body. The local treatment consists in fixation and extension by means of cast, brace, stretcher frame, or by the operative establishment of immobility, secured by a bone graft from the tibia implanted into the split spinous processes and extending one or two vertebræ above and below the lesion as devised by Albee of New York. Another successful method is that of Hibbs, consisting in a partial resection and fusion of the laminæ. This operation has the advantage of making but one incision and eliminates the slight prominence of the bone graft. Where the lesion is in the cervical section an extension of the brace or cast which will lift up the head is necessary. For example, the Taylor brace with head support (jury mast) is often used. Grafts which prevent collapse have been successfuly planted into the sacrum. A complication which necessitates special attention is abscess formation. They commonly follow the course of the psoas muscle, and point in the inner side of the thigh, but are subject to a wide variation and may point in almost any direction from the seat of the lesion. Aspiration under aseptic precautions is sometimes advisable. Sinuses already formed should be injected with Beck's bismuth paste.

They should be carefully dressed to prevent mixed infection and will usually clear up when proper measures are instituted at the seat of the original lesion.

TRAUMATIC INJURIES

Strain and Sprain. Prolonged carrying of heavy weights when the patient is not in proper condition may lead to back strain. An example of this is the heavy marching order on the part of the recruit not yet thoroughly hardened. Weight lifting in the stooping posture is the common cause of lower back strains. Sudden twisting or falls upon the back or the awkward landing after jumping, may lead to quite severe sprains of any of the various ligaments.

Treatment by means of heat, massage, rest, and support is indicated.

In sacro-iliac sprain the following strapping will be found most serviceable: The patient lying prone, the surgeon fixes the strap, which should be the full width of the roller, 3 to 5 inches in front of the anterior superior spine on the further side of the patient. The patient then rolls slowly away from the surgeon, who applies the strap tightly obliquely upward, ending just below the twelfth rib of the opposite side. The procedure is then repeated in the reverse direction, the two, broad, snugly fitting straps crossing over the sacrum. They may be reinforced by a short vertical strap of the same width over the sacrum and one or two lumbar vertebræ. Most corsets or belts which fasten in front aggravate the con-

dition because their pull tends to open the sacro-iliac joints.

Bruises. Bruises of the muscles and ligaments along the spine show, beside the swelling and discoloration which may be present, a localized tenderness on one side of the spine. The spinous processes should not be tender in this injury.

Fractures and Dislocations. Spinal fractures are rare.

Cervical Region. This region, because of its mobility, is prone to dislocations, but fractures do occur. Slight lesions only need treatment, as a fatal outcome is almost certain in severe injury. Dislocation of the atlas anteriorly on the axis is sometimes seen. Slight displacement, if associated with fracture of the odontoid process, may not be fatal. In this lesion the short spine of the axis may be palpated. The head is bent forward. Slight lateral dislocation at this joint, or between the other cervical vertebræ, is not uncommon and gives no other symptoms than slight pain and rigidity of the neck.

Treatment. After anesthesia, gentle hyperextension maintained by a jury mast is necessary. In lateral displacements tilt the head toward the opposite side, increasing the deformity, but unlocking the facets; turn the head toward the deformity to raise the caught facet and then re-turn the head to a correct position.

The third, fourth, or fifth cervical vertebræ may be fractured or partially dislocated by blows or falls on the head. Such injuries are reduced as described, under anesthesia, if required. When removal of the patient is necessary in any of the above injuries some means of ex-

tension is essential. A temporary collar of folded stiff paper, plaster or other stiff material will attain this result.

Dorsal Region. In the dorsal vertebræ the bodies or laminæ are seldom fractured except in fatal accidents. The spinous processes, however, are subject to fracture. The symptoms are sharp pain, crepitus, and abnormal mobility on palpation of the spinous process. Extravasation of blood in the tissues may be noticed. Deviation of a single spinous process, which may be gently pressed back to its normal position, and the localization of pain close to the skin are other prominent symptoms. The examination should be supplemented and the diagnosis confirmed by the X-ray. In the lower cervical and upper dorsal regions a support transferring the weight to the pelvis is efficient and permits of the patient getting about fairly early. In lower dorsal injuries this complete relief from weight bearing is difficult to attain. At least two months in the recumbent position is required for absolute safety.

Lumbar Region. The mobility of this region and the fact that it is unprotected by bony structures, as the dorsal region is, subject it to injury. Dislocation is extremely rare and even in fracture of the bodies we do not as a rule get marked displacement. Fatal outcome of such injuries is rare since they are below the level of the cord. Careful examination is required as it is easy to overlook fracture in this region. Any change in the normal lumbar curve is suspicious. X-ray should be used in diagnosis whenever possible. The appearance of lum-

bar deformity, particularly backward displacement, requires extension on the stretcher frame. As is the case with lower dorsal fracture, it is impossible to completely relieve weight bearing. Treatment in the horizontal position must be continued six to ten weeks.

Partial dislocation forward of the fifth lumbar vertebra on the sacrum is becoming increasingly common and often follows relaxation of the sacro-lumbar ligament. This is due to the abnormal obliquity of the pelvis, which occurs in lordosis, and which is often associated with the wearing of high heels. This is a common cause of backache and it is most difficult to obtain fixation by means of a brace. Treatment by orthopedic gymnastics is not satisfactory since the required muscle leverage is lacking. Fixation by bone graft is often the only permanent means of cure.

Partial sacro-iliac dislocations may in like manner require bony fixation if the lesion is an advanced one. Treatment of mild types of this condition have been described under the topic of sprain.

Penetrating Wounds. Wounds by shrapnel, bayonets and bullets are common in the spine. The bodies and the sacrum do not splinter to any extent. From the spinous process, pedicles or laminæ splinters or chips of bone may be driven into the cord. The occurrence of paralysis, which by its type will aid in localizing the injury, calls for operative interference. Use the X-ray for diagnosis and reduce probing to a minimum. Infected wounds should be treated by Carrel or other approved methods and the fixation should be prolonged.

Chapter VIII

CURVATURE OF THE SPINE

Kyphosis. This is an abnormal increase in the dorsal curve of the spine accompanied by a forward position of the shoulders and head. With accompanied lordosis it gives us a picture known as fatigue slump. There is a type of rounded back, the appearance of which is due to a heavy bed of muscle under and over the scapulæ. The pronounced development of the muscles beneath the scapulæ, but more especially of the supra- and infra-spinatus, the rhomboids, the trapezius, teres major and latissimus dorsi, found particularly in heavy-set athletes, rounds out the back. This heavy type of muscle is often found in weight-lifters, wrestlers, football players and apparatus and gymnastic team men, and we find the same heavy bed of muscles on the chest. The need for keeping such a build in mind is apparent at once in considering the relationship between this condition and corrective gymnastics. Exercises would of course be superfluous, since there is no weakness of the upper back groups and no generalized weakness.

Obviously an incorrect posture of head and shoulders is concomitant with this condition and when they do occur together the emphasis should be laid simply on the reëducation of the muscle sense to correct posture. As

shown clearly in the studies made and charts worked out by the American Posture League, the proper carriage without exaggeration, of the head erect, the shoulders back and the abdomen well retracted is that position which throws the least strain upon those groups of muscles whose action maintains the upright posture. With each small increase in deviation from this normal posture we are subject to a very great increase in the effort necessary to stand erect. There is, therefore, due to the weakening effect of such unnatural effort, a tendency to further slumping. For instance, this fatigue position into which a person has fallen during the weakness of a convalescence may of itself so increase the strain of standing correctly as often to make it impossible for him without special treatment to reassume his former normal posture even after complete return to vigor. The conditions once assumed tend to become habitual, and due to a gradually modified muscle sense, may be absolutely unconscious on the part of the patient.

The two great factors that determine the rapidity and the amount of increase of any postural defect are the strain to which the tissues of the body are subject and their resistance to that strain as determined by their state of health and development. In estimating the amount of strain we have to consider duration in relation to periods of rest, as well as intensity and amount.

Causes. As indicated above, the causes of this type of faulty posture fall naturally into two groups. First, where the tissues of the body are weakened because of too rapid growth, illness, faulty metabolism, impaired

mental development, overweight. Children handicapped in any of these ways are affected quickly by undue strain and we should never lose sight of the fact that the average burden may for them be too great. The second cause is where normal children have too great a burden placed upon them. Among the common strains to which childhood is subjected, habitually assumed faulty attitudes in school, at home or at work are the most common. The hanging of clothing from the shoulders where the weight falls, as it usually does, far out towards the tips, is another cause for slumping forward. Defects of vision and hearing and excessive abdominal weight are also frequent causes.

Symptoms. The earliest symptoms shown are forward position of the head and the prominence of the lower angles of the scapulæ, followed later by a rolling outward of their entire inner borders, with stretching of the rhomboid groups and a forward position of the shoulder tips. Up to this point there may be no noticeable involvement of the spine. This slight amount of stoop is not included in kyphosis by some authors. Some college medical examiners, who do include this degree of faulty posture under the term of kyphosis, have reported from sixty to eighty per cent of their students as in this class. The next degree involves the spine and it becomes increasingly difficult for the patient on command to assume the normal posture. In fact, it is often altogether impossible for him. There is a growing tendency for the deformity to become fixed and the spine less flexi-

ble. A structural shortening of the pectoral group is found in nearly all the marked cases.

Treatment. By this time the necessity for the early institution of the proper treatment, before the condition has progressed far in time or degree, must be evident to the reader. Our problem is not a simple one. It includes, of course, the removal of the cause, if possible, if it be of the type we have included under undue strain. The general health of the patient must be built up and especial emphasis laid upon this procedure where we have determined the cause to be subnormal strength due to any of the conditions mentioned in that group. Our corrective exercises are aimed at the particular group of muscles whose relaxed condition allows the faulty attitude, here largely the trapezius, rhomboids, supraspinatus, and the stretching out of their physiological opponents, with their tendency to contracture, in this case the pectoralis major and minor especially.

There is probably no type of deformity where the use of braces is so much abused as in this case. It is well to remind the reader again that it is only by proper use that muscles grow strong, and if the back muscles are weak and relaxed and the patient allows his shoulders to be pulled forward by the stronger pectorals, a brace would but make a bad matter worse. It would allow the upper back muscles to relax completely and to perform a very small proportion of their normal amount of work. It is evident that it is their increased development and not their relaxation which we desire. These same principles apply to all braces for the correction of faulty pos-

ture. They are as a class not only useless but often do great harm. Their only justifiable use is to prevent tissue relaxation during some temporary weakness and should then be coupled with definite effort to strengthen the affected parts.

The special fault to be found with shoulder braces as a class is that they exert their counter pressure against the mobile lumbar spine and tend to produce lordosis. It is not unusual for children wearing such braces to appear at the dispensary with their shoulders held back but their heads thrust forward and a very pronounced degree of lordosis developed.

EXERCISES

1. Corner exercises. Child facing the corner of the room about three feet in front of it places the hands, elbow high, against the wall about a foot on either side of the corner and the same distance below the shoulders. The body is lowered forward by bending elbows, keeping the chin and abdomen retracted, then pushed backward to straight arm. The teacher standing behind resists the push by exerting counter pressure with the hands between the scapulæ.

2. Arm—shoulder groups—using three counts.

(a) 1. Arms forward raise. 2. Sharply sideward carry. 3. Sideward lower—keeping shoulders retracted.

(b) 1. Arms forward raise. 2. Arms sharply forward bend. 3. Sideward lower—keeping shoulders firmly back.

(c) 1. Arms forward raise. 2. Obliquely side upward raise. 3. Sideward lower.

3. Knee bending at stall bars. Patient stands back to stall bars, grasps behind shoulders, then keeping head, shoulders and hips against the bars, does deep knee bend.

4. Hand suspension—spine twisting.

5. Pectoral stretching—supine on plinth or narrow bench, neck firm, counter pressure downward on elbows.

6. Swimming—arms forward bend, lower trunk forward, carry arms fore upward and slowly side downward in imitation of breast stroke.

7. Hand suspension with counter pressure between shoulder blades.

8. Arm rotation outward, forcing shoulders back.

9. Patient sitting on chair or bench, with neck firm. Teacher stands behind, knee, padded if necessary, between shoulder blades, grasps shoulders or upper arm, fingers in front, thumbs in back and passively stretches the pectorals.

10. Mirror—for reëducation of muscle sense with the aid of sight to proper posture.

11. Floor hang forward. Patient stands in back of slanting ladder grasping round, shoulder high, arms length in front. Without moving feet body sways forward.

12. Wands. Raise arms upward in line with shoulders. Marching head erect with wand behind shoulders. Thrusting upward, lowering behind shoulders, trunk lowering forward.

Exercises 1, 2, 6, 7, 8, 11, and 12 are given particularly for the strengthening of the dorsal muscles.

Exercises 3, 5, 9 and 11 aim at the stretching of the pectoral muscles.

For attaining general flexibility, exercise 4 is especially valuable.

Exercises 6 and 11 should not be used in cases where lordosis also occurs, as their action would tend to increase the lumbar curve.

The mirror is of particular value in training muscle

sense which must be reëducated before the patient will be able to retain a correct posture.

Whether or not all these exercises, which should be done four times each, are included in an ideal program, it must be remembered that in the development of tone and reëducation of muscle sense bodily tone must be raised, the weakened groups of muscles must be exercised, the contracted muscles must be stretched and general flexibility must be attained so that definite exercises for each of these aims must be included in every program.

Lordosis. Lordosis is an abnormal curve forward in the lumbar spine.

Occurrence. Slight degrees of lordosis are extremely common, but such an amount as will call for treatment is rather rare.

Causes. All the etiological factors mentioned for kyphosis may be secondary causes of this condition since lordosis often is secondary to and compensating for kyphosis. Such compensation is necessary for the reason that, with the head and shoulders forward, the center of weight transmission would fall too far forward in the lumbar region. The spine, therefore, adjusts itself by increasing the lumbar curve so as to reëstablish the transmission of weight in the normal plane.

Among the primary causes are: 1. High heels, which increase the inclination of the pelvis, thereby tilting forward the lower lumbar vertebræ also and making an increased curve necessary. 2. Excessive abdominal weight such as the deposition of a large amount of fat

in the abdominal wall. Pregnancy may be a temporary factor. Poor or exaggerated posture may also bring about this condition.

Sequelæ. The superincumbent weight of the body, the greater part of which is borne by the lumbar vertebræ, tends greatly to increase this condition when once it has been established. In addition the increased inclination of the pelvis changes a section of the lower front abdominal wall from being merely a retaining wall to a weight bearing floor of the abdominal cavity. The abdominal contents tend to follow the relaxed wall and their ligaments exert an increased pull forward and downward upon the lumbar spine. This condition in two ways again exemplifies the fact that a structural deformity once established tends to increase in degree.

Treatment. Braces are useless unless they take their fixation on the more immovable lower dorsal vertebræ and sacrum and are coupled with exercise. If the cause is indirectly due to kyphosis, that condition should be treated at the same time. General conditioning to remove the abdominal weight must be undertaken and the heels should be lowered when these evils are a part of the cause.

EXERCISES

1. Long sitting. (Legs extended forward on table or floor, knees straight.) Hold several minutes.
2. Supine lying.
   (a) Alternate knee bending upward.
   (b) Alternate leg raising forward.

(c) Stride seat on plinth or narrow bench. Raise wands fore—upward overhead and raise legs to long sitting position, lowering wand behind shoulders and return to starting position.

3. Hand suspension.
   Alternate knee raising.
4. Long sitting.
   Arms thrusting upward against counter-pressure.
5. Hand suspension with both knee raising. Later both leg raising, knees straight.
6. Supine lying, feet fixed—sitting up and returning to lying.

This last exercise can be made increasingly severe according to the arm position. It is the easiest by extending arms over head and flinging them sharply with raising of the body. Next, with arms beside the body, then extended sideward or folded, and hardest, with arms extended over head without flinging with the body raising.

7. Supine lying.
   (a) Bend both knees upward.
   (b) Raise both legs upward.
   (c) Flex and extend knees alternately in imitation of bicycle pedaling.
8. Long sitting—retain several minutes.

Numbers 1, 2, 3, 4 and 8 stretch the erector spinæ muscles.

The others strengthen the abdominal group of muscles, the object of which is to bring the sternum and the pubis closer together, decreasing the inclination of the pelvis.

Scoliosis—Rotary Lateral Curvature. One author has stated that "lateral curvature is the most difficult and subtle part of orthopedic surgery," and a survey of the

literature would certainly seem to confirm this statement. It is especially confused in regard to the causes of rotation and the direction in which it takes place.

A good deal of valuable research on this subject has been done by Lovett of Boston, Young of Philadelphia, and others. Lovett especially, in his excellent book, "Lateral Curvature of the Spine and Round Shoulders," devotes several chapters to the working out of the problem of rotation on the living model and the cadaver. He bases his conclusions, that the bodies rotate toward the concavity on his experiments in functional lateral trunk bending on the part of the model and on the torso of the cadaver, and assumes that this applies equally to functional lateral curvature. He also states in common with other authors, that the apparent curve as shown by the marked spines is no index of the latitude of deviation that may be present in the bodies—that the apparent curve may be less than the real curve. Most investigators believe that the rotation is a torsion or twisting due to superincumbent weight. Following the law that where those in the center of a column of block-like bodies are displaced so that the center of gravity falls nearer the periphery of some and weight or pressure is exerted on this column, those blocks displaced will twist upon their vertical axis, the amount of turning being in proportion to the amount of displacement. That the spine follows this rule is conclusively demonstrated by Young in his text-book. The bodies of the vertebræ rotate toward the convexity of the curve, turning the spines back toward

the mid line, thus making the apparent curve less than the real curve.

Many orthopedists believe that the structural curves are always associated with softening of bone, and that normal tissue may not be deformed. Recent operative procedures for the correction of scoliosis demonstrate that the bodies of the vertebræ rotate toward the convexity, as I have stated, and that bone deformity, especially wedge shaped vertebræ, is not by any means always found in rigid curves, but that these curves may readily be straightened out, once the muscles have been dissected away and that they are entirely responsible for the apparently fixed condition of the curve. This is a still further confirmation of the fact already stated that muscles, which are given slack, tend slowly but surely to a definite structural shortening, that may become extremely resistant to corrective measures.

Occurrence. Percentages given for this defect differ widely, and the acceptance of very slight degrees of scoliosis depends largely on the personal equation of the examiner. Seventeen per cent for girls, ten per cent for boys is probably a conservative estimate of the prevalence of this condition.

Classification. From the standpoint of the condition of the tissues involved scoliosis may be divided into functional, postural and flexible, and into rigid, fixed, structural or organic. From the standpoint of the appearance of the curve, or curves, we differentiate the single, simple, total or "C" shaped curves from the compound, double (sometimes triple) or "S" shaped curves. The

above classifications are not interchangeable for, while it is perfectly true that most curves in the beginning are both single and flexible, single curves may become fixed, or double curves remain flexible.

Causes. It has been stated that "school-rooms are factories of scoliosis." An exact knowledge of the mechanics of proper school sitting is necessary if we are to decrease this defect. The following requirements have been found most satisfactory: (a) Height of seat; feet should rest lightly on the floor, knees bent at right angles. (b) Seat should slope slightly back, three-eighths of an inch. (c) The length of the seat should be two-thirds the length of the thigh. (d) The width should be at least that of the hips. (e) The back should slope backward about one inch in twelve from the vertical. (f) The edge of the desk should be in a straight line over the edge of the chair. (g) The height should be such that the forearm rests easily with elbows at right angles. (h) The desk should slope back from 10 to 15 degrees; 30 degrees would be best for seeing, but the books would slide at this angle. (i) Pupils should sit back from the desk so that about two-thirds of the forearm rests on it.

The large easy chair, often set aside for the family's young hopeful, in which, because of its size, he is able to curl up and readily forms a postural habit, which continued through the years may markedly affect the spine, is also a cause to be considered. The habitual carrying of all burdens on one side, for example, newspaper bags, bundles of school books, hods of coal, etc., is another

Fig. 35. Self Correction for Right Dorsal Left Lumbar Scoliosis.

Fig. 36. Spring Sitting-position in Right Dorsal Left Lumbar Scoliosis.

common cause. It is remarkable how soon children form a habit of carrying a given burden in the same way, and many of them are continuously carried for a number of years. Shortness of one leg is a frequent cause. The careful following up of the 1916 infantile paralysis cases and careful comparison with earlier epidemics has led many orthopedic surgeons to the conclusions that this disease is among the very common causes for scoliosis, the pull of the muscles on the less affected side being responsible.

Diagnosis. The main reliance is placed on the five following symptoms: 1. Unequal distances of the inner border of the scapulæ from the spine; it is less on the convex side in a dorsal curve. 2. The rhomboid shaped space between the arm and the body, sometimes called the arm waist angle, is less on the side of the curve. 3. Uneven hips and shoulders; the shoulder tends to be high on the side of the dorsal curve. The hip on the side of the curve in the lumbar region is made prominent. This is often mistakenly called a high hip. 4. The marked spines show the direction but not the degree to which the vertebræ are involved. 5. Prominence of one side of the back is brought out by trunk bending forward, the arms hanging loosely and evenly, the Adams' position. Convexity caused by the prominence of the ribs is on the side of the curve in whatever region it may be, but it is less apparent in the lumbar region. On this sign alone diagnosis of functional curvature is justifiable.

Treatment. Preventative treatment consists in the study and proper regulation of all habitual postures,

keeping in mind how early such habits are fixed, and the importance of attacking the problem before faulty attitude is established. Postural habits are corrected by following the rules which apply to the overcoming of any other habit, physical, mental, or moral. Briefly they are: 1. To create a clear cut picture in the child's mind of the correct posture from which he habitually deviates in work, rest or play with reasons if necessary. 2. Punishment, if necessary, should follow immediately and should logically fit the misdemeanor. Here, then, it should be postural in type and, if possible, over-corrective in character. For instance, a child with a left total curvature, who is told to carry weights on the left side and has been given the reasons, is discovered carrying a weight on the wrong side. He should be made at once and under supervision to do some work carrying the weight on the proper side. 3. Allow no exceptions to occur. Relatives, teacher, physical director, etc., should all coöperate to see to it that the child is reminded of every single slip. Patience, long continued, may prevent serious deformity. Proper food and rest are all-important for the normal ossification of the bones and defects of vision and hearing or the shortness of one leg, or any other contributing cause should be remedied.

Not only will general strength and development help somewhat in postponing the onset of a scoliosis, but they are elements of the tissue resistance which delays the stage of structural deformity of the muscles. Local treatment consists of casts or braces and exercises.

Operations. Bone fusions or graft operations, which

have recently been done with what gives promise of being most brilliant results in selected cases, leave the patient with a stiffened but straight spine in the affected region. This rigidity is not especially an undesirable feature since these curves are all quite rigid in their deformed position.

Casts. Casts may be permanent or removable. Greater correction and counter pressure is obtained by the permanent cast, worn usually for about three months. During this time the spine tends to increase its rigidity, musculature is weakened and the general health often slightly impaired. The removable type gives some support, allows an opportunity for exercising, but cannot be applied to give as great correction. Casts may be put on in the sitting, standing, lying or suspended posture. When adjusted to the patient lying supine one of two methods is employed. First, that advocated by Abbott, Adams, Lovett, and Bradford with the spine flexed, and second, the method advocated by Whitman, Schultess and Bucholz with the spine in hyperextension. That two exactly opposite positions of the spine should be used with rather satisfactory results in both cases seems at first difficult to explain. The principles involved are these: The Abbott method aims at unlocking the articular facets, thereby unlocking the vertebræ and making rerotation possible. Since the first effect of such unlocking of the articulations is to increase the rotation, the apparent curve is of course less, and this fact has misled some men into thinking that the spine is actually straight in this position. It must be remembered that a consid-

erable amount of the correction or overcorrection force obtained by this method must be expended on merely re-rotating the vertebræ to their former position before any net gain can be secured.

The other method, that of hyperextension, aims at relieving the weight bearing rotary strain upon the bodies by shifting it backward upon the posterior part of the vertebral column. This position of course would greatly aid in the rerotation of the vertebra bodies, but necessarily more tightly locks the articular processes, which in itself prevents rotation. So that any corrective effect must act on the column as a whole. It is not yet certain which is the better way. The rather brilliant results reported by Abbott have not as a rule been obtained by those imitating him.

The postural type of scoliosis very seldom requires a cast. In fact, where constant exercise under supervision is available there is a tendency now to depend more than ever on active exercise. In any case a period of exercise for the improvement of muscle tone and greater flexibility should be interposed between the casts.

Various types of braces and corsets widely advertised usually do more harm than good. Successful treatment of scoliosis is not accomplished by the mail order plan.

In all cases with marked softness of bone and those of rapid development, casts should always be used. In situations where exercises under good supervision are not available main reliance must be placed on casts.

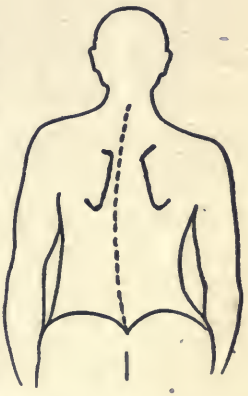
Exercises. Various corrective positions, using the body weight to secure counter pressure, on various types

of archaic apparatus now collecting dust in the attics of many orthopedic institutions were formerly greatly relied upon. A glance through the older text-books will reveal the wide variety of this type of armamentarium. Active exercise on simple apparatus supplemented by counter pressure on the part of the operator is now used almost exclusively.

PROGRAMS OF EXERCISES

I

Left Total Curve.



1. Corner exercise. Technic as described for kyphosis except counter pressure by operator with left hand on the greatest convexity on the left side and enough on the right hip to prevent the patient twisting to the right.

2. Stretch walk with self correction. Self correction must be worked out in each individual case. Here it would be with the right arm stretched up, hand resting lightly on the head, left palm pressing against the side as high and as far back as the patient can place it, the patient walking a few steps usually on the toes with active attempt to stretch the spine. Frequent periods of relaxation and short periods of intense effort should be insisted upon.

3. Hand suspension, spine twisting. Hanging on horizontal bar or rings and twisting as far as possible right and left.

4. Trunk bending left, hips fixed, self correction as above.

5. Mirror. Reëducate muscle sense through the eye. Assist patient to assume his best possible posture. Have him walk around the room, return to mirror and correct any slump that has occurred.

6. Hanging by right arm, back to stall bar or slanting ladder, left heel supported, right leg hanging.

7. Trunk forward bending or lowering, hips fixed, and raising against counter pressure as in 1.

8. Spring sitting. Sitting on right side of stool body inclined forward, right arm reaching actively toward wall or stall bars, right leg stretched backward. Work arm and leg toward the left, actively stretching the right side. Retain about half a minute.

9. Hand suspension, counter pressure. Hang from rings or bar, operator pushing patient forward, counter pressure as in 1.

10. Prone lying, feet strapped, trunk raising backward, self correction as in 2.

11. Stretching for head plate.

12. Floor hang, legs left. Patient grasps horizontal bar, stall bar or rings about shoulder high and hangs down to straight arm with the feet well out to the left.

13. Stretch walk, balancing weight on the head.

14. Supine hook lying—spine stretching. Patient on table, right knee over the end, the right arm extended upward and grasped by the operator who stretches the right side.

15. Creeping—in a circle to the left, reaching well forward with the right arm.

16. Prone leg lying, trunk raising. Patient lying prone with waist at end of table, feet fixed, trunk flexed over end of table and raised upward to fullest possible extension, self correction as in 2. A severe type of exercise for later progression.

17. Sayre suspension. The addition of hip harness to fix pelvis, patient on stool, is very efficacious.

18. Strap table—pelvis and shoulders fixed to the left, one or two central straps fixed to the right, running over the back, under the body, from which end traction is exerted toward the right and the straps fixed—maintain ten minutes.

A selection of eight or ten out of the above group, being

sure to pick at least two of each group and reserving the others for the varying of the program later, would be sufficient.

We must stretch the muscles on the concave side. This is done by exercises 2, 4, 6, 8, 11, 12, 14, 15, 16.

To increase flexibility exercises, 3, 13, and 16 are good.

Bilateral strengthening of the back is accomplished by exercises 1, 10, and 16.

Rerotation by counter pressure. Pressure on the convexity, on the ribs is transmitted to the side of the vertebral body and rerotates it. All the exercises in which counter pressure is used, exercises 1, 7, 9, and 18 do this.

Reeducation of muscle sense employs particularly exercises 2, 5, and 13. Note. Reverse each position for right total curve.

II

Right Dorsal Left Lumbar Curve.

1. Corner—counter pressure on right dorsal, left lumbar convexities.
2. Stretch walk with self correction. Right hand on posterior axilla, left at the waist line.
3. Hand suspension, spine twisting.
4. Trunk bending sideward toward principal curve.
5. Mirror.
6. Hanging by left arm at stall bar or slanting ladder, left heel supported, right leg hanging.
7. Trunk lowering forward, counter pressure as in 1.
8. Spring sitting, left arm up, right leg back.
9. Prone lying, feet strapped, trunk raising backward, self correction as in 2.
10. Stretching for head plate.
11. Stretch walk, balance weight on head.
12. Supine hook lying, spine stretching, right leg over end of table, traction on left arm.

13. Prone leg lying, trunk raising, self correction as in 2.

14. Creeping with left arm leading as much as possible and slightly dragging the right leg, wide movements of shoulders and pelvis giving some correction and increased mobility.

15. Sayre's suspension.

16. Strap table—shoulders fixed to the right, hips to the left, dorsal strap pulled and fixed to the left from below, lumbar strap pulled and fixed to the right from below.

To increase flexibility 3, 11, 14.

Bilateral strengthening 1, 9, 13, 15.

Rerotation by 1, 7, 8, 16.

Reëducation 2, 5, 11.

Note. Reverse all positions for left dorsal right lumbar curve.

In both the above programs there should be progression in the severity of the exercises selected and the number of repetitions which might be increased or varied from four to ten.

Chapter IX

JOINT INJURIES AND ARTHRITIS

Anatomy. Joints are formed by the approximation of two or more bones, whose surfaces are usually covered with articular cartilage, then with synovial membrane, moistened and lubricated in the healthy state by synovial fluid. In most movable joints, surrounding these structures is a sleeve-like capsular ligament, reinforced in certain portions where the strain is greatest. Closely associated with many joints and relieving the friction of tendons upon each other and the bone, are found closed, membranous sacks called bursæ, which are partially filled with synovial fluid. The crucial ligaments of the knee and ligamentum teres of the hip directly bind the bones together. Any or all of these structures may be acutely or chronically injured by trauma, toxins, or direct bacterial action. A common type of trauma is slight and long continued faulty posture.

Classification. Joints are classified as immovable and movable, which include sliding, hinge, pivotal, saddle, condyloid and ball and socket. With the first, as exemplified by the sutures of the skull, we are not here concerned.

Sprains and Dislocations—Traumatic Lesions. A strain is often described as the result of the application

of force, abnormal in degree or direction, which does not result in an anatomical lesion of any of the structures of the joint. It would, therefore, at most, but temporarily weaken the function of the joint, and would be treated, if necessary, by the means to be described under sprain.

A sprain is a partial but immediately replaced dislocation, during the process of which, however brief in time, there is an actual tearing or other injury to the tissues making up the joint. The symptoms are those of strain, but considerably aggravated, and include pain, swelling, sometimes slight hemorrhage and more or less limitation of function. The swelling is usually that of increased synovial fluid and lymph within the joint, bursæ or surrounding tissues, nature's object being to cushion the injured tissues with a water jacket and so to prevent further injury. Four undesirable results may follow here and demand our attention. First, an excess of fluid within the joint, as in the case of the knee, may so force the bones apart as to make them unstable in a direction in which, in the normal state, because of the bone formation, they are not apt to slip. In the joint named, the tendency to lateral instability is the case in point. Second, a large increase of fluid within the bursæ or tissues may make these supports of the joint boggy and unsecure. When the fluid is finally absorbed the ligaments tend to remain relaxed, as a result of long continued stretching. Third, there is a tendency, particularly in an unused joint, for this fluid to become gummy and gelatinous. This may lead to the formation of more solid bodies, the so-called rice kernels, within the joint. The

frequent reinjury, which so often accompanies untreated cases, with retarded recovery, may lead to a thickened, doughy synovial membrane, which, equally with the coagulated bodies just mentioned, may mechanically interfere with the normal range of movement, most commonly found in the knee.

Finally, comes the formation of scar tissue or even bone ankylosis by reinjury. This reinjury is most apt to occur during the healing process unless, while undergoing repair, the tissue is protected from any movement or position simulating that which brought about the original lesion.

In regard to dislocations, generalizations only are here in order. For detail in regard to each of the possible dislocations of the various joints the reader is referred to the section on fractures and dislocations and to the excellent texts of Cotton, Stimson, Preston, Jones and others.

Dislocation is a complete, temporary or permanent change in the relationship of the bones comprising the joint. The surrounding ligaments are always torn. Often through the rent one or more of the bones appear.

Diagnosis. Where the bony landmarks are all in normal positions, where the swelling and tenderness are on one side of a joint, and where gentle manipulation can be performed throughout nearly its normal range and direction but a given movement elicits more pain than other movements, in that joint we may assume that we are dealing with a sprain.

Where there is malposition of the bony landmarks, considerable swelling, only a moderate amount of hemorrhage, where the pain is diffused about the joint and the movement greatly limited in amount or direction, the probabilities are that we have a dislocation.

Where the greatest pain is localized above or below the joint, the hemorrhage marked, the bony landmarks changed in their relations and, except in impacted cases, the motion increased and not in the joint, a diagnosis of fracture is justifiable. When there is probability of the presence of either dislocation or fracture, the X-ray should always be resorted to if possible.

Treatment. With a clear-cut impression of the serious consequences that may follow untreated cases of sprain, it is yet just as important to remember that many patients suffer from overtreatment, or, better, overprotection, because the fundamental and best of all types of treatment, within reasonable limits, is use. This is shown by the fact that animals use lightly but constantly such an injured joint, and the rapidity with which it usually heals is enlightening. Hemorrhage in this type of injury, though usually slight, must be considered. When internal bleeding has ceased, the use of the joint, where hemorrhage had occurred, is desired. It will aid in preventing the clotting of blood in the tissues and in quickening its absorption. Use must be differentiated from overuse or resprain, and can be attained best by means of light or partial support, or complete prevention from movement in an undesired direction or degree. To cite again the knee joint, this might be accomplished

by the use of a simple hinge brace, locked against over-extension and preventing any twisting or lateral deviation. In the ankle the common injury to the external lateral ligament can be properly supported by reversing a flat foot strapping, omitting the plantar straps, and weaving in a few cross straps. If seen at once an application of cold generally prevents excessive swelling. In all the many and valued uses for the various types of baking there is none in which the results are more gratifying than in its application to these cases. Massage is also of great value and should, if possible, be used in combination with baking.

Dislocations are reset at once and treated as severer sprains with emphasis on fixation and protection. In dislocations or injuries involving severe tears of tissue the tendency to increase the amount of adhesion must be carefully guarded against. Too early and too violent movement of the joint will tear through the new formed tissue, increase the inflammation and the amount of fibrous exudate. Pain is our main guide. It is safe to move the joint slowly as far as we can without eliciting severe pain. Massage is of great help in increasing circulation. Passive movements should be limited to moving the joint once through its greatest range unchecked by pain and protective spasm. If it is necessary a little later the joint may be moved once through its entire range under anesthesia to break adhesions.

Arthritis. Traumatic lesions of the joints are described under sprains and dislocations and we are here concerned with infective and toxic arthritis.

Toxic Arthritis. The common diseases which often manifest themselves in joint inflammations are acute articular rheumatism, tuberculosis, gonorrhea and syphilis. Inflammations of joint tissues, due to the absorption of toxins from more or less distant foci, are from pyorrhea or abscesses around the teeth, infected tonsils, faulty digestion or insufficient intestinal or kidney elimination.

Acute rheumatic arthritis or rheumatic fever in the acute and severe stage cannot be treated by orthopedic measures other than support, but in the mild or chronic stage can be dealt with in the same manner as arthritis in general.

Tuberculous arthritis is treated first constitutionally following the approved methods employed for arresting any tuberculous process in the body—rest, outdoor living and forced feeding. Locally, by means of brace, extension or rest in bed, we attempt to immobilize a joint and remove all weight bearing from it.

Arthritis Deformans, Osteoarthritis, Rheumatoid Arthritis, Rheumatic Gout. Degenerative and Proliferative Arthritis. Whitman * of New York, in his treatise on orthopedic surgery, has given us perhaps the best brief description of this group of conditions. He says, "Under these titles are included a group of chronic diseases of the joints whose etiology is obscure. At the present time, as these diseases are often classed as varying manifestations of one pathological process, the titles are usually considered as synonymous."

This group of chronic affections of the joints are of

* "Orthopedic Surgery." Royal Whitman (Lea & Febiger, Philadelphia).

uncertain origin, derangements of the nervous system probably accounting for a considerable portion of them and, when present, are associated with marked deterioration of the skin appendages, the hair, nails, etc.

Clinically, we have two rather sharply defined types, hypertrophic and atrophic arthritis.

Hypertrophic arthritis occurs from early adult life through old age. It is often confined to one or more large joints but associated enlargement of the joints of the fingers is common. The synovial membranes, cartilages and periarticular structures are all involved. According to Da Costa, the changes begin in the cartilage with a multiplication of the cells and a degeneration of intercellular substance. Wearing away of the joint cartilage in places brings pressure on the bones which causes thinning, bulging and lengthening by deposits. The deformity is marked and the motion limited but without ankylosis. The fingers often show Heberden's nodes. The process when located in the spine produces spondylitis deformans.

Atrophic chronic arthritis is largely a disease of childhood and early adult life. Its onset is rather more rapid than the hypertrophic type and more general in its distribution. The joints become spindle shaped; there is general muscular atrophy. It is progressive in character and the pronounced destruction of cartilage leads to ankylosis.

Treatment. In no type of arthritis is the constitutional treatment of as great importance as in this condition. Change of climate, particularly to one both warm

and dry, is beneficial. Suitable exercise, fresh air, rest and diet must be provided for. Tonics have their place but sedative drugs must be carefully guarded against because of the long duration of these joint affections. Use, within the limit of strain, is to be recommended and strain may be guarded against by a brace if desired. Complete immobilization is only desirable for very short periods during acute exacerbation, and prolonged fixation will but lead to earlier ankylosis. Local treatment by means of the various forms of baking, massage and passive movements are of value in arresting the progress of this condition. Operative interference, except for the removal of solid bodies, or to excise small joints is contraindicated.

Acute Rheumatic Arthritis, Rheumatic Fever or Acute Rheumatism is caused by a micro-organism and is characterized by high fever, multiple joint inflammation and predisposition to further attacks. It is often complicated by endocarditis. The administration of salicylates, the application of oil of wintergreen, or lead and opium wash and the fixation of the affected joints constitute the treatment.

Acute arthritis secondary to meningitis, scarlet fever, etc., would receive the same local treatment while the disease itself was being properly attended to.

Tuberculous Arthritis. The process starts first in a single joint. Others may later be involved.

Causes. The indirect causes are the lowering of local resistance of joint structures as a result of trauma, chilling, or chronic strain. The direct cause is the inva-

sion of the tissues by the tubercle bacillus which as a rule first involves the bone.

Pathology. It spreads from the primary focus by sinus formation to the synovial membrane and then to the other parts of the joint. Tubercles form throughout the joint structures which soften and thicken through caseation. There is not marked fluid formation. This process may develop into sinus formation opening externally with consequent danger of pyogenic infection.

Symptoms. Swelling is usually not marked. Protective spasms of the muscles followed by their atrophy is usually seen. Pain is often referred to structures at some distance from the involved joint, for instance, in hip cases to the inner side of the knee, and in spinal cases to the front of the abdomen. Finally the tissues become matted together, the joint distinctly rigid, the skin white and thickened, the whole swelling spindle shaped. Pain on movement is a constant symptom. There is danger of systemic involvement with the tuberculous process.

Treatment. Constitutional treatment is the same as for other forms of tuberculosis. Local treatment consists of fixation and extension. Superheated dry air and Bier's hyperemia are helpful. The joint may be aspirated and injected with iodoform and glycerin when there is a large accumulation of fluid. When sinuses are formed, opening externally, care must be taken to avoid mixed infection. They may be injected with Beck's bismuth paste. These conservative measures may prove sufficient. If a trial of such treatment fails to improve the

patient, operation is indicated and should be radical and thorough. In cases showing amyloid degeneration attempts at removing sequestra or forming bony ankylosis of fresh healthy bone are useless and amputation should be resorted to.

Gonorrheal Arthritis. Gonorrheal arthritis is a complication occurring in about two per cent of the cases of this disease. Its distribution in order of frequency is knee, ankle, wrist, shoulder.

Treatment. This is first aimed at clearing up every focus of infection, particularly the prostate and Bartholin's glands, and unless this is thoroughly done local treatment is of little avail. A large amount of destruction may follow the involvement of a joint and lead to complete bony ankylosis. In the acute stage immobilize and counter irritate by heat or ichthyol ointment. If very severe aspirate, irrigate with hot saline and, if joint fluid is purulent, incise, irrigate and fixate with drainage. In the subacute stage treat with baking or passive hyperemia, massage and gentle passive movements.

Syphilitic Arthritis. Syphilis of the joints is rare as compared to tuberculosis, the diaphysis of the bone being the part most often attacked. Hereditary syphilis manifests itself during infancy as an osteochondritis which may resemble rickets. It is not, however, usually bilateral in distribution nor does it usually involve more than two or three joints at once. In older children an accompanying periostitis is common and the synovial membrane may be so thickened as to interfere with normal joint movement. In acquired syphilis the joint may

be involved in the secondary and tertiary stages. The local symptoms are thickening of the joint structures and increase in its fluid with but slight atrophy of surrounding muscles. There is pain on movement but it is not usually limited by muscle spasm and it often persists at night. Knee, shoulder and elbow are most often involved. The diagnosis can be confirmed by the other constitutional manifestations of the disease and by the Wassermann test.

Treatment. Local treatment consists in rest and protection of the joint. The constitutional treatment is that usually followed in this disease.

Chapter X

DISEASES OF BONES

Periostitis. Inflammation of the periosteum may be acute or chronic. Acute periostitis usually follows injury. There is a local inflammatory process, the pain from which is marked at night. Function is interfered with. The swelling is usually spindle shaped and may be due to a thickening of the periosteum and the accumulation of fluid in or beneath it. A subperiosteal hematoma may form. This is sometimes difficult to differentiate from an abscess. The latter would, however, give much more marked signs of inflammation, together with constitutional symptoms. The breaking down of a hematoma through infection may occur and should be guarded against. Periostitis, secondary to typhoid, syphilis, tuberculosis and other diseases, is common, but more apt to be chronic in type and to occur late in the disease. In syphilis and tuberculosis a slight and unnoticed injury may lead to localized periostitis.

Pathologically the periosteum becomes thickened, cell proliferation increases and there is an extravasation of serum in the tissues. In acute cases a discharging sinus may form or the bone may become soft through sclerotic condition of the overlying parts. In chronic cases, though healing without the formation of a sinus, the

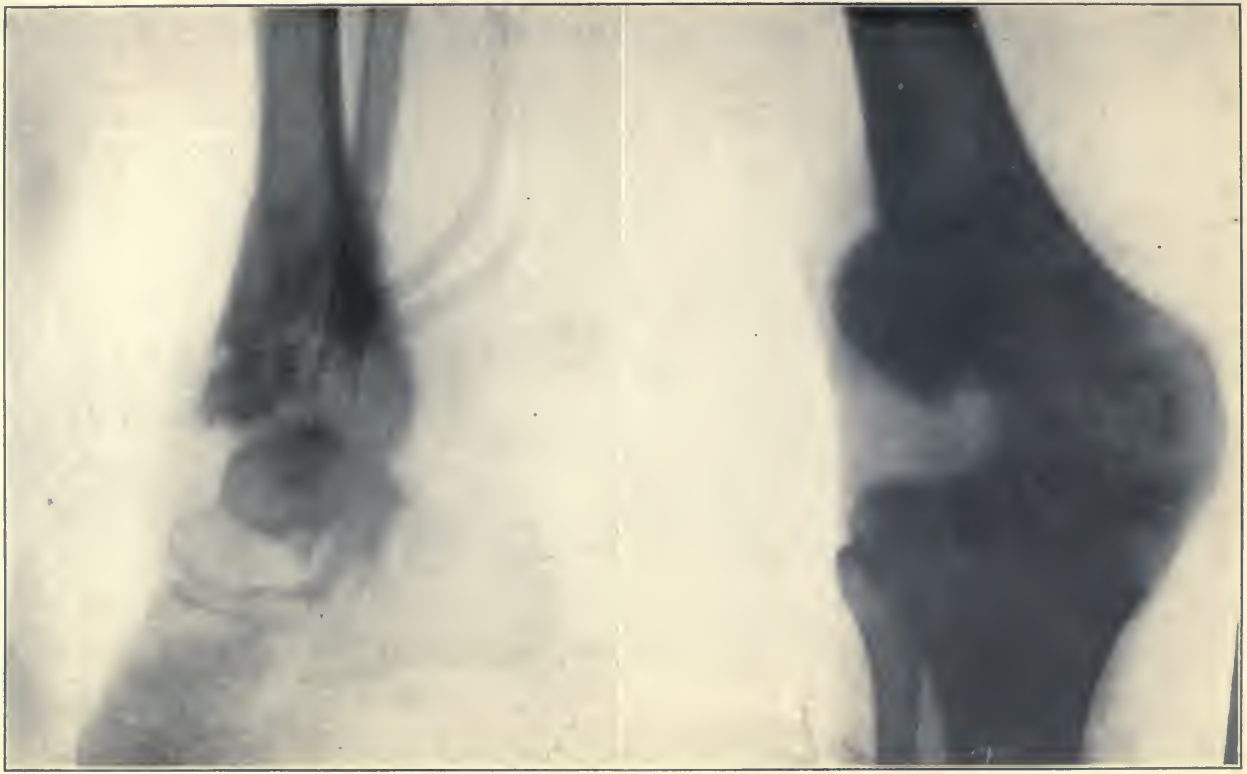


FIG. 37. OSTEOMYELITIS OF LOWER END OF TIBIA AND OSTEO-ARTHRITIS OF ANKLE JOINT.
Carrel-Dakin tubes in position.

FIG. 38. EXTERNAL CONDYLE OF FEMUR SHOT AWAY. OSTEOMYELITIS AND ANKYLOSIS.

calcareous deposit within the periosteum of the affected region may cause a roughened, granular character of the surface.

Treatment. The most important consideration is absolute rest of the diseased part. Complete immobilization and elevation should be secured. Swelling and tension may be relieved by incisions to the bone into which several small holes may be bored. In acute cases, where septic conditions exist, the splitting of the periosteum is advocated. Baking to improve circulation, and massage to break up granules, and remove excessive exudate are of utmost value.

Osteitis. This condition, being usually secondary to periostitis or myelitis, has much the same symptoms. The manifestation, especially in tuberculous cases, is very slow, but pain and tenderness are more marked than in periostitis. Tucerculous osteitis has been referred to under arthritis. Sequestra, if formed in the bone, should be excised and all operative procedures, if indicated, should be radical and thorough.

Osteomyelitis. This acute disease first starts in the spongy ends or medullary cavity of the bone and may from there spread into the joint or along the shaft. Its onset is characterized by high temperature and the general symptoms of an acute infection. Suppuration may take place and an abscess form. Periostitis, which is usually present, may blur the picture. When this disease occurs in the vertebræ, the bodies may be broken down with subsequent injuries to the cord. The infective agent may be ordinary pyogenic bacteria, tuberculous bacillus,

the causative agent of typhoid, syphilis, measles, etc., or by the action of phosphorus in the body. Bone necrosis may follow rapidly. The concurrent formation of new bone by the periosteum may develop an irregular cortex while the deeper layers of the bone are being destroyed. Direct infection from infected wounds, especially where the bone is shattered and the circulation impaired, is common. The process has been likened to gangrene of the soft parts. A definite line of demarkation between the sequestrum and true bone is often seen. The dead bone, if small, is sometimes absorbed. If not, it breaks down and produces a sinus. Osteomyelitis is extremely serious, a fatal outcome being not unusual. Its early diagnosis is most important. The X-ray is an invaluable aid in the diagnosis in the following up of the condition.

Treatment. The infected area should be opened freely and drained. The Carrel-Dakin drip is extremely helpful. Autogenous vaccines are sometimes of great assistance. Thyroid medication is also used. In case of a large amount of bone destruction all the diseased part may be removed and a bone transplant may prove of great assistance.

Osteomalacia. Pain and muscular weakness, similar to conditions in rheumatism or some diseases of the spinal cord, are the first symptoms of this disease, which is most frequently found in nursing women, though it may occur in men and even in children. Increasing deformities, chiefly in the spinal column and the pelvis, shown by decrease in height and a waddling gait, are due to the

progressive softening of the bone, which can seldom be arrested. Slight injuries often cause fracture, and death occurs from exhaustion or disease of the lungs.

This condition may be differentiated from rheumatism by the fact that the pain is found in numerous places. Urinalysis usually discloses the presence of calcium salts in excess.

As the lime salts are removed the basement substance remains, retaining its laminated appearance, but further progression may lead to disintegration and absorption of this remaining substance.

Treatment. Improved hygiene, tonics, phosphorus and iodides are useful. When the onset of the disease is associated with pregnancy, oöphorectomy is indicated and further pregnancy should be avoided. In other types Sajous recommends epinephrin injection.

Tuberculosis. Tuberculous disease of the bones is very largely confined to cancellous bone. In the long bones it would then make its appearance in fairly close proximity to the joint and from there extend to the periarticular tissues and often directly into the joint.

Symptoms and treatment of tuberculosis in these localities have been described under tuberculous arthritis.

Spinal Tuberculosis. The special manifestations of this disease in the vertebræ have been described under diseases and abnormalities of the spine.

Chapter XI

FRACTURES AND DISLOCATIONS

THE UPPER EXTREMITY

Clavicle.—*Sterno-clavicular Joint Dislocation.* This joint is dependent almost entirely on its ligaments for support. Its dislocations are forward, backward and upward, in order of frequency.

In forward dislocations, the sternal end of the clavicle is prominent and occasionally overlaps part of the sternum so that the downward inclination of the clavicle is increased.

In backward dislocation, the prominence is less, and there may be congestion of the face and neck on the affected side. It is easily reduced by using the arm as a lever with counter pressure in the axilla, assisted by deep respiration on the part of the patient. Retention is obtained by a molded pad and pressure with adhesive plaster, assisted if necessary by a posterior figure of eight to hold the shoulder back. The arm is supported in a sling.

Fractures. Fractures of the clavicle are exceedingly common. Its exposed position and the fact that it unites the movable upper extremity and the trunk are the reasons for its frequent fractures. At its inner aspect, the attached fibers of the sterno-mastoid muscle pull upward

and the pectoralis major downward, but the direct pull of the former is nearly at right angles to the bone, that of the latter more nearly parallel to it. The pull of the sterno-mastoid is, therefore, stronger and the inner fragment is usually displaced upward. On the outer third of the bone, the antagonistic pull of the deltoid and the trapezius are nearly equal and displacement is not usually marked.

Symptoms. Pain, loss of function, and change of normal outline immediately follow.

Treatment. Reduce by traction on the shoulder, outward, backward and upward and retain by a permanent dressing. The modified Velpeau bandage or Sayre's dressing is good. In children, the Taylor brace and the brace devised by Crane of Waterbury are both useful. All of these dressings need constant care and adjustment to take up slack and keep the part secure.

Acromio-clavicular Joint Dislocation. The joint is covered by the superior and inferior clavicular and the coraco-clavicular ligaments, the deltoid muscle in front and the trapezius behind adding their support. Dislocation of the clavicle upward is the common injury.

Symptoms. Pain in the joint, moderate loss of function, prominence of the outer end of the clavicle, and sometimes prominence of the tip of the scapula are evident. Sir Robert Jones uses a simple sling for the wrist and then binds down a small pad on the tip of the clavicle by a bandage passed under the elbow and knotted firmly on the shoulder.

Scapula.—*Fractures.* The heavy, springy bed of mus-

cle nearly surrounding the scapula makes it extremely difficult to fracture this bone. The spine and acromion process, being more exposed, are occasionally fractured. Separation of the acromial epiphysis, which unites quite late, may be mistaken for fracture. The fracture may involve the coracoid process, the glenoid cavity, or the body below the spine.

Symptoms. Loss of function, pain increased by deep respiration and crepitus are noted. X-ray is often necessary to ascertain the extent, since crepitus may be lacking. In the treatment, prevent muscular pull or movement of the fragment and, if the body is affected, immobilize the scapula as a whole by strapping, Velpeau bandage or cast. Maintain from four to six weeks. Complete return of function is the rule.

Shoulder. *Surgical Anatomy.* The shallow socket, large variety of movement, and exposed position of the shoulder joint make it the most frequent seat of dislocation. The coracoid and acromion processes of the scapula and their ligaments, while not entering into the joint proper, protect it from above and prevent upward dislocation, making this type the rarest of all. Mobility being of prime importance, the socket is very shallow and stability is dependent largely upon the muscles and tendons. The capsular ligament entirely encircles the joint from the rim of the glenoid cavity to the anatomical neck of the humerus. It is quite lax and is put upon a tension only at the limit of arm movement in the various directions. Muscle tone alone keeps the joint surfaces in apposition and the deltoid is mainly responsible for this.

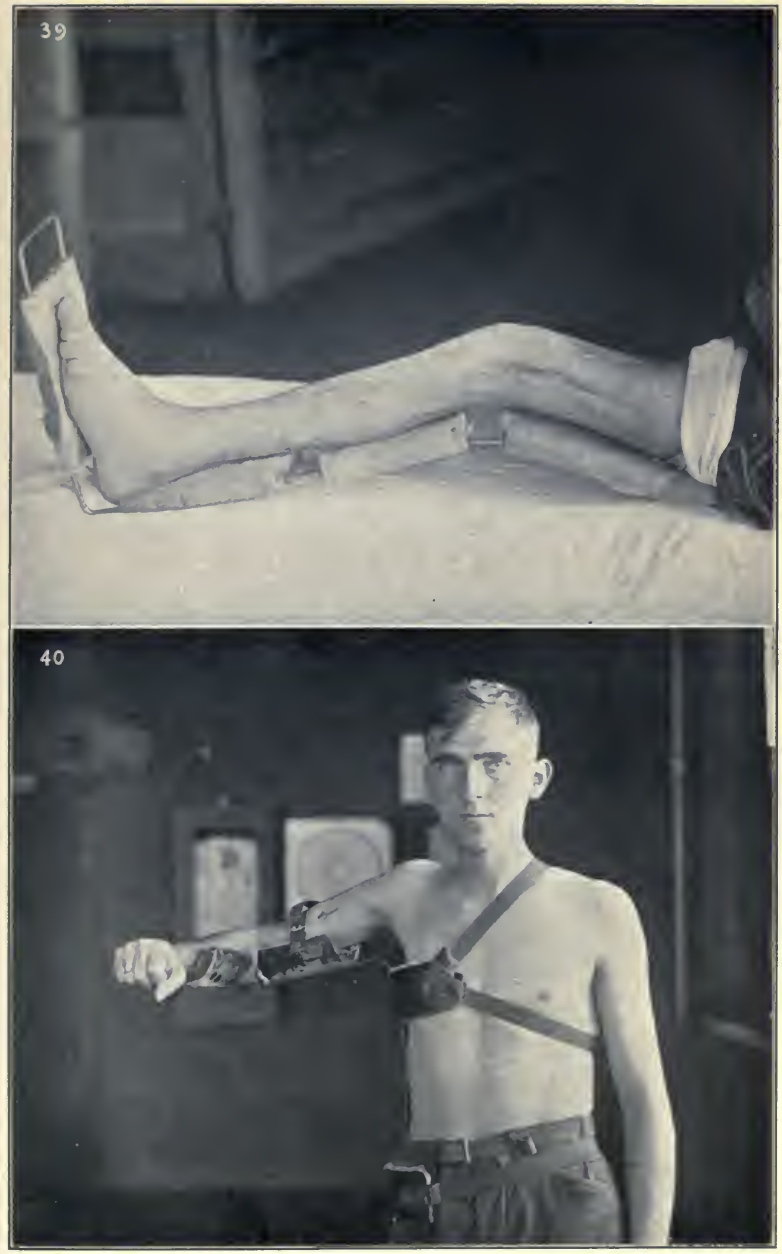


Fig. 39. Cabot Posterior Leg Splint.
[X-Ray (Fig. 38) shows injury to external condyle.

Fig. 40. Airplane Splint with Elbow Joint.

The brachial plexus and vessels lie just internal to the head. In injury the capsular ligament is always torn and more or less harm is often done to the tendons overlying it.

Dislocations. In spite of the variety of directions which the head may take, the following classification is sufficient:

1. Forward. { Subcoracoid. (Most common.) / Subclavicular.
2. Downward. { Subglenoid. (Very common.) / Subglenoid erecta.
3. Backward. { Subacromial. (Fairly common.) / Subspinous.
4. Upward. (Uncommon.)

Subcoracoid. The head lies just below the coracoid process, tearing the anterior and inferior part of the capsule. The humerus is rotated inward; the subscapularis tendon is sometimes torn. Extreme degrees become subclavicular.

Subclavicular. In this type the head is further inward and slightly higher and all the structures are more lacerated. Kocher's method of reduction is inefficient. We get a flattening and sharpening of the shoulder; the anterior axillary fold is lower; the elbow is abducted and the head of the humerus lies beneath the coracoid process. It is hard to place the hand on the uninjured shoulder as the arm cannot be abducted. The patient leans toward the injured side and usually allows the arm to hang when he is standing.

Treatment. Subcoracoid dislocation is most easily reduced by Kocher's method, the three main manipulations of which are: 1. The surgeon standing in front, grasps the patient's elbow with his opposite hand and holds it against the side, grasping the wrist with his other hand. The elbow is flexed to a right angle and the arm rotated externally. 2. The elbow is brought gently inward across the chest, the hand remaining fixed. Slight force may be used several times if necessary and the head slips into the glenoid cavity with a distinct sound. The third manipulation should not be attempted until this has happened, as replacement usually occurs at this point. 3. This consists in rotating the arm inward, bringing the hand toward the opposite shoulder.

Another method is by horizontal abduction and manipulation with surgeon's knee or flexed thigh under the axilla while an assistant exerts traction on the arm. It is of further advantage to have the scapula fixed. Slight swinging or rotating of the arm will aid reduction.

Subglenoid. The head escapes through the inferior and posterior fibers of the capsule, resting below the acromion process or, in the subspinous variety, further back under the spine of the scapula.

The shoulder is flattened; the head cannot be palpated in its normal position, but below the acromion process; the humerus is rotated inward and is held in adduction.

Treatment by Kocher's method may be successfully employed, but in the first movement the elbow should be farther back to approximately the mid-axillary line. Reduction may be obtained by traction accompanied by

Fig. 41. Abduction Splint for Shoulder.

Fig. 42. Humeral Extension Splint.

slight rotation and adduction. Operative treatment should never be necessary in uncomplicated cases.

After treatment. Immobilize for several days to facilitate repair and carry arm in sling, but forbid abduction. Allow slight active movements during the second and third weeks and obtain complete abduction by the exercises described for this desired result, the patient lying prone. Common complications are fracture of the surgical neck; associated dislocation is rare. It should be treated by the open method and the use of McBurney's hook to replace the head. Fracture of the anatomical neck is still more rare. Here the head should be wired, or, if it cannot be replaced, excised. Fracture of the greater or lesser tuberosity should be wired unless it is possible, after setting the dislocation, to abduct and externally rotate the arm without redislocation. Bone pegs and screws are sometimes used.

Fracture of the neck of the scapula leaves a movable joint. The arm is easily adducted; the whole shoulder dropped. The elbow is raised and retained by a fixating handage.

Recurring dislocations are treated by operation with repair of the rent and occasionally tucks taken in the relaxed capsular ligament.

Fractures of the Humerus. *Fracture of the Anatomical Neck.* The line of fracture seldom follows the anatomical neck exactly; often the greater tuberosity is included. Impaction and the separation of fragments are common, especially in the aged. There are pain, swell-

ing and hemorrhage, but the head is in place; crepitus is not easily obtained; the shortening is not great.

When firmly impacted do not attempt to disengage. Bind the arm with a modified Velpeau bandage, using a triangular axillary pad. Massage is begun early, passive movements late; three weeks at least should elapse. Abduction is then obtained in the prone lying position or with overhead pulley weights. Several of our patients have done extremely well when put up in a plaster in extreme extension for five weeks, followed by massage and passive movements.

Fractures of the Surgical Neck. A great tendency to displacement is manifest in these fractures. The lower fragment is usually drawn toward the body, rotated internally and often elevated by the action of the deltoid and biceps. This is best treated by traction made on the arm in the line of its long axis with abduction and outward rotation. The abduction should be carried to an oblique side-upward plane. In this position traction corrects the overriding and accurate setting is possible. When secured the arm may then be lowered gently and with great care, the elbow flexed to less than a right angle and the arm fixed in this position. When displacement tends to reoccur the arm should again be abducted as described and fixed in that position in a cast. The forearm should be included to insure external rotation and may rest easily behind the head.

The unavoidable formation of adhesions after any of these injuries, should be treated as described in arthritis of the shoulder as soon as repair is complete.

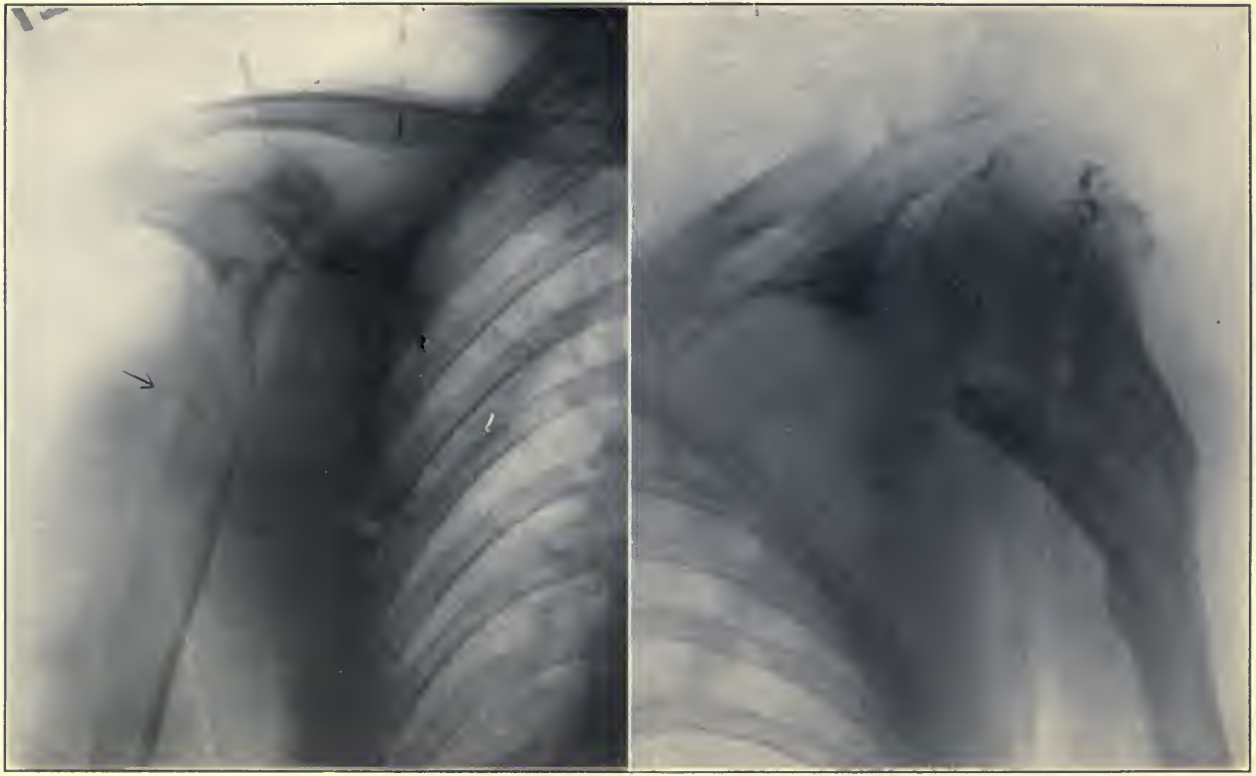


FIG. 43. COMMINUTED GUNSHOT FRACTURE OF GLENOID AND HUMERUS AT SURGICAL NECK, WITH LARGE AMOUNT OF BONE DESTRUCTION.

FIG. 44. HUMERAL NECK AND HEAD FRACTURED, BEGINNING BONY UNION. SHRAPNEL IN THE HEAD.

Ankylosis of the Shoulder. Where this complication is inevitable Jones gives the following directions for obtaining the most useful position for the shoulder joint. He says: "First, the arm should be abducted about sixty degrees or more from the side, movement of the scapula will easily replace the amount of abduction. Second, the arm should be rotated out far enough for the hand to be brought to the back of the head when the shoulder is raised. Third, the elbow should be a little in front of the mid-axillary line, for convenience in handling table implements, etc.

"If these three points are attended to during the treatment of an injury of the shoulder in which ankylosis is inevitable, the muscles about the scapula will soon learn to increase their range of movement. To hasten this the patient should assiduously practice all possible movements of the arm.

"A patient with an arm ankylosed in this position can perform all ordinary movements so unobtrusively that many people will fail to observe he has any limitation of movement at the shoulder."

Fractures of the Shaft of the Humerus. The wide range of movement obtained by this bone makes it subject to a great variety of types of trauma. Single, transverse or oblique through and through fractures are the usual types. The close apposition of the musculospiral nerve makes it especially prone to direct injury or to later compression by the formation of a callus.

These fractures are usually easily recognized by the deformity, shortening, hemorrhage, point of abnormal

mobility and crepitus. Treatment will vary according to the degree and amount of displacement. Simple traction and manipulation will usually realign the fragments though anesthesia may be necessary. Fractures are put up in the same manner as those of the upper end with the triangular pad in the axilla, splint or plaster support and bandage to include the body. A protecting cap of plaster over the shoulder or entire arm, including the elbow, is of great service.

In the operative treatment, the fixation, which is occasionally necessary, may be secured by bone pegs, screws, wire or the Lane plate.

Fractures of the Lower End of the Humerus.—Surgical Anatomy. Preston, in his description of the surgical anatomy, says: "The lower end of the humerus articulates with two bones; the types of these articulations are entirely different and the fractures occurring in this region are complex. The lower end of the bone curves forward and is flattened from before backward. The articular surfaces may be described roughly as a cylinder mounted on the lower end of the shaft, with the axis of the cylinder nearly transverse to the long axis of the shaft. The outer end of the cylinder is at a slightly higher level than the inner end. When the elbow is fully extended the arm and forearm are not in the same straight line, but form an angle of about 170 degrees, half of which is caused by the obliquity of the articular surfaces of the lower end of the humerus, while the other half is the result of the position of the bones of the forearm. In complete extension, therefore, we have the "carrying

angle'' while in complete flexion the forearm comes in contact with and folds directly upon the arm. When the fragments, in fractures of the lower end of the humerus, are allowed to unite in deformity, there may be a disturbance in the carrying angle which is apparent when the arm is extended, and in addition there may also be a deformity in which the forearm does not fold directly against the arm in acute flexion. The carrying angle varies considerably in different individuals and the examination should therefore include comparison with the uninjured elbow.'' *

Types of these fractures are commonly transverse above the condyles or through them. Either of the condyles may be fractured; that of the external often including the capitellum and the internal, the trochlea. Fractures of the capitellum by indirect violence, separation of the epiphysis, Y or T shaped fractures into the joint are commonly noted fractures with extensive involvement of the lower end of the humerus.

All of these fractures, except those of the olecranon, are put up with the elbow in extreme flexion. Olecranon fractures require extension.

Impairment of function is almost certain to follow incomplete reduction or large callus formation.

Supra-condylar Fractures. When by direct or indirect violence the lower fragment is displaced backward, reduce by flexion and downward traction on the forearm. Put up fully flexed to prevent callus formation.

* Preston, ''Fractures and Dislocations,'' Mosby Company, St. Louis. Page 120.

Reduce the extent of the flexion slightly after a few days, reaching the right angle in about ten days. Passive and active movements used early should be confined to the range of movement between semi- and full flexion.

Epicondylar Fractures. Fractures of the epicondyle not involving the joint or the capitellum are rare. There is swelling and tenderness of the external condyle. The fragment is not usually much displaced.

Epitrochlear Fractures. In this type there is separation of the internal epicondyle not involving the joint or the trochlea. The symptoms are tenderness, pain and hemorrhage along the inner side of the arm. Flexion and extension of the elbow are not usually painful except at their extreme limits.

Fractures Involving the Joint.—*Fracture of the External Condyle.* This includes the capitellum, is quite common and the symptoms resemble epicondylar fracture but are much more severe. There are almost total loss of function, severe pain and marked swelling. The joint is very unstable from side to side and may be moved freely in this direction; crepitus is usually present. The deformity is described as "gunstock." The fragment is displaced downward and greatly turned.

Fractures of the Internal Condyle. The break extends through the trochlea. The same symptoms of pain, swelling, hemorrhage and crepitus are present on the inner side; the same lateral mobility is found.

Y shaped or comminuted fractures may partake largely of either or both of the sets of symptoms just described and are produced by the force of a blow transmitted

through the olecranon and splitting the humerus. There may be backward displacement of the elbow, but the olecranon is uninjured.

Treatment. The surgeon grasps the back of the elbow with one hand, the wrist with the other and exerts traction on the wrist until the forearm returns to its normal alignment. The elbow is then fully flexed. Some force may be required, as it may necessitate pushing back fragments which have been displaced forward. The hand behind the elbow can aid this replacement. Complete flexion is absolutely essential.

After Treatment. Jones gives a simple rule for the protection of any injury about the elbow from too early movement. It is that the absence of tenderness about the elbow indicates that it is ready for the second test, which is the lengthening of the sling and allowing the wrist to drop three inches. After two days, if the patient is able actively to flex the elbow fully, he may repeat the exercise to full extension daily. If, on the other hand, the elbow becomes stiff by protective spasm, it is an index that this procedure is premature and the elbow should be put up in full flexion for another week. He advises against the use of the right angle internal splint for the elbow.

Fractures of the Olecranon. Fracture may be of the tip only or a large part of the process. If there is no displacement of the fragment upward a pad placed above and an anterior splint with the arm fully extended should secure firm union in two or three weeks.

Fractures involving marked displacemnt by the ac-

tion of the triceps should be fixed by wire, peg or kangaroo tendon and then treated as indicated. Care must be taken not to injure the epiphysis in children and it is sometimes wiser even with displacement to use the former method. In cases of elderly persons sufficient function can usually be obtained by extension and the pad.

Dislocation of the Elbow. Dislocations may be backward, which are very common; outward, which are also common; inward and forward, which are rare.

Surgical Anatomy. The radio-humeral joint is of the condyloid variety, while the ulnar-humeral is a hinge joint. The internal lateral ligament is divided into a strong anterior and posterior band, as is also the external lateral ligament. Overextension of the elbow is prevented by the anterior segments of the lateral ligaments, the anterior fibers of the capsular ligament and the checking of the tip of the olecranon at the olecranon fossa. Overflexion is prevented by resistance of the lower part of the biceps to the forearm and by the coronoid process checked by the coronoid fossa.

Backward Dislocations. The forearm is held almost in extension; the tip of the olecranon is above its usual plane and more prominent; the forearm is shortened; the triceps tendon is prominent. The coronoid process is behind the trochlea, the whole forearm rotated slightly inward, the head of the radius behind the capitellum. The same pain, immobility and swelling which occur in other dislocations are of course present. We treat by hyperextension and traction enough to clear the coronoid

FIG. 45. EXTENSIVE SHRAPNEL WOUND OF RIGHT ARM WITH COMPOUND COMMINUTED FRACTURE OF HUMERUS.

Some union with beginning necrosis of loose fragment metallic body 4 x 6 mm. in front of injury.

FIG. 46. MACHINE-GUN BULLET THROUGH CONDYLES OF THE LEFT HUMERUS.

Treated by removable cast February 6, 1919. Elbow nearly ankylosed only five degrees of movement in flexion. Four weeks of treatment increased this range to forty degrees.

FIG. 47. OLD INFECTED GUNSHOT WOUND OF UPPER END OF RIGHT RADIUS AND ULNA INVOLVING ELBOW JOINT.

Elbow ankylosed.

process, and then fixation in complete flexion for two to three weeks is necessary.

Lateral Dislocations. These dislocations are rare and can usually be reduced by flexion of the forearm and extension of the arm, but an anesthetic may be necessary to thoroughly relax the muscles.

Forward Dislocations. This type is very rare except with olecranon fracture. Reduction is accomplished by flexing the forearm and exerting traction under anesthesia if necessary.

Myositis Ossificans Traumatica. Improvement in X-ray technique is revealing this as a rather common sequela of elbow dislocation, especially of the backward type. Torn tags of periosteum with its osteo-genetic power probably start the ossification process. No known means of arresting or curing this condition are available but its prevention can to some extent be obtained by the earliest possible reduction and the limitation of trauma both then and later. Too early passive and active movements should be avoided. The onset and progress of the condition, if it occurs, is followed by means of the X-ray. It is well to warn the patient of the possibility of this complication and against too early vigorous use of the arm.

Dislocation of the Radial Head. The orbicular ligament is always torn. Press the head of the radius back into place, flex fully with the forearm completely supinated, place pad over the radial head and bandage firmly.

Ankylosis of the Elbow. Where it is necessary to fixate the elbow joint it should be done at just about forty-

five degrees, as the weight of the arm may in time slightly increase the angle to about fifty or fifty-five degrees.

Wounds of the Elbow Joint. There has been a large proportion of septic wounds in the present war, many of them causing a marked amount of destruction of joint tissue. An extension wire splint, which will allow the wound to be dressed without disturbing the joint, the Carrel-Dakin drip and the use of passive movements when the inflammation has entirely subsided, are achieving splendid results.

Fractures of the Head of the Radius. The head is displaced; crepitus may be obtained by pronating and supinating the hand, the head not rotating with the shaft. This sign is absent in impacted cases. The biceps may pull the upper fragment forward. The pressure pad should be placed over the upper fragment and the arm should be fixed in moderate flexion. In fractures near the head acute flexion without the pad is better. In comminuted fractures of the head operation is indicated. After treatment, dressing should be tightened as the swelling decreases and should be kept on from three to five weeks.

Fractures of the Shaft of the Radius. There may be a concavity over the point of fracture when the fragments are displaced toward the ulna. Crepitus can usually be elicited. The greenstick fracture is the rule in children and a slight bulging or depression may be the only sign besides the localized pain.

Fracture of the Ulna. Symptoms are similar to the

FIGS. 48 & 49. COMPOUND COMMINUTED FRACTURE, OBLIQUE OF RADIUS AND TRANSVERSE OF ULNA WITH OVER-RIDING OF FRAGMENTS.
Pieces of shrapnel scattered over hand and wrist.

FIG. 50. LOSS OF BONE IN THE 2ND AND 3RD METACARPALS WITH NEW JOINT FORMATION. (X-Ray FIG. 48.)

FIG. 51. LOSS OF PORTION OF 2ND AND 3RD METACARPAL.

above. This fracture is commonly caused by the back kick of an automobile engine.

Fracture of Radius and Ulna. The deformity is more marked and sharper and there may be overriding. Greenstick fractures show less angular deformity and the mobility at the point of the fracture, seen in through and through breaks, is not present. All injuries to children which could cause this type of fracture should be X-rayed. Setting of transverse fractures is usually not difficult except where there is overriding. This overriding must be corrected by traction before attempting to reduce the angle deformity. In trying to reduce angular deformity pressure should not be made directly on it, but above. Care must be taken to avoid tearing the soft parts. Anesthesia may be required and the open method can then be pursued if necessary. A broad single splint will suffice in greenstick. Anterior and posterior splints of curved wood may be used where both bones are broken. Much injury has been done by too tight bandaging. The rule should be to use one broad splint where possible.

The Wrist.—*Colles' Fractures.* Colles' fracture is a fracture of the radius about three-quarters of an inch from its lower end. It is usually associated with backward displacement of the lower fragment, giving rise to the typical "silver fork" deformity, with occasional rotation of the lower fragment toward the ulna. The close approximation of important tendons, the function of which is interfered with in displacement, makes accurate reduction of great importance.

Reduction. A new and excellent procedure has been

outlined by Sir Robert Jones. It is as follows: The surgeon grasps the patient's forearm with one hand so that he can exert pressure against the projecting end of the shaft; with his other hand on the back of the patient's wrist he presses on the displaced fragment. A slight pull and twist under pressure reduces the deformity.*

Another method of reduction is to grasp with the thumbs above and the first fingers below the two fragments. Use traction on the lower fragment to free it. It may be necessary to increase the deformity at first to unlock impaction. Pressure with the thumbs, especially the one on the lower fragment to correct its rerotation, will bring the bones into proper apposition.

Where vicious union has taken place the use of the Thomas wrench or open operation may be necessary.

Sprains of the wrist and associated synovitis are treated as those elsewhere. Careful X-ray work will reveal the fact that many supposed sprains are in reality fractures.

Dislocations. Dislocation of the wrist is rare. The deformity and tenderness are below the wrist joint. The tenderness is diffuse and the relation between the styloid process of the radius and the ulna is undisturbed. These dislocations are put up in overextension and the usual treatment applied.

The Hand.—*Fractures.* Fractures of the phalanges and metacarpals may follow direct violence and are common in bare-hand fighting.

*Jones, Col. Sir Robert, "Injuries to Joints"—Frowde, London. Page 110.

Fig. 52. Extension Applied to Fracture of Both Bones of the Forearm.

Fig. 53. Bradford Frame with Extension Applied to Leg for Fracture of Femur with Shortening.

Diagnosis and treatment are usually easy. Fixation of the clenched hand over a roller bandage with adhesive is a convenient means of splinting the metacarpals. A straight posterior splint or, if preferred, an anterior one, the splint being slightly wider than the finger, may be used for fixation of the phalanges.

The metacarpo-phalangeal joints are condyloid and allow adduction, abduction and circumduction, in addition to flexion and extension. There are two lateral and one anterior ligament, the extension tendon serving this purpose posteriorly. There is great variation among different individuals in the normal range of movement possible. The thumb and index finger are the most frequently injured. These joints may be dislocated in any direction.

Diagnosis is easily apparent by the displacement of the finger. Occasionally the anterior ligament makes reduction difficult. When there is overriding, increase the deformity until the distal bone can be started over the head of the proximal. Fixation with early passive movement is indicated.

Dislocation of the carpal-metacarpal joint is usually confined to the first, which is easily diagnosed and reduced. A curved splint extended over the base of the thumb will retain the corrected position.

Dislocations. Dislocation of the phalangeal joints is obvious; the pain and displacement usually marked. Extension with accurate setting and the fixation is all that is required. These injuries are common in athletics,

often following awkward catching of a baseball or basketball, and tend to recur easily.

Separation and displacement of the epiphysis instead of dislocation at the joint is common, and perfect realignment with fixation for two weeks is necessary.

Chapter XII

FRACTURES AND DISLOCATIONS *(Con't)*

THE LOWER EXTREMITY

Pelvis.—Types of Fracture. The following varieties of fracture of the pelvis may be seen: 1. Fracture through the rami of the ischium. 2. Fracture of the acetabulum. 3. Fracture of the tuberosity of the ischium. 4. Fractures of the iliac crest. 5. Fracture of the anterior superior spines.

Fractures of the Rami. These fractures result from falls or blows on the front of the pelvis, or by crushing from the side. They may include the pubic bone or be complicated by fractures near the sacro-iliac joint or communicating with it. Displacement is not usually great, though it may be at first followed by partial return to position. During its excursion it may extensively injure the soft parts, which must be carefully examined for injury in all fractures of this type.

Symptoms noted are hemorrhage, pain and local tenderness, aggravated by leg movements, but are limited to the affected side. Mobility and crepitus are occasionally present. Displacement is uncommon, but if present replacement manually is not difficult. We treat by support by a sandbag, strapping or a snug, heavy bandage,

canvas and leather supports are often useful. Good recovery of function is the rule.

When complicated by a fracture at the back of the pelvis, so-called double-vertical fracture, which is usually caused by tremendous pressure, the treatment is more complicated. The fragment is usually displaced upward; occasionally the front of one side of the pelvis and the back of the other is broken, usually with less displacement. The main symptoms are—asymmetry, mobility, pain, etc. X-ray diagnosis is essential.

The pain is felt both front and back on bilateral pressure upon the crests of the ilia. Treat by reducing the upward displacement by Buck's extension apparatus, using eighteen to twenty-four pounds. If the patient survives the extensive shock, fair return of function may be hoped for.

Fracture of the Acetabulum. This fracture is often complicated with backward dislocation of the hip joint and may cause recurrence of the subluxation beside adding to the difficulty of replacement.

Fractures extending through the center of the acetabulum are caused by the impact of the femoral head. Unless the head penetrates the acetabulum symptoms are not marked and the condition is seldom diagnosed. Mobility and the bony landmarks remain about the same. When complicated with penetration there is often extensive injury to the soft parts and the injury, though rare, is usually fatal. Usually the great trochanter of the femur is less prominent; the fascia lata is relaxed; occasionally there is outward rotation of the hip; hem-

orrhage is apt to be severe. The leg should be abducted and extended and a block for counter pressure may be placed between the thighs so that the femoral head is wedged.

Prognosis is unfavorable for functional recovery.

Fracture of the Iliac Crests. This occurs from blows or falls on the side. There is little impairment of function. Displacement is usually inward. Swelling, tenderness, crepitus and internal displacement are marked. It is possible to reduce the fragment occasionally in thin subjects. Immobilize with adhesive plaster or bandage with even, very light pressure. Tight bandaging will force the fragment inward. Early union takes place, but at least four weeks must be allowed before the fragment can be safely pulled upon by its attached muscles.

Fractures of the Anterior Superior Spine. This is rare, but is occasionally caused by direct muscular action in sprinting or jumping. Every "pulled" tendon should be carefully examined. Displacement is not great.

Flex the leg slightly and immobilize.

Dislocation of the Symphysis Pubis.—Diagnosis. This condition, which is most frequently post-obstetric, is characterized by pain on pressure, or by abduction of the thighs and usually hemorrhage. More marked separation is very rare but may occur as a result of falls or horseback riding. In such cases the symptoms are more marked and may be accompanied by laceration of the soft internal parts, by fractures or by dislocation of the sacroiliac joints. One should immobilize by a pelvic girdle, by traction and immobilization in case of vertical dis-

placement, or wiring in case of separation without too extensive injury; generally there results a good restoration of function.

Dislocation of the Hip Joint. Hip dislocation is rare in comparison with fractures of the femur and does not warrant the space given to this subject in the average text-book. It is commonest in the adult male. The simplest classification is into anterior and posterior types, according to the position of the femoral head in relation to the acetabulum and the ligaments, especially the Y ligament of Bigelow.

The anterior dislocations are sometimes divided into pubic, suprapubic, perineal and obturator types, and the posterior into ischial and dorsal.

Posterior Dislocations, the commonest type, is usually caused by falls or blows from in back. Inward rotation makes possible this backward slipping, especially when accompanied by adduction and partial flexion. The posterior and inferior fibers of the capsule are torn. The following muscle tendons and sometimes the muscles themselves are frequently torn: the obturator externus and internus, quadratus and pyriformis and sometimes the gluteus maximus. The other muscles are less often affected. When this dislocation occurs the leg is held flexed and adducted; there is often some real and a large amount of apparent shortening. The leg is also inverted and the patient may rest on the sound foot. All these symptoms are aggravated when the head is dislocated posteriorly and inferiorly and the higher its position, the less marked they are. The head is absent from

its normal position and is felt posteriorly and is felt to move on any movement of the femur. The trochanter is above Nélaton's line and shortening is found by the usual measurement from the anterior superior spine to the internal malleolus. A still more accurate measurement is by means of Bryant's triangle. The patient supine, a line between the great trochanter and the anterior superior spine, and a perpendicular line from the anterior superior spine to the table are drawn. The short side of the triangle will be the horizontal line between the perpendicular and the great trochanter, and it is this line that is shortened.

Treat by Bigelow's method. Patient supine, the leg is adducted, flexed and internally rotated followed by forward traction and abduction. This should be done as one continuous movement if possible.

There is considerable injury to soft parts by Bigelow's method which, however, is a great improvement over the older and more forceful maneuvers. Less injury is apt to be done by the Allis and gravity method.

The Allis Method. Patient supine, the thigh and knee are flexed to right angles depressing the head with counter pressure downward on the pelvis by strap, assistant or surgeon's foot, the surgeon exerts traction upward as if trying to lift the patient by the lower leg, the femur perpendicular. Gently rotate inward and outward several times, each followed by upward traction if necessary.

Gravity Method. Patient lies prone, pelvis at end of table, hip and knee flexed at right angles. Support the ankle and give gentle pressure downward just behind the

knee. It may take a little time before the muscles relax and the bone slips into place. If one or both of these methods fail, then the Bigelow method should be tried.

Anterior Dislocation. This occurs most often in blows or falls on the abducted leg. Here, too, the head escapes low down and then travels forward through the lower and anterior fibers. The Y ligament is not usually injured; the ligamentum teres is usually torn; the muscles are rarely injured. The leg is extended, abducted and rotated outward; the patient can bear considerable weight on the leg. The head is displaced inward, generally below the center of Poupart's ligament. The Y ligament generally lies in close apposition to the neck and may be used as a fulcrum to restore the head to place.

Allis Method. The patient lies supine, the surgeon grasps just behind the flexed knee, abducts the slightly flexed thigh sharply and exerts traction. An assistant presses against the head while the thigh is adducted.

Rotation Method. This method is attended by danger of injury to the soft parts and the sciatic nerve and should, therefore, be very gently performed. It may be performed in two ways:

1. *Inward Rotation.* The thigh is partially flexed and then, with downward traction, is abducted, adducted and rotated inward so that the head slips into place and the thigh may be lowered to full extension.

2. *Outward Rotation.* The thigh is partially flexed and adducted, the knee lowered and adducted and the thigh then rotated outward.

Fractures of the Upper End of the Femur. These

FIG. 54. CALLIPER WALKING SPLINT.
Upper fifth part of femur missing. (See FIG. 55.)

FIG. 55. HIGH EXPLOSIVE SHELL WOUND OF THE HIPS, SUSTAINED JULY 14, 1918.

Head and neck of the femur resected Feb. 3, 1919. X-Ray shows attempt at the formation of a new head. Joint flail. Nutrition of soft parts maintained by baking and massage.

fractures are divided roughly into intra-capsular and extra-capsular types. Displacement varies slightly by the plane of the fracture and the direction of the muscle pull. As a general rule in fractures of the neck there is overriding of the lower fragment upward which is corrected by extension in the abducted position with slight inward rotation. Fixation of the pelvis as well as the leg is essential, and fixation of the whole trunk desirable. This can be done by means of a posterior body frame-brace by the Thomas posterior splint or by extending the plaster cast to the axilla. The question of the amount of impaction is more important to determine than the exact location of the break. As a rule impaction favors union.

Fractures at the Epiphysis of the Head. Injury at this point is of fairly common occurrence among schoolboy athletes. It often follows slight trauma, or repeated slight trauma, the symptoms of which at the time are mainly those of hip joint strain or sprain. For this reason it is very often not discovered for some time. All the movements of the limb may be normal except for some pain and spasm upon abduction and rotation. Increasing lameness after another similar injury may lead to an X-ray, when the trouble is discovered. Again the symptoms may resemble a beginning hip tuberculosis with some limitation of movement in all directions, and obvious shortening, the great trochanter being above Nélaton's line. The symptoms also resemble coxa vara and some authors call this condition traumatic coxa vera. We must also differentiate this condition from Perth's disease, or osteochondritis, with its flattening of

the head and shortening and thickening of the neck. Especially difficult is it without the help of the X-ray to differentiate this condition from late rickets.

Treatment consists in abduction and extension under anesthesia if necessary with fixation for five or six weeks.

Intracapsular Fractures. Fractures of this type through the neck of the femur occur most often in late life as a result of falls. Sudden twists of the leg are sufficient to produce it when the bone is much rarefied.

Pain, mobility, crepitus, and shortening to some extent are present. Treatment should be by the posterior abduction frame or Thomas splint in extension, abduction, and slight inward rotation, the correction of the deformity being verified by the X-ray. Fixation may be obtained by plaster, in which case the cast should run from the chest to the toes. Special care to prevent a collection of fluid in the posterior lobe of the lung by too long recumbency, or the development of pressure sores must be guarded against.

Extracapsular Fractures. These are more apt to occur in adult life by severe blows or falls on the trochanter. There is likely to be firm impaction with little loss of function and I have known of one heavy woman who walked for weeks with such a fracture.

More marked shortening occurs than in the previous type unless there is impaction. Slight eversion of the leg, apparent broadening of the trochanter, crepitus and pain are noted.

The treatment is the same as for the intracapsular

type except when there is marked impaction with deformity. Here the impaction must first be broken up.

Fractures of the Shaft of the Femur. These fractures are apt to be oblique with considerable tearing of the soft parts.

Symptoms. Great swelling and disability, pain, deformity, marked mobility at the seat of the fracture, rotation of the leg at this point and crepitus are noted. Measurements unless accurate are useless. A simple rule is to lay the patient on a hard, even surface with a vertical line corresponding exactly to the sagittal plane and another at right angles directly under the anterior superior spines.

For transportation, if necessary, a pillow or roll of blankets should be placed around the extended leg supported by side and rear splints of wood. When all the material is at hand for setting, the patient may be anesthetized. The foot should be included in the permanent dressing and kept at right angles. Extension should be by means of weights with the leg elevated by a Bradford frame or bed elevated at the foot.

The Caliper Extension. The caliper or ice tong method of extension, devised by Major F. A. Berley, has been used with good success in the army. A small incision just large enough to admit the point of the caliper is made just over the most prominent part of the condyles and they are driven about a quarter of an inch into the bone, a little higher on the inner side. Care must be taken not to enter the knee joint. The leg is slung by a Balkan frame with ten to fifteen pounds weight

exerting traction in the line of the femur. This position facilitates nursing the patient, and infection incident to the use of the tongs has now been reduced to two or three per cent.

Fractures of the Lower End of the Femur. Surgical Anatomy. Most of the lateral surface of the condyles is subcutaneous. The popliteal artery lies close to the posterior surface and is often pressed upon by one of the fragments. The nerve and vein of the same name are further from the bone and not as often injured. The most common fracture is transverse, just above the condyles, but they may be fractured separately or a T shaped fracture may extend to the joint. The epiphysis may be separated. A fragment may be displaced in any direction but the pull of the gastrocnemius will usually displace the fragment backward. When the epiphysis is separated, on the other hand, it is usually displaced forward. There are pain, swelling, unnatural mobility; the leg may be helplessly rotated outward; crepitus may be present. Soft crepitus denotes epiphyseal separation but overriding and shortening are the rule.

Anesthesia is usually necessary. Early reduction is essential because of the danger of possible injury to the popliteal artery. Since there is great danger of injury to this vessel by the manipulations incident to setting, great care must be used. Never press in the popliteal space. Besides the caliper method mentioned, the Cabot posterior wire splint, the Dupuy adjustable splint or the Hogden splint may be used. The first two are arranged in a double inclined plane. Operative treatment is indi-

cated whenever good reduction cannot be obtained. The incision should be along the inner border of the quadriceps extensor. The use of the bone-hooks or forceps may be necessary. In fractures involving the joints two incisions may be necessary. Open the knee joint only as a last resort and then only under rigid aseptic precautions. The Lane plate or bone pegs may be used when the epiphysis is not involved.

After Treatment. Considerable swelling and some arthritis of the knee joint are to be expected. The use of ice is an important aid. Between the second and fourth weeks the knee should be gradually extended, massage and passive movements begun; after which an ambulatory splint may be worn for two weeks.

Fractures of the Patella. It must be remembered that the patella is really the sesamoid bone enveloped by the tendon of the quadriceps extensor, and is attached below to the tubercle of the tibia by the patellar ligament. Its under surface directly connects with the knee joint. Fractures are usually transverse, caused by blows on the flexed knee. Muscular action alone causes a great many fractures. Many of them, especially of the lower half, are comminuted.

Symptoms. Pain with difficulty or inability to extend the leg is constantly present. Crepitus is present if the fragments are not too widely separated. The swelling is rapid and extensive; there is usually considerable hemorrhage, especially at the sides. With improved technique the operative method is to be preferred. Bony union seldom follows conservative treatment. In non-

operative treatment the leg should be well padded and splinted behind; the leg and thigh fixed firmly and a figure of eight strapping crossing at the sides pressing the fragments firmly together should be used.

Operative Treatment. The knee may be opened by semi-lunar incision, concave above, or by vertical incision. The fragments should be wired, preferably by mattress suture after any blood clot in the joint has been removed and the joint washed out with saline. The patellar ligament should be inspected for tears and any such repaired. In comminuted fractures all small fragments should be removed. In a recent case of extreme fragmentation following a kick by a horse more than half of the patella was removed with an excellent functional result. J. T. Rugh of Philadelphia has demonstrated in a number of cases that a patient can get along perfectly well with the bone excised. Passive movements and massage are indicated after the fourth week. If healing is delayed protection for several months is indicated.

Dislocations of the Patella. These injuries are not very common; the internal are more common than the external subluxations. The symptoms of intense pain, loss of function, and the easily recognized deformity, are marked.

Spontaneous reduction may take place. The knee should be completely extended with the thigh flexed. Slight pressure is usually enough to cause it to slip back into place. When the patella is rotated, palpation of the ligament will show the direction. Old unreduced cases may necessitate operation.

After Treatment. A supporting bandage, and ice-cap if necessary, are used, and careful use of the knee for some time should be insisted upon.

Dislocation of the Knee. This is a rare condition. The most common type is forward and backward, outward and inward in order. We get pain, swelling, loss of function and considerable shock.

Treat by traction, Buck's extension if necessary. Operation may be necessary in complete dislocation. Immobilize for three months with a posterior splint and watch the circulation carefully. Stimulation and opiates are sometimes required by the patient's general condition. Immobilize for three months, using baking frequently.

Fractures and Dislocations of the Semi-lunar Cartilages. These cartilages are semi-lunar in shape, thickened at their margin, the inner edge being free in the joint. The internal cartilage is closely associated with the internal lateral ligament and they are both affected by the same type of strain. Sudden pain in the knee after strain or injury and partial flexion is noted. The joint locks and extension is impossible. After manipulation a sudden snap is felt in the joint with return of normal function. Inflammatory reaction is set up in the joint tissues and persists for a varying length of time. Recurrence with increasing frequency is the rule. Occasionally locking is not present. The internal cartilage is the most often injured. The pain may be here or referred to the patella.

Place the patient prone, knee flexed, rotate slowly from side to side. Flexing the knee over the surgeon's wrist is a means of separating the articular surfaces of the joint.

Free, painless extension is the sign of reduction of the deformity. The knee should then be protected from overuse or strain by a simple hinge brace. In recurrent cases the cartilage should be excised.

Rupture of the Crucial Ligaments. This follows severe twists of the knee. Almost immediately there are severe pain and great swelling which make the joint insecure. The function of the anterior ligament is to prevent forward displacement of the tibia and it is tense in complete extension of the leg. The posterior ligament, on the other hand, holds the tibia forward and is placed in tension when the knee is completely flexed. Acting together, they prevent twisting of the leg inward. Testing these different movements will show the extent of the injury which has taken place.

Treat by fixation in extension; a posterior splint followed by the use of the hinge brace is recommended. Operative interference is seldom indicated. The spine of the tibia is sometimes torn off in association with rupture of these ligaments. The knee should be put up in full extension. X-ray diagnosis is essential.

Fracture of the Upper End of the Tibia and Fibula. Fractures of Tibial Tuberosities. We find disability, pain, swelling and traumatic arthritis are present; lateral stability of the knee is often lost. The deformity is usually recognized since it is subcutaneous. Separation of the upper epiphysis of the tibia is rather rare; the fragment may be displaced in any direction and crepitus is soft.

Fracture of the Upper End of the Fibula. There are

FIG. 56. FRACTURE OF TIBIA, COMPOUND COMMINUTED, WITH LARGE LOSS OF BONE SUBSTANCE.
Pieces of shrapnel shown imbedded in the soft parts.

FIG. 57. FALL FROM HORSE CAUSING FRACTURE THROUGH HEAD OF ASTRAGALUS.
Larger fragment displaced backward and inward with one inch separation resulting.

FIG. 58. COMPOUND COMMINUTED FRACTURE OF TIBIA AND FIBULA. (See FIG. 20.)

pain and local tenderness, but less involvement of the knee and less disability; the head may be movable; the perineal nerve may be injured. Reduce, immobilize, and begin passive movement and massage the third week. In case of impaction use Buck's extension. Operative treatment may be necessary. Treatment may have to be applied to the knee joint.

Fractures of the Shaft of the Tibia and Fibula. These fractures are rather common from either direct or indirect violence. Fracture of either bone separately is usually the result of a direct blow. Compound fractures are common.

Pain, swelling and deformity, abnormal mobility, and crepitus are common. Abnormal mobility is greater when both bones are broken. There may be little loss of function in fractures of the fibula alone. Hemorrhage is often severe. The greenstick fractures of children sometimes present few symptoms but pain and bowing. The diagnosis is made by X-ray.

For transportation the leg should be splinted both sides and rear, supported below the foot and well padded. Extension applied to the foot flexed nearly to a right angle is useful. Posterior wire splints or plaster splints are commonly used. Operative treatment should be instituted wherever good apposition is otherwise impossible. An ambulatory splint should be used if possible at the end of the first week. Great caution is necessary when beginning use of the limb. Weight bearing should be extremely gradual and the condition of the callus watched by the

X-ray. Heat, massage, and passive movements of the ankle and knee should be used early.

Fractures of the Lower End of the Tibia and Fibula. Pott's Fracture. This is a combination of fracture and dislocation.

Surgical Anatomy. The ankle joint is formed by the fibula externally, the tibia above and internally and the astragalus below. The two leg bones are bound by the strong tibio-fibular ligaments. The lateral ligaments are also very strong and are more apt to be pulled away than torn through. The external malleolus is longer and lower than the internal. The weight-bearing surface of the heel is slightly outside in the longitudinal plane of the tibia, hence, landing squarely on the feet with great force tends to lateral and upward displacement of the foot. This force is applied directly against the lower end of the fibula and on the internal lateral ligament. Either this ligament is ruptured or the tip of the malleolus is torn off.

There are absolute loss of function, pain, swelling and characteristic eversion of the foot; the greater prominence of the internal malleolus; crepitus is usually lacking and the heel may appear prominent. Marked swelling may mask the symptoms; delayed hemorrhage is often seen.

Inversion and upward replacement of the foot is necessary. The padded internal splint of Dupuytren should be used early. The padding just above the fracture is used as a fulcrum to invert the foot. The Cabot wire splint may be used throughout. Stimson's plaster splint is best after the first week. It consists of a posterior seg-

ment from the knee to the toes and an external one which is continued beneath the foot and over its dorsum to the external malleolus. The foot must be placed at a right angle. The splint should remain on five or six weeks, massage begun in the second week. Weight bearing should be gradual and guarded.

Fracture of Both Bones Above the Ankle. The symptoms are pain, swelling, loss of function, crepitus, preternatural mobility. The deformity is usually marked and easily recognized.

Treatment is the same as for fractures of the shaft.

Dislocation of the Ankle. These are usually forward or backward. Lateral dislocations are generally associated with fracture.

Posterior Dislocations. Prominence of the tibia and the obvious deformity are seen.

Place the patient supine, fix the ankle with traction downward, grasp behind the heel, pull backward, downward, forward.

Forward Dislocations. This is usually associated with fracture, and if so, operative treatment may be necessary.

Fractures of the Tarsus. These should be diagnosed by the X-ray, replaced as well as possible and immobilized with plaster.

Fractures of the Metatarsus. The symptoms vary greatly with the severity of the injury. Crushed wounds often cause multiple fractures with extensive damage to the soft parts. Pain, swelling, crepitus, and tenderness are the usual symptoms. Pressure beneath the toes on the head of the metatarsal bones is one method of elicit-

ing pain. Reduce the deformity by pressure pad and immobilize in a cast.

Fractures and Dislocations of the Phalanges. The symptoms are similar to those described for the fingers. The deformity should be reduced and the foot encased in plaster. Where the injury has been done to the great toe, the patient should not be allowed to walk until bony union has taken place or inflammatory reaction has subsided. In the other phalanges use may be allowed much earlier.

Chapter XIII

FOOT STRAIN

The Main Arch. Classification. Three degrees of this condition have been described:

1. The weak foot. This is a condition in which the patient complains of discomfort or pain in the arch when overfatigued or following prolonged use of the foot, especially during hot weather. The arch is little, if any, lowered.

2. The strained foot. Here the arch is coming down. The pain is very severe and may be referred to the back of the leg, front of the thigh, or even the back. The scaphoid is usually prominent. This condition must be visualized as the breaking stage.

3. Absolute flat foot. Here the damage has been done. The arch is flat and the inner border of the foot bulges considerably. There is no pain and, indeed, sometimes never has been, if the condition is gradual enough in its onset. The patient often consults the orthopedist because some person has told him he is flat footed, or because he has been rejected from the service. The author has been consulted by many young men, from naval recruiting stations, who were utterly unaware of the existence of this condition or their probable rejection from the service on account of it.

Causes. Before any intelligent conception of the reasons underlying the great prevalence of this condition can be gained, it is necessary to consider the way in which savage, or natural, man used his feet, and the extensive changes that civilization has brought about. The normal movement of the bare or moccasined foot in walking is a grasping one, which constantly exercises the three layers of muscle whose normal tone, with the long and short plantar ligaments, helps to retain the form of the arch. The foot is pointed straight forward or slightly toeing in; the heel, outer border, ball of the foot and toes carry the weight.

We no longer usually walk upon sand or springy turf, but a rapidly increasing part of our population is condemned to solid pavements and hardwood floors, and such conditions cause strain. It being considered the proper thing to toe out, it is insisted upon that the child fall in line with this convention. In such a foot position, since the momentum of the body is going straight forward, if the weight hits the heel on the outer side with the foot everted, it must necessarily be transmitted across the foot directly onto the arch, instead of along the outer border of the foot, and straight forward.

We further impede normal use of the arch muscles by placing a rigid leather sole on the shoe. In women's shoes several points in consideration of the heel are important. The very high heel, by causing long held contraction of the calf muscle, may lead to its structural shortening. This height induces an artificially high arch, which is withal a weak one. It makes such a steep incline in the

Fig. 59. Exercise II. Walking Forward on Outer Edge.

Fig. 60. Exercise III. Rising on Toes, Toeing in.

Fig. 61. Exercise IV. Walking Forward on Outer Edge, Toeing in.

Fig. 62. Exercise V. Ground Gripper Walk.

shank that efficient weight bearing there is impossible and the weight is unduly thrust forward onto the ball of the foot. Constant variations in the height of the heel are in themselves a danger because they do not allow time for readjustment of the muscles and ligaments to varied planes of weight bearing. Moreover, these heels are usually extremely small in base, which necessitates a stilt-like balancing by the muscles of the leg. This is a most severe type of exertion and, occurring in that part of the body where the removal of waste products is most sluggish, it is no wonder that fatigue and strain almost inevitably ensue. Still further, the shortness of such a heel fails to give support far enough forward under the os calcis and so brings increased strain on the arch. The constricted fore part of the shoe, absolutely eliminating the normal spread and movement of the toes, adds its quota of injury. Occupations requiring long standing or the enforced immobility of the muscles of the foot are a far more frequent cause of flat foot than walking. Certain constitutional conditions predispose to arch trouble, especially the general lack of muscular tone following acute or chronic illness, too rapid growth, or any other condition which lowers bodily tone.

Diagnosis. Heretofore great emphasis has been placed upon the arch impression, which, when normal, is supposed to be broad in the heel and ball of the foot and to show only the outer border between them. A low or fallen arch is indicated by the breadth of the central part of this impression, with sometimes a total obliteration of the curved indentation of the arch in the normal impres-

son. Impressions are commonly taken by means of water, powder, lamp black, ferric chloride solution, or other substance applied to the soles, the patient standing with feet parallel and about six inches apart, his weight evenly distributed on both feet. The ferric chloride or lamp blacked paper shellacked may serve for permanent record. An ingenious device is the small plate glass stand with slanting mirror beneath, showing the pressure imprint of the arch to the surgeon standing in front. I take it that these impressions are of little intrinsic value except when kept in series as a record of the success of the treatment given. The most painful arches I have ever seen have been naturally high ones that were beginning to break. On the other hand, the examinations of several hundred normal students of physical education have shown, in a great majority of cases, the low strong arch with no untoward symptoms. This fact confirms the conclusions of Major John Ridlon of Chicago, embodied in his advice to surgeons examining for the service, that the low arch, showing good strength of the intrinsic muscles of the foot and without painful symptoms, was much more apt to stand up under forced marching than the very high arch. The pain, with its frequent reference to more or less remote parts of the body, is important. Abduction of the fore part of the foot must be looked for in all types. A ridge of callus along the outer edge of the foot is a sure sign of faulty weight bearing.

No treatment should be instituted without inverting the foot and passively flexing it to determine the angle of dorsal flexion, which should be ten to fifteen degrees less

than a right angle. A flexion limited to a right angle or more shows the muscle-bound foot described by Hibbs. Proper treatment for that condition, consisting of the stretching of the calf muscle, if possible, if not, by operative lengthening of the Achilles tendon, must be instituted before attempting to treat the arch. These patients receive a strain or stretching of the calf muscle just as the heel leaves the ground in the step, and, in order to decrease the amount of foot flexion necessary, they turn the foot out more and more. This, as before shown, transmits the weight more directly onto the arch and aggravates the strain upon it. They are given temporary relief by certain plates, but, more often, by a higher heel, until the calf muscle takes up the new slack, when the vicious cycle is repeated. In numerous clinics I have seen patients arrive with a bagful of arches of various descriptions, when this condition, the root of their trouble, has been overlooked.

Treatment. Individual cause must first be sought and if possible eliminated. The patient should walk with the foot straight forward. He should wear a heel of moderate height, broad and long, especially on the inner side. A wide, sensible heel and a flexible shank is often of advantage. Beginning cases, as of type 1, may often be cured by two or three strappings and a program of exercises. The other two types need all the resources at our command.

Strapping. Strapping is usually done in one of two ways: 1. The partial figure of 8. This is a long doubled strapping starting at the inner border of the tibia, cross-

ing the front of the ankle and the external malleolus, going under the heel at the anterior border of the os calcis to the internal malleolus, crossing in front of the ankle and attached to the outer side of the leg. This strapping is intended to lift up the front part of the heel and makes no attempt at holding the foot in inversion. It takes little plaster, is quickly and easily applied and is a good type for dispensary work.

2. The basket strapping. This consists of two sets of six straps each, the shorter set in length from the base of the toes to about an inch over the heel, the other set six inches longer. With the foot flexed to a right angle and inverted the first short strap is placed from the base of the small toe to the back of the outside of the heel. The second and long strap is started just over the dorsum of the foot at the base of the little toe, is carried diagonally under the ball of the foot, back to the anterior part of the arch, up across the front of the ankle, to the outer side of the leg. The third is placed parallel to the first, overlapping it one-half in the direction of the arch. The fourth is parallel to the second and slightly posterior to it, so that it overlaps it one-half. The rest are placed in alternation, until the arch is covered and supported in its center by four thicknesses, the result of the interweaving of the two groups. This strapping holds the foot in slight inversion, supports the arch through its entire length, and has been most satisfactory in practice. Such a strapping should last from four to seven days and will relieve symptoms while a plate is being made.

Arch Plates. There are two principles involved in the

Fig. 63. The Hammock Arch Plate.

Fig. 64. The Hammock Arch Applied.

prescribing of arch supports. One is thoroughly to support the arch and relieve the symptoms consequent to strain, the other partially to support and assist the arch muscles in regaining their tone. The first principle is typified by the Whitman plate, which is made from a cast of the foot and so gives perfect support. It consists of an outer flange, preventing displacement of the support, and a high inner flange, which supports the scaphoid and prevents the rolling in of the ankle. I believe this to be the best plate for patients beyond middle life, those distinctly over weight, or those whose feet are rigid. A second plate, on the principle of a sling or hammock for the arch, improved on greatly by E. H. Arnold of New Haven, gives partial support to the arch by means of two ribbons placed under the arch, one passing over the dorsum of the foot, the other under the heel, buckling in front of the internal malleolus. This plate allows considerable movement in the foot muscles without abduction of the forefoot, and in young and strong patients, where the ability to regain normal muscular power remains, has given extremely satisfactory results. The leaving off of this support, after it has performed its function, does not usually lead to a renewed relaxation of the arch muscles. The ordinary stock plate neither fits the individual patient, nor assists the return of muscular function, nor gives adequate support and, therefore, is usually a failure. Moreover, nearly every type of arch plate on the market compels the abduction of the forefoot.

Massage. Frictions of the arch can be done easily by the patient himself and should be followed by stroking.

This is a valuable means of improving the circulation and relieving fatigue.

Exercises. Of the many kinds of exercise that have been tried the following are typical examples and, when coupled with the above outlined forms of treatment, will greatly hasten a return to normal:

1. Stand with the feet parallel and roll out.
2. Stand with the feet parallel and walk forward on the outer edge, keeping the toes flexed as far as possible.
3. Toe in and rise on toes.
4. Walk forward on the outer edge, toeing in.
5. Ground gripper walk. Step forward, flex the toes to the greatest possible extent, and relax. Repeat step forward with other foot.
6. Pick up marbles with the toes.

Anterior arch. The anterior arch extends transversely across the fore part of the foot and is formed by the anterior ends of the metatarsal bones at right angles to the main arch. It is supported by the transverse metatarsal ligament and the transversus pedis muscle. Strictly speaking, it is not a real arch since it always disappears under weight bearing.

Cause. Obliteration of the anterior arch, often called "anterior metatarsalgia," is very much more frequently diagnosed now than a few years ago. Its more common occurrence is, in large measure, due to the increased vogue of the thin-soled, high-heeled shoe and pump, and, to some extent, to the increased amount of hard pave-

ments. With the falling of the main arch there is an internal rotation at the metatarso-phalangeal joint that produces marked ligamental strain.

Diagnosis. As before stated, the high heel necessitates the crowding forward of an undue amount of weight upon the ball of the foot. The thin sole very frequently curls, in such a way as to form a hollow inside the shoe. Into this the anterior arch is apt to fall, by first spreading the but slightly resistant upper of the shoe, and then dropping and assuming the shape of the sole. Nature may attempt to build it up by forming, underneath the foot, a pad of callus, which is often the first sign of impending trouble at this point. The pain is sharply localized near the head of the second metatarsal bone and is extremely acute in character. An interesting case in point is that of a young woman of nineteen, who came to the dispensary with all the classic symptoms of this condition. Her case had been diagnosed and routine treatment had been applied on several occasions without result. X-ray showed tuberculosis of the distal end of the second metatarsal bone of each foot, an extremely rare bilateral manifestation of this disease, which was then treated by the appropriate means with good result. I cite this case as an example of the fact that, where the recognized treatment of any apparent orthopedic condition has repeatedly failed, we should exhaust all means at our command before giving the case up or continuing the ineffectual treatment. It must not be forgotten that one may be dealing with a *referred* pain from longitudinal arch strain.

Treatment. The treatment of this condition is, first, to eliminate the cause, for instance, by a thick-soled, sensible shoe; by the removal of the ofttimes painful callus by chromic acid or other means; by the use of strapping, or a support, as well as passively attempting to remold the arch; by the use of exercises, one being a picking up of marbles or other small objects with the toes. Other exercises, such as flexion and extension and the longitudinal arch exercises, help greatly. Sometimes a circular adhesive strapping running several times around the fore part of the foot, the arch being held in a corrected position, will suffice. A very excellent pad can be made from a circular piece of chamois, a little larger than a silver dollar, surrounding a piece of cotton and securely sewed, so as to be about the size of a half dollar and two or three times as thick. If this is not at hand, a simple pad of cotton will often bring immediate relief when held in place by the above mentioned circular adhesive strapping. A laced "collar" with pocket for pad is useful.

ARMY TREATMENT OF FOOT AILMENTS

Strained Foot. The methods of classifying and treating acute and chronic foot strain in the Army is so different from that heretofore used in private practice, that to avoid confusion it may be dealt with separately in this section.

Literature. The latest material will be found in the War Department Manual, "Minor Foot Ailments" and "Medical Manual No. 4" (Military Orthopædic Surgery), Colonel Sir Robert Jones' work on "Military Orthopæd-

ics," Colonel Munson's book, "The Soldier's Foot and the Military Shoe," and the printed lectures of Captain W. J. Merrill of Philadelphia, delivered at the Camp Greenleaf School.

Viewpoint of Military Orthopedics. It is now the consensus of opinion that we are dealing with soldiers disabled or potentially disabled (amounting at times to ten per cent of the troops) by (1) weak muscles, (2) acute or chronic foot strain, (3) arthritis or ostitis, secondary to focal or systematic infection.

Classification. Following to some extent the classification of Jones, the soldiers' feet are divided into the following types: (1) Weak foot, (2) Flaccid flat foot, (3) Rigid foot: (a) Muscle bound, (b) Contracted, (c) Rigid, (d) Spastic, (e) Claw (first, second and third degrees).

Anatomy. The weight bearing is done normally when the heel is raised, by the inner three segments of the metatarsals, cuneiforms, scaphoid and astragalus. The os calcis, cuboid and outer two metatarsals add lateral stability. Movement involving flexion and extension of the foot—or, as it is called in the Army, plantar flexion and dorsal flexion—takes place on the trochlear surface of the astragalus. Lateral movement occurs in the subastragaloid joint and between the head of that bone and the scaphoid. (This point is important to bear in mind when judging the claims for merit of several styles of shoes which are supposed properly to adduct the foot. In the types I have in mind the foot is not grasped far enough back by the shoe, and the toes are merely crowded out of alignment.) It should never be forgotten that liga-

ments are non-elastic and non-sensitive, and that the pain of strained foot occurs very often where the ligaments attach to or pierce the periosteum, which structure is extremely sensitive.

Methods of Examination. "The examination of the soldier's feet begins at his head." This axiom indicates the close association and importance of bodily posture to foot strain. A clear picture of the normal posture and normal foot must constantly be kept in mind. (Place patient's feet parallel and six inches apart.) Determine the lines of weight bearing. They should pass anteriorly through the center of the patella, the crest of the tibia and the middle of the second toe. In the rear from the center of the popliteal space to just outside the center of the heel. Examine carefully for scars, discolorations, swellings, sweating. Note the condition of the toes—corns, callosities, hallux valgus, etc. Manipulate thoroughly to bring out any restriction of normal motion or roughening of joint surfaces. The following exercises will be of service in the examination: 1. Dorsal flexion (overextension) of the toes, kept *straight.* 2. Rise on heels, foot dosi-flexed. 3. Rise on toes, avert ankles. 4. Supinate foot (bear weight on outer edge) and flex toes.

Diagnosis and Treatment. 1. Weak Foot. In this type we find slight pronation. This foot cannot perform the common exercise movements normally. The muscles are untrained and hence liable to break down under unusual exertion. Any foot which shows the weakness out of proportion to the obvious deformity should be placed in this group. These feet should be treated by proper

shoes with wedge or Thomas heel if desired, exercises, passive movements, massage and contrast baths. This type must be noted in the history.

2. Flaccid Flat Foot. There is much obvious deformity in this type—marked pronation, prominent scaphoid, abducted forefoot, and often flattened transverse arch. The important point is, however, that the foot can go through the standard exercises in a nearly normal manner. The treatment is similar to that just given for weak foot.

3. Advanced Type with Joint and Muscle Complications.

(a) Muscle Bound. These conditions are brought about by over-use *per se,* at times but a careful search will generally reveal some constitutional disorder at the root of it. Indeed, Captain Merrill states that in his opinion over ninety-five per cent of these cases are due to infection somewhere in the body. The teeth, tonsils, gastro-intestinal tract, urethra or prostate are the points of predilection.

We must then seek the focus of infection and if still active, eliminate it. This done, a short rest from strain will allow of nearly normal movements being executed. The treatment by massage, exercises, etc., will then rapidly restore the foot to full usefulness.

(b) Contracted. Here there is actual structural shortening added to muscle spasm. The conditions found in the muscle-bound foot are present in aggravated form. Try to locate the constitutional predisposing cause. Treat as above outlined.

(c) Rigid. An infectious process has been at work on the joints of the tarsus and mid-tarsus. Gonorrhea is a common cause, supplemented by foot strain. Here prostatic massage and medication should be added. If the palliative measures used above do not cause a return of flexibility the patient may be anesthetized, the foot placed over a padded Koenig block and the adhesions broken up. Place in a cast, the foot being inverted, flexed to 90 degrees and supinated. It should remain in the cast two or three weeks and then the regular treatment instituted as for the other types heretofore outlined.

(d) Spastic. In this type we have the added feature of a marked pronation maintained by the spasm of the peronei muscles. These tendons must first be lengthened by tenotomy or better by tenoplasty. The latter is done by two transverse cuts from opposite sides of the tendon extending halfway through and then stretching it until it tears within its sheath, giving the desired and usually permanent lengthening. Put up in plaster and treat as above.

(e) Claw. This condition is always progressive, usually rapidly so, and is a cause for rejection from the service. Several varieties are described. First Degree: (a) First toe contracted, (b) the other toes contracted, (c) all contracted. Second Degree: An intensification of the first, with marked varus of the os calcis, callosities and short tendo Achillis. Third Degree (Jones' Fifth Degree): Intense neuro-vascular changes, with blisters, blebs and gangrene. Sometimes also deep-seated, painful callosities and corns. Treat by the palliative methods

given with a great deal of dry hot air. The first degree may be relieved by fasciotomy and tenoplasty. Lift up the heads of the metatarsal bones by fixing the extensor tendons to the heads of the phalanges. Occasionally the flexor tendons are fixed to the proximal heads of the phalanges. In the second degree operate at once. In the third degree it may be necessary, because of the poor circulation, to amputate the toes or to perform an astragalectomy.

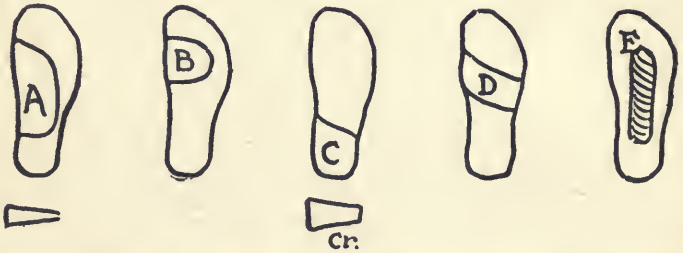
Acute Foot Strain. This condition occurs most often in the new recruit, and is treated by rest in the recumbent position. The pain, swelling and tenderness rapidly subside when massage, passive movements, active movements without weight bearing, and finally walking are resumed as soon as they can be done without pain. In the more severe types strap with double stirrup-strapping or partial figure-of-eight already described, or else place in the corrected position with knee flexed, and apply a plaster of Paris splint, from the toes to the middle of the thigh.

Chronic Foot Strain. Here the onset is slower. The typical symptoms are the pain and stiffness on first getting onto the feet in the morning, which may return toward night with fatigue of the muscles. Change the occupation so as to relieve the feet from strain. Order proper shoes, strapping, or arch if necessary, and treat as above.

Hammer Toe. Never amputate for this condition; remember that every toe in its normal position contributes

to the lateral support of the others. If due to habit, it may be corrected by strapping from base to tip, running under the adjoining toes and over the hammer toe. Cut the flexor tendon if necessary.

Corrective Appliances for Shoes. In the Army no removable appliance may be worn by men on active duty. An intensive study of the methods by which the shoe itself may be altered by any cobbler has been most successful in its results.



(A) Long inner wedge inserted, between the layers of the sole, to help supinate the foot extended under the first four metatarso-phalangeal joints.

(B) The "D" shaped wedge of Jones for the same purpose.

(C) The Thomas Heel. "C" the higher (⅛ to ¼ inch) inner side for eversion. "Cr" the flare on the inside of the heel to add stability.

(D) Jones across bar now inserted between the layers of the sole for anterior arch trouble.

(E) Steel insert to prevent weak shank from adding to foot strain on rough ground.

TREATMENT OF MINOR FOOT AILMENTS

Synovitis of Anterior Tendons. Lace the shoes only with the broad ribbon laces laid flat. At the fifth holes carry lacer through twice to retain snugness below, and prevent the foot going forward in the shoe. Above the fifth eyelets lace loosely and tie behind so puttees do not press on knot. Massage (effleurage upward), rest, bake

or paint with iodine, for curative treatment. Watch for and treat constitutional disorders.

Blisters. (a) Small superficial type, open with sterile needle at periphery if desired. Place pad on sticky side of plaster directly over the blister, and strap tightly to promote absorption. (b) Deeply inflamed type. Clean hands and area carefully. Open at periphery with sterile needle or bistoury. Press out all exudate. Paint with iodine or ambrine, pad and strap tightly. Be careful always not to break the skin on top of the blister.

Abrasions. Disinfect with iodine or alcohol. Pad and strap if caused by puttee or knotted laces, readjust shoe lace as above indicated.

Fissures. Clean out superficial ones with iodine 2½ per cent, pad and strap. Cauterize deep ones with silver nitrate, pad and strap.

Over-Riding Toes. These are not important except for the liability of corn formation, and can be neglected.

Corns. No man in the service is allowed to have his corns cut or pared. Their deep and irregular under surface makes the liability to infection very great. Remove the cause, which is generally pressure by improperly fitting shoes. Clean and dry the corn and apply the standard corn collodion. Dress with gauze and reapply every other night for six to ten days; after a thorough soaking, the corn can then be lifted out in its entirety by some blunt instrument. Fulguration will usually cure.

Soft Corns. Clean carefully, apply corn salve, covered by a pledget of wet gauze, bring the toes together

and strap them; bathing the feet frequently with cold water and proper shoes will prevent their formation.

Callosities. Soak with water, scrape and apply corn salve. Chromic acid or excision may be necessary for the removal of deep ones.

Warts. These growths are of great importance, as the pain from even a very small one may cause foot strain in the effort to avoid weight bearing on them. They are essentially fungi, have hard glistening surfaces and dark spots in them. Ring them with vaseline or other grease and paint with glacial, acetic or nitric acid. Dress and strap, treating the same number of times as directed for corns. Fulgurate with high-frequency current if necessary.

Sweating Feet. This condition is a great source of danger to the soldier. Daily cold water baths should be used. Rub with 10 per cent salicylic acid in alcohol. Dry and apply 1-1000 potassium permanganate, 10 per cent formalin, or 25 per cent aluminum chloride. The sock may be dipped in 1-2000 bichloride and dried. Treat daily with foot liniment.

Chilblains. In mild cases stimulate by friction, foot liniment and frequent changes of dry woolen socks. The severe cases demand only cold applications, rest and elevation. No massage or heat should be used.

Trench Foot. The phenomenon is similar to the effect of frost-bite and was formerly common. When proper precautions are taken it is largely preventable at the present time. The cause is cold, wet and interference with the circulation. The onset is gradual, characterized

by chilling and numbness. There is no pain at first. Later on swelling of the feet and marked pain develop where the blood still circulates sluggishly just above the affected area. Treatment is aimed largely at prevention by cleanliness, oiling and several pairs of clean dry socks, with the outer coverings of the foot and leg loosely applied. It was aimed to keep the trenches as dry as possible, the feet and toes in constant motion, and not to allow the shrinking of wet leggins to constrict the leg. Foot coverings were removed, dried with hot pebbles or oats, the feet rubbed and again covered. Warm drinks and dry garments are factors of importance in prevention. Treat by elevation with exposure to sun and air. Electric light baths followed by massage when the œdema lessens. Aspirate bullæ if present, and give antitetanic serum if the feet have been abraded. Morphine is indicated where the pain is severe.

Shoe Fitting. No study of foot ailments is complete without a consideration of that greatest of all factors in their avoidance, namely, proper shoes.

The Munson last with its straight inner line and broad toe provides the best shoe for men. In the Army the recruit is fitted as follows:—He stands on the rule on his left foot, with forty pounds on his back. His foot length is then determined and he is given the second larger size. The width is determined by a scale from the circumference of the fore foot at its broadest part. After six months his strengthened foot muscles require refitting of his shoes.

When the shoe is on and his weight all on the left foot,

PRESCRIPTIONS

Corn Collodion

Salicylic Acid .... 11 parts
Ext. Cannabis Indica ..... 2 parts
Alcohol. 95 per cent. 10 parts
Flexible Collodion .....ad 100 parts

Corn Salve

Salicylic Acid ..... 40 parts
Vaseline ..... 30 parts
Lanolin ..... 30 parts

Stimulating Liniment

Chloroform. ..... 1 part
Spirits of Turpentine ..... 3½ parts
Olive Oil ..... 3½ parts

Oily Liniment for Sweating

Methyl Salicylate or Oil Wintergreen... 2 oz.
Carbolic Acid ..... 1 dr.
Camphor,
Chloral,
Menthol .....āā 2 dr.
Spirits of Turpentine.. 4 dr.
Alberine Oil.....q.s. ad 8 oz.

Aqueous Liniment for Sweating

Salicylic Acid. ..... 3 dr.
Camphor,
Carbolic Acid .....āā 30 gr.
Dissolve in Alcohol 95 per cent., add 3 oz.
Glycerine ..... 1 oz.
Ext. Hamamelis ..... 4 oz.
Alum, pulv..... 4 dr.
Aquæ .....q.s. ad 12 oz.

there should be spare length of about the breadth of the forefinger in front of the longest toe. The leather over the dorsum should just wrinkle but not enough to be grasped by the fingers.

Chapter XIV

BRACES AND CASTS

Braces. A good generalization on the theory of the treatment of orthopedic defects by braces is hard to find in the literature. The descriptions of use of different types of braces in the various deformities are scattered throughout the text books, and the application of the same general principles in each case is often obscure. This failure to grasp the fundamental principles has been evident in some of our army orthopedic instruction as is stated by Major R. W. Lovett, of Boston. He says: "The student as a rule is taught that a certain splint is used for tuberculosis of the hip, another for Pott's disease, another for club foot and a fourth for flat foot. He does not connect these, nor does he understand their principles very well, and as a rule speedily forgets all about them except, perhaps, the name. It has been found possible to get some knowledge, apparently more permanent, into the minds of the students by a different method of approach. It is taught that apparatus may be of wood, plaster, iron, tin, leather and other materials; that crutches are apparatus and so are ham splints; that apparatus should be used for a definite mechanical purpose, and that if the student does not understand what he is trying to do, he will probably not fit satisfactory braces;

that apparatus is used for four purposes: (1) fixation, (2) traction, (3) support or protection, and (4) correction of deformity. A case is shown, its pathology analyzed, and its mechanical needs, if any, are formulated. It may require the application of one of the four purposes described above, and if so the student is required to work out the mechanical needs without calling apparatus by name. He is asked to work out in wire or paper or on the blackboard the theory of the required apparatus. He is then requested to state practically how it could be done in plaster, leather or metal, and he is then made familar with the accepted splint to meet that need. The response of students to this method of instruction has in this department been most satisfactory." *

The same broad treatment of the question of braces and splints was being taught by Major E. S. Geist, M. C., U. S. A., at Camp Greenleaf. A set of simple tools, which he has devised and called the "Oglethorpe Kit," with bench and vise, was sufficient for the improvisation of many splints from wire, which he found to be a most useful material. For the heavier braces a blacksmith's tools are necessary. Provision for lengthening each type of the various braces here described should always be made, except in the case of adults.

Arch braces are described under the topic of flat foot.

Talipes Calcaneus. This brace consists of two lateral bars curved forward to about an angle of 130 degrees at the external malleolus, joined in front and below by a thin

* A System of Orthopedic Instruction, *American Journal of Orthopedic Surgery*, August, 1918, page 487.

sole plate and above by a leather cuff. Complicated by valgus or varus, the deformity is checked by a plate under the sole and over the edge of the foot.

Knee. For arthritis, or ligament strain about the knee joint, the best brace is a simple hinge, locked against over-extension and supported by a broad leather cuff on the upper curve of the calf and lower half of the thigh.

For tubercular knee, the best brace is the Thomas splint, consisting of two side bars extending below the shoe and joined by a cross bar, which acts as a stilt. It is joined together above by a padded ring, which fits snugly at the upper part of the thigh, this ring so inclined that the weight is evenly distributed. Certain common modifications allow for active extension of the knee by means of moleskin plaster and buckles and various other mechanical means.

The caliper splint of Ridlon and Jones is used in the recovery stage, and is so arranged that a gradually increasing amount of weight can be borne upon the foot.

The bow-leg brace consists of a strong inside column and, occasionally, a lighter external one with cross bar through the heel of the shoe. There is a hinge at the ankle joint and a posterior band above, curved obliquely upward and outward to the great trochanter. A short, hinged, vertical piece from this point is connected with a waist strap. Two broad cuffs on the thigh and calf exert traction toward the strong inner bar. There is a modification of this long brace by Napier and a short Knight bow-leg brace.

The knock-knee brace of the Thomas and other types

are very similar, with the strong supporting column hinged at ankle and hip on the outer side. There is not usually an inner support.

Leg. Infantile leg braces are similar to the last two types described with the exception that they have two firm lateral supports usually hinged at the hip and at the knee, with a lock which the patient may manipulate. A hinge at the ankle is locked against extension, and an arch plate fits inside the shoe.

Back. Back braces, for use largely in tuberculous spine, consist of two strong bands of steel shaped to the contour of the spine from the bony pelvis to the neck, with a semi-circular steel hip band and a front canvas apron, cut to fit the chest and abdomen firmly. A head support by means of a ring around the chin or a jury-mast over the head with a sling is indicated where surgical lesions are present.

Casts. Plaster-of-Paris as a means for securing well fitted support, protection and extension, is worthy of a wider use in general practice than it has yet attained. Its ease of application, quick setting and the convenience with which it can be carried are greatly in its favor.

Plaster bandages are easily prepared at home by cutting long strips of coarse muslin or crinoline to the desired width of two, four, or six inches. White plaster is best, but gray, coarse plaster is serviceable. It should be rubbed thoroughly into the meshes of the cloth, which is tightly rolled as you go along, and then kept in a moisture proof metal or glass container. Wide bandages when well rolled are easily cut by a plaster knife.

It is impossible to avoid some spreading of the plaster in rapid work, so the clothing and floor should be properly protected. The skin should be cleansed with warm water and soap, or alcohol, dried and then powdered. Any abraded surface should be covered with sterile gauze and later a window cut through the cast at that point. The part to be incased should be wrapped in some soft material, cotton roller bandage, a thin layer of cotton, jersey or other material. A felt jacket may be used for the body. Joints and points of pressure need extra padding. Crushed tissue paper or even newspaper is of service here. The bandage is then immersed in warm water for twenty or thirty seconds or until bubbling has ceased, when it should be picked up with the open ends against the palms of the hands, and excess of water gently squeezed out. This hold prevents undue loss of plaster. The surgeon should protect his hands if possible, with cheap rubber gloves. If this is not possible protect the under side of the nails by filling them with soap or cold cream. Plaster is easily removed by the use of a little sugar or corn meal.

The part is held in the desired position by an assistant until after setting is fairly complete, the bandages being applied in the same manner as in simple bandaging. It is often desirable to increase the rigidity of the cast by rubbing in dry plaster scattered over the surface during the application. Another means of strengthening a weak point is by doubling the bandage back and forth and overlaying it again with circular strips.

In club foot and several other conditions there is

plenty of time to secure the correction after the cast has been applied, maintaining it during setting. With an indelible pencil, while the cast is still wet, the upper and lower edges and any desired windows can be marked and then cut. Some surgeons insert at the beginning a sheet of tin or other substance upon which to cut down when the time comes for removal. With care and a little skill in cutting this is usually unnecessary. Two vertical and parallel cuts a quarter of an inch apart, with the free use of vinegar, in an old cast make removal fairly easy. All wounds are dressed through sufficiently large windows. The extremities, toes and finger tips should, when possible, be exposed as a guide to the condition of the circulation under the cast. X-rays are usually more readable through casts than through many of the common prepared splints. See that the edges are rounded and well padded in such places as, for instance, the axilla.

GLOSSARY

TISSUE; NAME	PERTAINING TO
arthral	*joint*
cardiac	*heart*
carpal	*wrist*
colonic	*large intestine*
enteric	*small intestine*
gastric	*stomach*
genu	*knee*
hallux	*great toe*
hemal, hæmal	*blood*
myo	*muscle*
nephric	*kidney*
neural	*nerve*
osteo	*bone*
pedal	*foot*
synovial	*membrane (joint)*
talipes	*foot deformity*
tarsal	*ankle*
teno-synovial	*membrane (tendon)*

POSITIONS	
abduction	*away from the body*
adduction	*toward body*
calcaneus	*heel walking*
equinous	*toe walking*
epi supra	*above*

infra, sub	*below*
end—endo	*inner*
peri	*outer*
prone	*face or palm down*
supine	*face or palm up*
distal, peripheral	*away from center of body*
proximal	*toward center of body*
cervical	*neck vertebræ—seven*
ventral, dorsal	*chest vertebræ—twelve*
lumbar	*abdominal vertebræ—five*
valgus	*turned in*
varus	*turned out*

SUFFIXES

algia	*pain*
ectomy	*to cut out*
itis	*inflammation of*
osteomy	*to leave opening into*
otomy	*to cut into*

SPINE

kyphosis	*increased dorsal curve*
lordosis	*increased lumbar curve*
scoliosis	*rotary lateral curve*
torticollis	*wry neck*

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