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APPENDICITIS

ITS HISTORY, ANATOMY, CLINICAL ÆTIOLOGY,
PATHOLOGY, SYMPTOMATOLOGY, DIAGNOSIS,
PROGNOSIS, TREATMENT, TECHNIQUE OF
OPERATION, COMPLICATIONS AND SEQUELS

BY

JOHN B. DEEVER, M.D.

Surgeon-in-Chief to the German Hospital, Philadelphia

THIRD EDITION

THOROUGHLY REVISED AND ENLARGED

CONTAINING SIXTY-FOUR FULL-PAGE
PLATES, EIGHT OF WHICH ARE COLOURED

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TO THE MEMORY OF MY FATHER

J. M. DEEVER, M. D.

WHOSE CHARACTER AND STERLING QUALITIES AS A PHYSICIAN HAVE BEEN THE GUIDING
INFLUENCES OF MY PROFESSIONAL LIFE

THIS BOOK IS AFFECTIONATELY DEDICATED

PREFACE TO THE THIRD EDITION.

In preparing this work on Appendicitis for a third edition the author has spared no pains to render it worthy of a continuance of the favour with which it has heretofore been received. He has not been unmindful of, and he trusts he has profited by, the criticisms, both kindly and adverse, with which the second and particularly the first edition were greeted. At the date of the appearance of the first edition—now nearly nine years ago—the position taken by the author with reference to early operation for appendicitis was assailed by innumerable criticisms; and it has been a great pleasure to him to see the marked change that has taken place in the opinion of the profession at large in reference to this question. Some of the gentlemen who were most vicious in their attacks at that time were among that class of individuals whose ability with the pen exceeds their experience with the knife; so that it has been no small satisfaction to the author to note that many of these very surgeons have, as their acquaintance with the living pathology of appendicitis increased, gradually abandoned their former ground, and have finally acknowledged that an early operation, which they once thought so criminal, is in reality the safest form of treatment.

The present edition has been revised with the utmost care, and has been considerably enlarged. In reviewing the literature while preparing the present edition the author has been impressed with the remarkable preponderance of valuable contributions in the English language. It is true that in the last few years some notable work has been done in Germany, particularly along the lines of investigation of the toxins produced and absorbed, and in the endeavours made to obtain immunity; but the path-

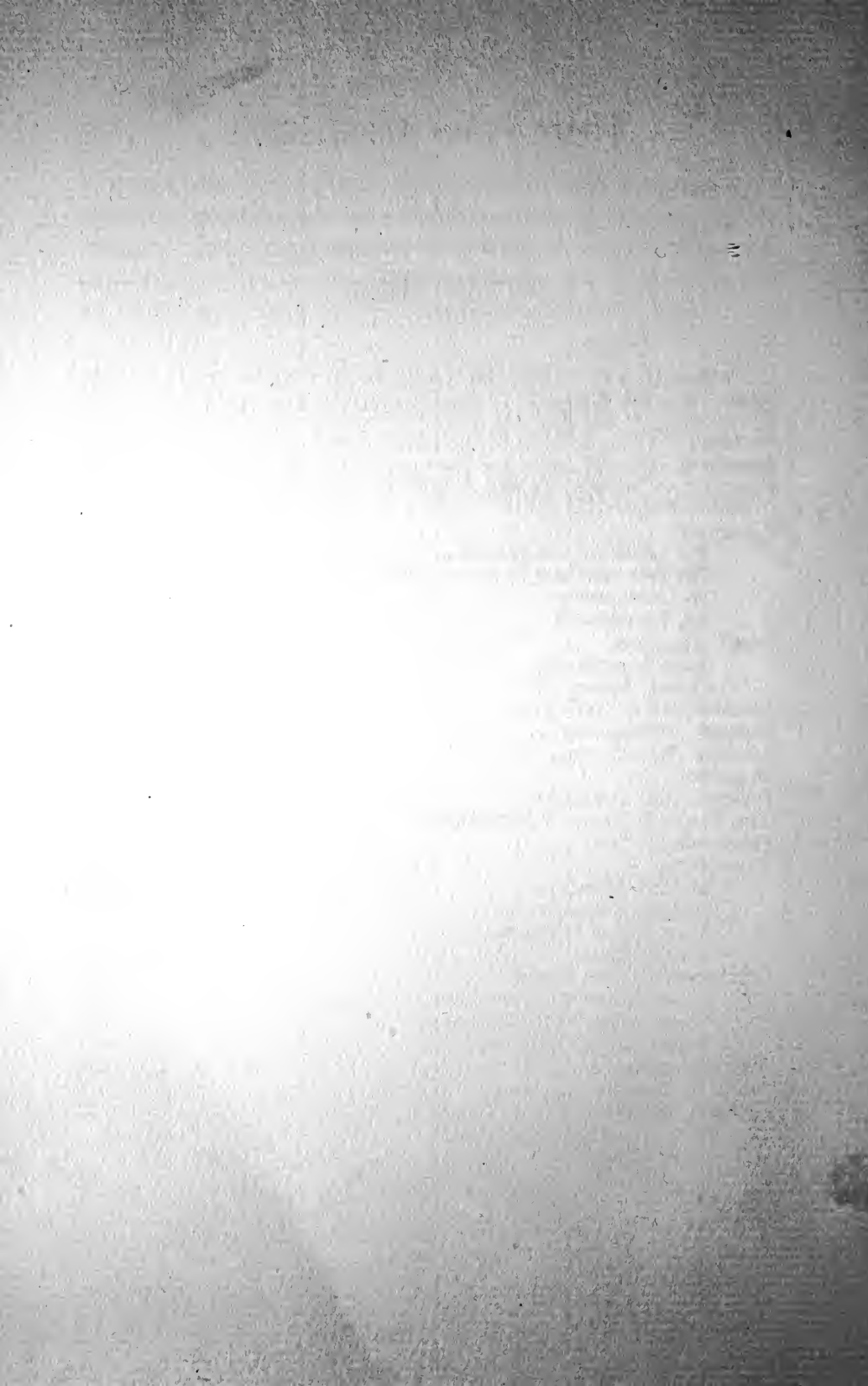
ology, certain refinements in diagnosis, and especially surgical technique have been perfected by American and English surgeons. Several new chapters have been added, namely those on "The Function of the Cæcum and Appendix," "Appendicitis in Children," "Chronic Appendicitis," and "Typhoid Appendicitis," as well as that on "The Blood-count in Appendicitis," which last has been contributed by Dr. George P. Müller. The chapter on "The History of Appendicitis" has been rewritten by Dr. Astley P. C. Ashhurst, and that dealing with the subject of "Treatment" has also been entirely rewritten; the chapter on "Pathology," written for the second edition of this work by Dr. A. O. J. Kelly, has received thorough revision at his hands; and all other portions of the book, especially the sections on "Anatomy" and on the "Complications and Sequels" have been considerably enlarged. Although these changes have materially increased the size of the volume, it is hoped that they will meet with the approval of the profession, since they render the book as nearly complete as it is possible to render a treatise on any subject of such perennial activity and interest as Appendicitis. The opinions expressed are, as in former editions, largely based upon the author's personal experience, which now embraces several thousands of cases; but he has endeavoured to neglect in no particular the excellent work which has already been done, and which is still being done, by many other surgeons both at home and abroad. It has been deemed inadvisable to encumber the text with bibliographical references, but a list of the authors consulted is placed at the end of the work.

Certain radical changes will be observed in the treatment recommended. These changes, particularly the teaching in regard to the use of saline cathartics, and in reference to abdominal section and its technique in the presence of general peritonitis, are such as have seemed wise to the author to make, as a result of his increased experience as clinician and operating surgeon, and he makes no apology for following the dictates of that hardest of task-mistresses.

There have been added forty-two new plates, while several of those appearing in earlier editions have been entirely re-drawn. A number of those illustrating the surgical anatomy of the appendix are new, as are also the several series of plates illustrating the various operative procedures. These have been drawn by Mr. C. F. Bauer.

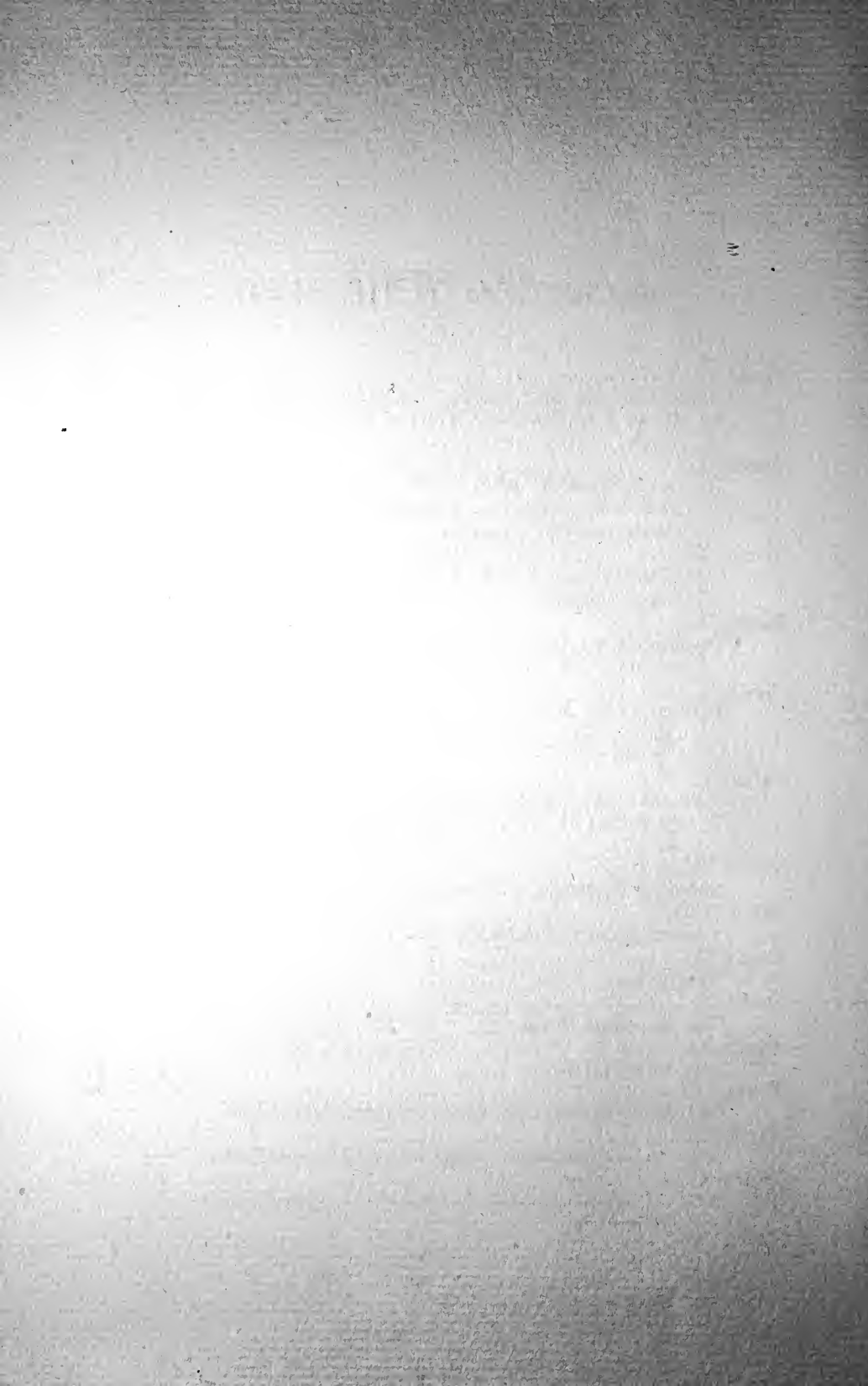
The author owes especial thanks to his friends, Dr. George P. Müller and Dr. Astley P. C. Ashhurst for much valuable work done on this edition. Owing to the many demands upon the author's time if it had not been for the services of these gentlemen it is questionable if this edition would not have been long delayed.

1634 WALNUT STREET,
March, 1905.



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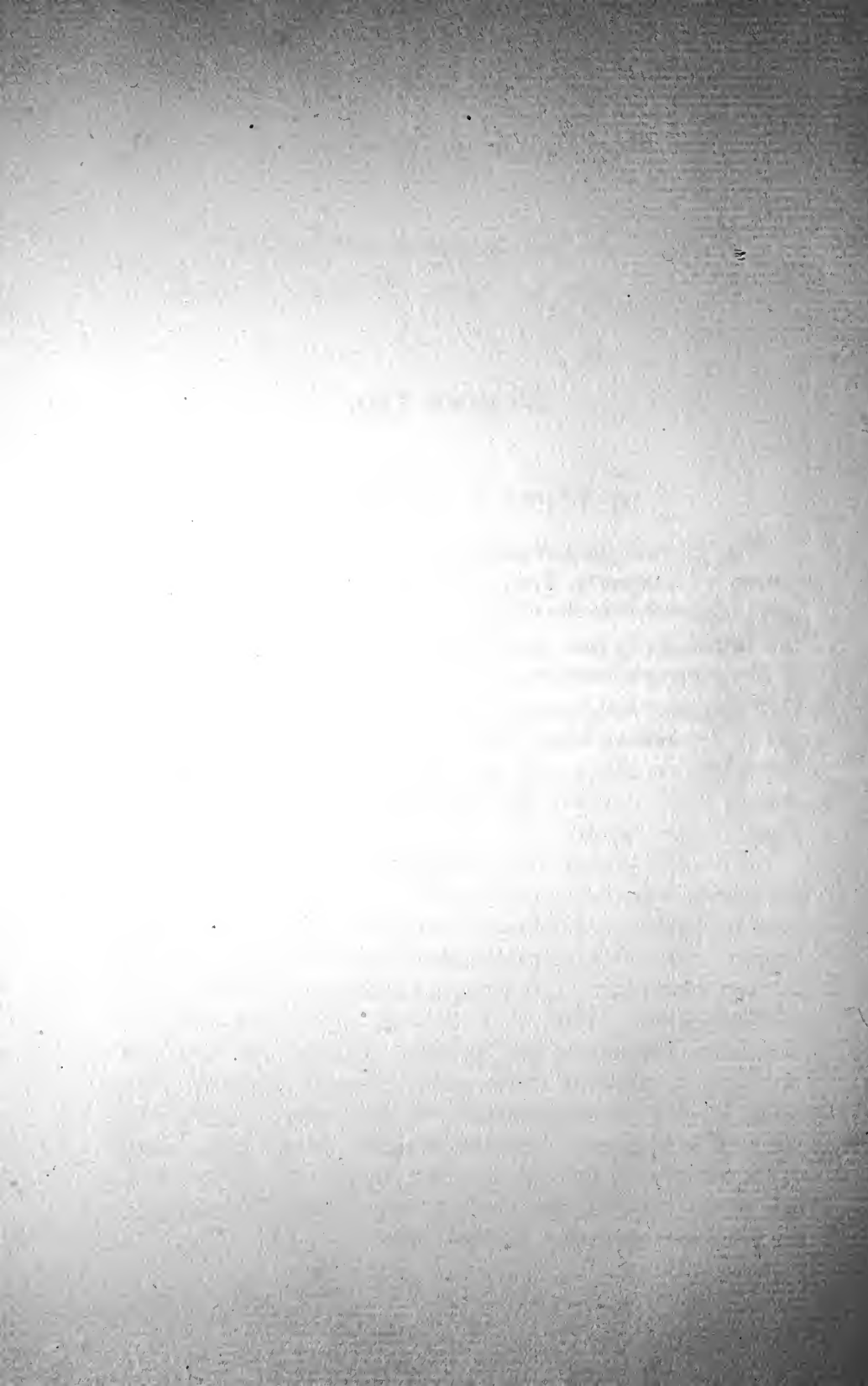
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APPENDICITIS.

HISTORY OF APPENDICITIS.

The gradual developement of any department of science is always an interesting study; and this is true to an unusual degree of the search for the real cause of various pathological phenomena which have been recognized from the time of the Father of Medicine as occurring in the right iliac fossa. So many times does it appear that acute observers stumbled on the very threshold of the discovery that the original lesion in these conditions was in the vermiform appendix, that it seems scarcely credible that for less than twenty years have we had any adequate knowledge of appendicitis.

As in other regions of the body, so in the neighbourhood of the cæcum, a thorough appreciation of the anatomy of the parts concerned must have been first acquired before students of the subject were prepared to elucidate the pathological conditions at times found there. As Galen says, in the quaint phraseology of Peter Lowe, "Hard is it to cure any disease except we first know the nature and situation of that part whereupon we work, as also the cause of the disease; otherwise neither salve is able to prognosticate of the event, nor cure the same." So it appears expedient to review the rise of knowledge of the anatomy of the appendix first, then to discuss the clinical side of the question, and finally to trace briefly the progress of the treatment employed in these cases.

Appendicitis.

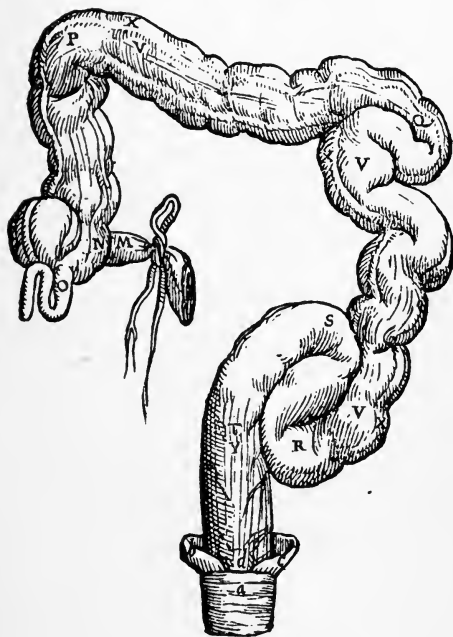
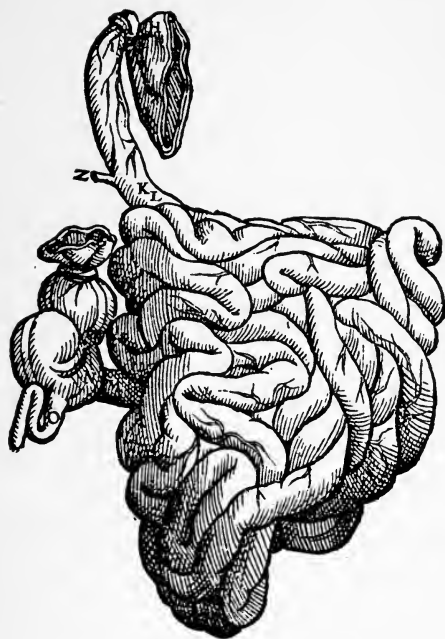
PLATE I.

ANDRÆE VESALII

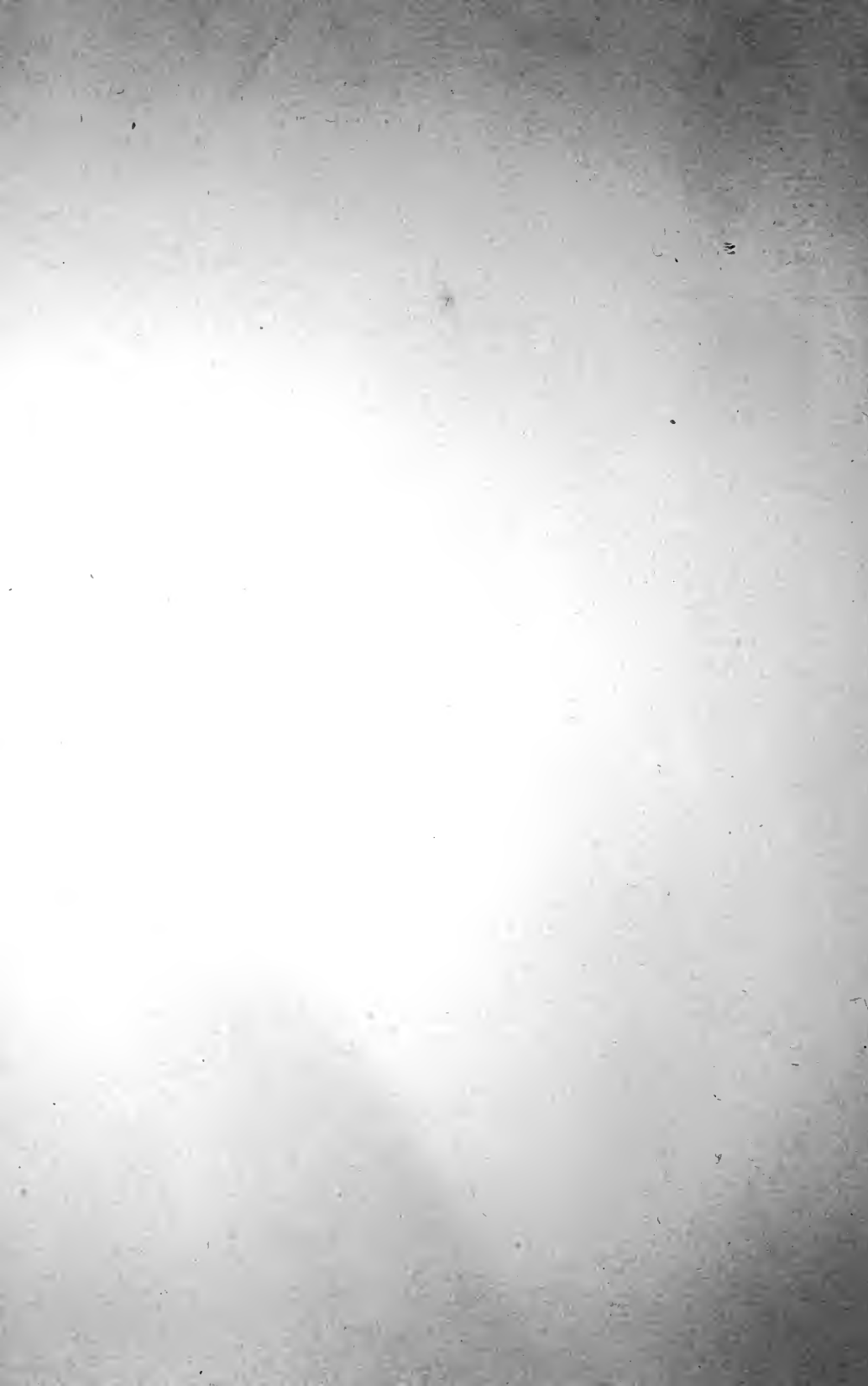
Bruxellensis, Scholæ
 medicorum Patavinæ professoris, de
 Humani corporis fabrica
 Libri septem.

Basileæ, officina
 Joannis Oporini,
 Anno salutis reparatæ MDXLIII.
 Mense Junio.

- H, Ventriculi portio, quæ inferius ventriculi constituit orificium, seu intestinorum principium quod hic chordula ligatum fiximus.
- I, K Pars intestinorum ab I ad K protenda, vulgato nomine nunc duodenum intestinum, nunc intestinum duodenum digitorum longitudine, mihi vocatur.
- L, Jejuni intestini initium, graciliumque intestinorum sedes, ubi primum in anfractus convolvi atque antrorsum assurgere incipiunt.
- M, Ilei intestini terminus, et gracilium intestinorum finis. Verum quam sede jejuni intestini terminus, aut ilei intestini principium sit pomendum, augurari nequeo, quum toto ductu qui ab L in septima figura in eadem et octava ad M usque pertinet, nullibi discrimen commonstret, quo jejuni ab ileo liceret interstinguere.
- N, Extuberans crassorum intestinorum initium.
- O, Hoc intestinum mihi cæcum nuncupatur, non admodum contententi an quis eo nomine aliam crassorum intestinorum partem donari velit: modo is non adeo nominum sit studiosus, ut illorum occasione ea intestinorum fabrica negligat, quæ in partium aliarum constructione sedulo inquirimus.
- N, P, Q, R, S, T, Colum intestinum his characteribus insignitur, verum singuli privatim aliquid notant. N enim ad P usque coli intestini ductum notat, a dextri renis sede ad jecoris usque cavum pertinentem. A P vero ad Q coli ductus notatur, secundum ventriculi fundum a jecoris cavo ad lienis usque regionem protensus. A Q autem ad R ductus coli insinuat, a lienis regione ad pubis os, secundum sinistrum ile procedens. Cæterum ab R ad S coli indicatur ascensus anfractusque quem sursi ad umbilici usque regionem molitur. At S ad T usque progressum notat, ducti nunc ascensus ad recti intestini initium.
- V, V, Depressa coli intestini sedes.
- X, X, Coli intestini utrinque extuberantes semiglobuli, quos cellulas vulgus vocat.
- Y, Recti intestini initium. Quicquid vero sub Y consistit, rectum est intestinum.
- Z, Portio meatus bilem in intestina proferentis.
- a, Musculus recti intestini finem orbiculatim amplectus, fæciumque excretioni præfectus.
- b, c, Duo musculi rectum intestinum virorum peni et mulierum uteri cervici interventu musculosæ substantiæ connascitur.



From the "Anatomy" of Andreas Vesalius, published in 1543. . The 7th and 8th figures from the 5th book.



ANATOMICAL DATA.

It has always been a mooted question whether the ancients—Hippocrates, Celsus, Aretæus, Galen, and others—ever dissected the human body. Vesalius, writing in 1543, implies that Galen did not describe an appendix to the caput coli because he dissected only monkeys, which have no appendix; and as Galen, who of all the ancient writers gave by far the most complete anatomical descriptions, thus ignored so important an organ, it is readily understood that those who immediately followed him, and even the medical writers of the middle ages, made no mention at all of the appendix.

Not until 1522 A.D. is any reference to this structure to be found. In that year Berengarius Carpus, Professor of Surgery at Pavia and Bologna, published a work on anatomy in which he speaks of there being found at the end of the cæcum a certain "additamentum," "empty within, and in breadth less than the smallest finger of the hand, and of a length of three inches or thereabouts." As Berengarius is believed to have been the first modern who practised dissection it is probable that this observation was original with him. Vesalius, writing twenty-one years later, proposes that this "appendix" should properly be called the cæcum, inasmuch as that part generally termed cæcum is not a cæcum, or blind sac, having in reality three openings, one each into the ileum, the colon and the appendix. He gives several illustrations of the abdominal viscera, showing the appendix curled upon itself, both in the body, and also removed with the whole bulk of the intestines. Two years afterward, in 1545, Stephanus published at Paris his work on the dissection of the human body. He makes no mention at all of the appendix in his text, saying plainly that the cæcum is so called because it has no outlet at its lower extremity; however, he publishes a very curious plate, showing the appendix dangling from a very capacious cæcum. He adds the infor-

PLATE II.

DE DISSECTIONE PARTIUM CORPORIS humani libri tres, a Carolo Stephano,
doctore Medico, editi. Una cum figuris et incisionum declarationibus,
a Stephano Riverio Chirurgo compositis.

Parisiis
Apud Simonem Colinæum.

1545.



From Charles Estienne's work on the "Dissection of the Human Body," published in 1545. This illustration is from page 172.

mation, quoted nearly word for word from Galen, that in some birds the cæcum is double, "for stronger action."

Ambroise Paré wrote in 1582 that "This intestine (cæcum) has a long and narrow apophysis, which some have thought, evidently erroneously, slips down into the scrotum for it is prevented by its close adherence to the peritoneum." He adds that the majority of anatomists of his time understood by the term cæcum this apophysis which he had just described.

Fallopian wrote in his "Anatomy" which was first published in 1561, as follows: "After the small intestines follow the large, the beginning of which is the cæcum, which in man is so small that it resembles a worm rather than an intestine. For it appears that the extremity of the colon ends off in this; and that transversely from where the cæcum arises the ileum is continued, so that the colon appears to divide into two branches, the shorter being the cæcum, the longer the ileum. The cæcum is so called because it has only one opening. In some animals, especially hogs, monkeys, dogs, and oxen, it is very large, and seems to serve the purpose of delaying the fæces for some time, lest they should too soon escape from the body through the large bowels, which is not so apt to occur in man on account of his erect posture." Fallopian appears to have been the first writer to compare the appendix to a worm. References to its vermiform appearance are frequent after his time. Thus Bauhin published in 1597 an explanation of the ileo-cæcal valve, in which he speaks of the "appendix lumbricum" in a manner which shows it to have been already well recognized in 1579. He also proposed the ingenious theory that the appendix served during intra-uterine life as a receptacle for the fæces; from which it seems not improbable that he confounded it with the diverticulum described nearly two hundred years later by Meckel, whose name it bears. In his anatomical atlas, Bauhin gives illustrations calling the caput coli the "cæcum of Galen,"

and the appendix vermiformis the "cæcum intestinum posteriorum." Laurentius also, in 1600 described the appendix as a twisted worm—"appendiculam contorti lumbrici specie."

Vidus Vidius enters into more detail. He describes two coats to the intestines, and says that to these is added a third tunic, from the peritoneum, which not only adds firmness, but binds all the intestines to the back and vertebral column. Joined to the cæcum he describes an appendix, "not unlike a worm coiled in a circle." He reproduces the illustrations of Vesalius. Tulpius in 1641 gives an illustration showing the vermiform appendix, and follows the teaching of Vesalius in calling it the "cæcum," while he terms the caput coli the "colon."

Fabricius ab Aquapendente likewise describes the human cæcum as very small, as if it were an appendix, oblong and very narrow, rivaling a worm in appearance; at autopsy, he adds, he had at times found a worm in it. This appendix, which he calls cæcum, he says is bound by folds of membrane to the sides of the ilium (*sic*), and its chief function (*loc. cit.*, f. 147) he thinks to be to hold the caput coli in place, as a ligament. He discusses in some detail the cæcum of animals, of birds and of fishes, and recognizes from comparative anatomy that man's appendix takes the place of the lower end of the cæcum, which in man is not nearly so capacious as in the lower animals that have no appendix.

Morgagni, in his "Adversaria Anatomia," first published in 1706, devotes considerable space to an account of the vermiform appendix. He says that hitherto it had been considered to exercise one of two functions, either to receive something from, or to give something to, the intestinal tract. The former function Morgagni believed to be impossible because of the size of the appendix and the condition of its lumen and its orifice. As an instance in support of his views, he quotes the observation of Zambeccarius, who, although he cut off a portion of the appendix of a puppy-dog, ligating it, yet after three months found the base of the appendix clearly open, and yet no fæcal matter had fallen from it into

the abdominal cavity. Morgagni asserts that the appendix does not hang down from the cæcum, but, as it were, empties itself down into the cæcum. Of ten cadavers which he examined in only two did the appendix open into the middle of the base of the cæcum; in the eight others the orifice was to the left, between the base of the cæcum and the ileo-cæcal valve. In two other cases he observed that the appendix even pointed perpendicularly upward, one being without any curvature closely applied to the cæcum. He gives good illustrations of the cæcum and appendix.

Verheyen gives "appendix vermiformis" as a marginal heading in his work on anatomy published in 1710. He says there is much dispute as to the application of the word cæcum, whether it should be used with reference to the caput coli, as was done by the ancients, or to the appendix, as we have seen was first done in 1543 by Vesalius. Verheyen sides with the ancient authors, in favour of calling the caput coli the cæcum.

Santorini in 1724 writes of having seen the appendix lying directly upwards between the psoas muscle and the hollow of the liver. At autopsies he had also observed fæcal concretions and worms in the appendix, and had in one instance found the appendix absent. He notes the presence of a meso-appendix, and thought the chief function of the appendix was to serve as a nest for round worms, where they might be cherished, and be prevented from escaping into the general intestinal tract.

Lieberkühn's essay, which appeared in 1739, is looked upon as a classic in this department of literature. He remarks that he could readily understand from its construction that some have asserted, while others have denied, that fæcal matter, when the appendix is wounded, escapes into the abdomen. Referring to the experience of Zambeccari, as reported by Morgagni, he says, "This I have also observed myself, but of several dogs not even one lived till the next day after the operation."

Vosse in 1749 appears to have been the first to recognize the part played by the various pockets of the peritoneum around the

cæcum in concealing the appendix from view. He says that sometimes the appendix hides beneath the cæcum, and hence is not found. He also observed some cases in which the cæcal orifice of the appendix was the narrowest part of its lumen, and in three out of six cadavers he noted that the orifice was occluded by a fold of mucous membrane. Weitbrecht, who died in 1747, also says he observed a valve at the cæcal orifice of the appendix. Haller in 1778 states that in the fœtus the appendix is relatively larger than in the adult—often half the size of the ileum.

Sabatier in 1781 called attention to the large number of mucous glands in the appendix, but added nothing new to the knowledge of its anatomy.

Since the close of the eighteenth century the gross anatomy of the appendix has been fairly well known: its three coats; its mucous glands, and their abundant secretion; the meso-appendix, and the folds produced by the peritoneum in this region—these were discussed in more or less detail by all anatomical writers during the early part of the century just closed. In the succeeding decades, among an innumerable number of articles on this phase of the subject, a few stand out as of pre-eminent importance. Gerlach in 1847 called renewed attention to the fold of mucous membrane which may act as a valve in occluding the orifice of the appendix, and which has since gone by his name; and in 1859 he still further discussed the anatomy of this organ.

Treitz in 1857 described the peri-cæcal fossæ, but no adequate account of these folds of peritoneum appeared until 1891, when Lockwood and Rolleston published their elaborate studies, while Clado, in the next year, in an exhaustive article, aroused interest in a fold of peritoneum running from the ovary to the meso-appendix, and since known under his name, as Clado's ligament.

The minute anatomy of the appendix has not received atten-

tion until comparatively recent years, some of the best studies being those of Lockwood.

CLINICAL DATA.

“Suppuration upon a protracted pain of the parts about the bowels is bad.” This aphorism of Hippocrates forms practically the first recorded observation of a disease known for centuries subsequently under the rather vague name of the iliac or the colic passion. Its cause was not understood, but it was explained, in a manner more or less satisfactory to themselves, by the various authors of classic times. Another aphorism of Hippocrates records the fact that from the rupture of an internal abscess prostration of strength, vomiting, and *deliquium animi* result. That some of these cases seen by the Father of Medicine were instances of appendicular abscess is scarcely for a moment to be doubted. That many of them were other affections seems even more certain.

Celsus, who lived in the latter part of the first century B.C., and in the early part of the first century of our era, distinguishes between the colic passion, situated in the large intestines (and therefore, according to him, below the umbilicus), and the iliac passion, an affection afflicting the small bowel exclusively, and therefore having its seat entirely above the navel. These two terms, iliac and colic passion, are used by medical writers until well toward the end of the eighteenth century, without there being made any very great distinction between the two, either as regards causation, symptoms or treatment; and what at one period were considered rather indicative of the colic passion were symptoms at another time attributed to the other. Celsus made the clinical observation that the colic passion was more often on the right of the abdomen, near the cæcum, than on the left; and he also noted that it was very apt to recur. Aretæus, who is believed to have lived about one hundred years later, considered death

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from the pain alone, in cases of the iliac passion, quite possible, even before local lesions had formed; while, he added, some survive the pain only to die of suppuration or gangrene of the bowels.

Galen, writing in the close of the second century A.D., says the iliac passion is an inflammation of the intestines, so that neither flatus nor fæcal matters can pass through; "violent gripes follow, and intolerable pains." Oribasius, a medical writer of the fourth century, although his complete works were not published until 1858, asserts that ileus is due only to inflammations, and that the lumen of the bowels may or may not be obstructed, according to the seat of the lesion and its severity. If the inflammation arises high in the intestinal tract, obstruction is not complete, but if the large bowel is affected the obstruction is complete. He recognizes the formation of peritoneal abscesses, but adds nothing new.

None of these writers paid much attention to differential diagnosis, although they recognized that symptoms such as these might be caused by volvulus, intussusception, strangulated hernia, and other pathological conditions.

The Arabian school of medicine, which forms the bridge between the classic and the mediæval, is fairly represented by Avicenna, who flourished in the eleventh century. He makes the usual distinction between the colic and iliac passions, but contents himself with saying that the causes of both are the same, although the symptoms of the iliac are more severe, and require more strenuous treatment. He considers it a good sign if the pain shifts, a bad sign if it remains in one place, or if an abscess forms. The occurrence of this last complication may be suspected if the pain, having become fixed in one place, becomes of a throbbing character, with a feeling of weight, pulsation, and inflammation, with acute fever, redness and swelling.

Among the earliest of the mediæval writers is Arnaldus Villanovanus, who flourished about 1300 A.D. He adds to the stereo-

typed description of this disease the opinion that one form of passion may turn into the other, or that both may exist at once. If the disease persists and becomes severe abscesses may form.

Fernelius recorded in 1567 a case of ileus, or iliac passion, from obstructed and narrowed "cæcum," in a girl nine years of age. This child had been suffering from a diarrhœa, and her grandmother, taking counsel "with other old women," decided to give her a quince, this fruit being known from the time of Dioscorides for its extreme astringency in the green state. As a consequence of this dose the diarrhœa was not only checked, but no passage from the bowels occurred at all that day and the following night: the most excruciating and agonizing pains arose in the abdomen, which swelled up in a marvellous manner. A physician being now called in, and suspecting what the trouble was, endeavoured, but in vain, to alleviate the child's sufferings, first by mild, and then by more active enemata, and by soothing abdominal applications. Finally the vomiting became stercoraceous in character, there were frequent periods of *deliquium animi*, and within two days a pitiable death ended the child's pain. At the autopsy the "cæcum" was found to have the interior of its "duct" narrowed and constricted by the remains of the quince, with the result that the "corrupt matter," being prohibited from its normal outlet ("meatus"), had made an unaccustomed way for itself, by perforating the intestine above the obstruction, and thus had filled the whole abdominal cavity. It is an interesting question whether Fernelius understood by the term "cæcum" the vermiform appendix, as did his contemporaries Vesalius and Fallopius, and as did even some fifty years later Tulpius. It is to be recollected that Paré said that most of the anatomists of his time understood the word cæcum as referring to the vermiform appendix. That this was the case with Fernelius seems probable when we consider the application of the words "duct" and "meatus," which do not seem particularly appropriate to

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the caput coli. Moreover, the scholia, by Simon Paulus, which follow this case where it is quoted in the "Sepulchretum" of Bonetus, are largely concerned with the function of the "cæcum intestinum," which is referred to as "that apophysis," a little appendix ("appendicula"); sewed on to the junction of the small and large intestine, and is further described as having been taken from the bodies of still living dogs by the writer's son, John Henry Paul, who found that this "appendicula" was generally filled with fæcal matter, and often had in its lumen "little drops of its own kind of excrement, as yet unnamed by anatomists."

Reading then "appendix vermiformis" for "cæcum" in the above reported case, we evidently have an instance of appendicitis, which is the earliest thus far known. But even if we consider it as a case of appendicitis, it is evident from subsequent writers that the vermiform appendix was not for a long time afterwards recognized as a cause of disease. Yet the works of Erastus, who published his commentary on Paracelsus in 1572, show a distinct advance in differential diagnosis. Paracelsus had taught that all colic pains came from flatus, whereas Erastus himself says very distinctly that some of these cases are due to inflammations, and that the variety so arising is more difficult to cure as well as of less frequent occurrence. The colic pains arising from inflammation become fixed to one place, and by this fact, together with the presence of bilious vomiting, thirst, fever and wakefulness, the more serious disease may be distinguished from that due only to wind.

In 1612 Peter Lowe treats briefly of the iliac passion, and gives the interesting information, on the authority of Lonicerius, that "Hippocrates did die of this disease." Lowe does not even mention the appendix in this connection. Fabricius ab Aquapendente (1634) describes both the colic and the iliac passion, the causes and signs of both being the same in kind, but those of the iliac much worse in degree. His account is in every way

inferior to that of his contemporary Fabricius Hildanus, who often made autopsies in those who had died of the iliac passion, and always found lesions around the ileo-cæcal region. He thought, however, that the affection originated as an inflammation of the ileo-cæcal valve, which thus caused intestinal obstruction by swelling and occluding the lumen of the bowels. Most of these cadavers, he ingenuously adds, smelt so horribly that he was not very minute in his examination.

Saracenus in 1642, in a letter to a medical friend, gives the details of a case occurring in a woman of fifty years, which he thought sufficiently curious to be thus recorded. There arose in her right groin a swelling, which at length suppurated, and finally pointed and broke externally, discharging for a long time pus of a filthy odour. As gangrene of the parts seemed imminent, the physician in charge of the case applied an escharotic ointment. Soon after this the sinus began to discharge half-digested food and fæcal matters from day to day; so that it was easy to recognize in the discharge whatever the patient had eaten shortly before, especially such matters as dried plums. After awhile six lumbricoid worms were discharged. From all these symptoms Saracenus concluded that a lesion of the large intestines was indisputable. It was not until she had reached this stage of the disease that Saracenus saw her himself, but with his own eyes he beheld eight worms discharged from the fæcal fistula at various times. By degrees the ulcer contracted, the fæcal discharge became less, and the patient returned to good health, although Saracenus expresses the anticipation that a return of her trouble is to be apprehended. He tells his friend that he will advise him of the further progress of the case; also that he is under the impression that he has seen a similar case described somewhere, but cannot recall the author's name. Unfortunately Roussel, who first published this letter, fails to inform us where he discovered the original epistle of Saracenus, nor does he say whether

Saracenus fulfilled his promise of recording the patient's subsequent history. However this may be, there can be little doubt in any one's mind that this is the earliest known example of recovery from a peri-appendiceal abscess.

Helmont says (1664) that all abdominal pains are from flatus, and that all obstructions may be removed by swallowing lead bullets. He does not mention the appendix, nor does he speak of inflammation as a cause of the iliac passion. Two years later, in 1666, Sydenham made the important clinical observation that in the commencement of this disease the pain is less fixed than it becomes later, when it is wont to settle to one spot, and remain there. It is true that Avicenna recognized the fact that the pain at times—when an abscess forms—becomes fixed to one spot; but it seems that Sydenham was the first to lay stress on this localization of the symptoms as one of the most valuable diagnostic points; in fact, he seems to have had an inkling that these symptoms arose from a disease that was distinct in its causation from volvulus, strangulated hernia, intussusception, and all other intra-abdominal affections. Erastus, to be sure, nearly a hundred years before Sydenham, had noted that the pain became fixed in all inflammatory diseases of the abdomen, but he does not appear to have been aware, as Sydenham apparently was, that there was one disease especially characterized first by diffuse abdominal pain, and then by pain settling to the part of the abdomen affected, which disease was later proved to be appendicitis. As causes of this disease, Sydenham gives improper indulgence in the fruits of the season, or in any indigestible food. He remarks that the disease is prone to return after recovery.

In 1682 Thomas Willis wrote, "Inflammation or sphacelus about the beginning of the colon, which I have often noted, arises from vain efforts to expel fæcal matters, which becoming stagnated against the ileum, produce the iliac passion." Baglivus (1696) adds his testimony to the usual symptoms of this

malady, by stating that when a colic pain becomes fixed, and a fever supervenes, it is accustomed to terminate in abscess; not so if the pain shifts from place to place.

Boerhave, who first published his "Aphorisms" in 1709, graphically describes the course of events in this disease somewhat as follows: Inflammation of the bowels produces an obstruction, which causes an ardent fixed pain; vomiting ensues, and an iliac passion is formed, whence an abscess or gangrene may arise; then follows "a most sharp fever, and extreme weakness, from the violent pains, which next close by a speedy death." He adds a caution to the attending physician which is not without its value at the present day: "As long as this malady continues in its inflammatory stage, it often imposes upon those who are incautious under the name of a colicky pain, by whom it is, with the most dangerous events, ascribed to cold, to wind, or to flatulencies, and accordingly ill-treated by carminative and hot medicines, with the most fatal consequences." If he be not cured, either an abscess will form, and rupture into the bowels, with recovery, or into the abdominal cavity, with death; or else gangrene will occur, and a quiet death speedily ensue.

Santorini in 1724 writes of having observed fæcal concretions as well as worms in the appendix at autopsies.

Ruyschius, his contemporary, strives to differentiate the various causes of the iliac passion, but does not mention the appendix.

In 1735 Amyand operated on an inguinal hernia in which he found the perforated vermiform process. This case will be more fully discussed under the head of Treatment.

Crellius in 1752 published notes of an autopsy, in which he describes a peculiar vermiform appendix which he found in a woman. This appendix was not only larger and more capacious than is usual in adults, but was filled with a compact substance. On opening the caput coli he found the cæcal orifice of the appendix unusually large, admitting with

ease the tip of the little finger, and its lumen filled with fæcal matter in the form of little globules. This phenomenon he thought supported the theory of those who maintain that the function of the appendix was to serve during intra-uterine life as a receptacle for the fæces, inasmuch as in the present case he found on further search that the descending colon was constricted to the size of the small bowel, while the ascending and transverse portions of the colon were remarkably dilated.

Heister in 1753 published the details of a case in which he had made an autopsy as early as 1711. In the abdomen of a malfactor he found the vermiform process gangrenous and lying in a small collection of pus, among adhesions. This proves, says Heister, that this part can be the seat of inflammation and abscess as well as other parts; a fact which he thinks had not been sufficiently noted before. And if we reject the somewhat doubtful case of Fernelius, cited above, this case of Heister's is undoubtedly the first instance known in which the lesions are positively stated to be in the appendix. For the case recorded by Saracenus is merely one of fæcal fistula following suppuration in the right iliac region, the patient not coming to autopsy, so far as we know, and the appendix not being mentioned in any way.

In 1755 Wedels records a recurrent attack of iliac passion which had been observed in 1670. The patient experienced sudden, causeless pain in the right iliac region, similar in character to that occurring one year before; there was fever and vomiting, with local tenderness, and a mass was palpable. The affection was rebellious to clysters, but the patient recovered on the third day, after a dose of opium. In the same year Garman's saw a woman who had an abscess over the region of the cæcum which was opened by poultices, and discharged many round worms. This patient also recovered.

In 1759, four years after the publication of these cases, Mes-tivier reported a fatal case of abscess on the right side of the

umbilicus, found at the postmortem examination to be due to the perforation of the appendix by a pin.

In 1766 de Lamotte found, at an autopsy on a man who died after acute abdominal pains, intestinal obstruction and peritonitis, that the appendix was much enlarged, and contained a large concretion the size of an orange, but resembling a potato in appearance, though more spherical. This concretion weighed four ounces. Although there was no perforation he recognized the appendix as the cause of the disease.

In 1768 Herlin discussed the function of the appendix, stating that in 1734 M. Delatoison made an autopsy on a man-servant who had died of the iliac passion, and who had been made to swallow three large balls (in hope of overcoming the obstruction). These were found in the appendix, which was dilated by fæcal matters nearly to the size of the rest of the gut.

In 1778 Haller wrote that he had twice seen the lumen of the appendix obliterated; and that, wonderful as it may seem, it had been possible to remove the appendix without harm not alone from hens, but even from man and dogs. "*Mirum videri possit, potuisse non gallinis solis, sed homini (hernioso Zambeccari apud Fantonum) sed canibus ipsis, absque noxa absecari.*" The reference to the ruptured patient of Zambeccarius, as quoted by Fantonus, it has been impossible to find.

In 1794 Baillie in describing the pathological anatomy of the vermiform process says that he had seen it varying from as long as five inches to scarcely a half inch long; that he had noted its presence in a congenital hernia, lying close to the testicle; had seen its canal obliterated; and had found both worms and earthy concretions in it.

In 1808 Jadelot observed the case of a boy, which clinically showed only fever of an adynamic type. At the autopsy lumbricoid worms were found in the ileum, cæcum, and appendix.

In 1812 Parkinson saw a young man who was ill for two days

with abdominal symptoms. At the autopsy he found the distal one inch only of the appendix swollen and inflamed, and perforated. Nearer the base of the organ was a fæcal concretion impacted in the lumen. The cæcum and other viscera were normal except for the peritonitis. Copeland was more fortunate in a case which he observed the same year: a fæcal abscess developing in the right groin, was opened by poultices; some weeks later an oval calculus, a half inch long, was removed from the sinus with forceps. The fæcal discharge lessened, and complete cure resulted.

In 1813 Wegeler recorded the case of a youth of eighteen, who, after a fit of anger, drank a quantity of ice-water. Soon he experienced excruciating abdominal pains in the right iliac region, well localized. Persistent bilious vomiting developed, which after twelve hours became stercoraceous. Wegeler diagnosed "that well known obscure form of enteritis, later turning into ileus, as an effect, not a cause." At autopsy the cæcum was found destroyed by gangrene, which evidently had arisen from the base of the appendix. This process itself, of an even more intensely red color, was larger than usual, and its mesentery injected. It contained many calculi. Wegeler is very far, he says, from thinking these calculi were the origin of the disease; but he could very readily be led to believe that an inflammation arising elsewhere would rather attack a part so affected than some other region, and thus the severity of the disease be markedly increased.

In 1815 is found what is apparently the first American case to have been reported. Prescott narrates that his patient had had pain in the right iliac region for about one year, when he was suddenly attacked with a very severe pain in this region, and died on the fifth day, after symptoms of general peritonitis had developed. The autopsy showed the cæcum with the neighbouring parts of the colon and ileum sphacelated, and the cæcal orifice of the appendicula vermiformis obstructed

by a cocoa or chocolate nut, which was recognized as the cause of the disease. Prescott says that he is not familiar with any similar case, but suggests foreign bodies in the appendix as a cause for many symptoms arising in the right iliac region.

In 1824 Louyer-Willermay records two fatal cases of peritonitis due directly to perforation of the appendix; and Blackadder a case in which death occurred about three hours after the onset of acute abdominal symptoms, with a semi-comatose condition of the patient. The autopsy in Blackadder's case disclosed as the only abdominal lesion the vermiform appendix immensely distended by a huge lumbricoid worm, but with no perforation. The heart was the seat of long standing disease. Blackadder says he had also observed fæcal concretions in the appendix, and calls attention to this fact in connection with the operation recently proposed by Monro for the purpose of removing such concretions from the cæcum by the extra-peritoneal route. No one, however, appears to have followed this suggestion until 1883, when Symonds, at the instance of Mahomed, successfully extracted a calculus from the appendix, in the manner described by Blackadder.

In 1827 Husson and Dance at the suggestion of Dupuytren, who later published his own views, discussed diseases of the cæcum at considerable length. They held that as a rule the retro-peritoneal cellular tissue was first involved in these cases, but that in rare instances the peritoneum itself was first inflamed, the disease attacking the cellular tissue only at a later date. If the abscess formed were intra-peritoneal, and this they thought was always the case unless the cellular tissue were first attacked, then its rupture into the bowels was very rare, these cases usually terminating by general peritonitis and death. Some cases they had observed as long as nine and even sixteen years ago, the patients having recovered after rupture of the abscess into the bowels, and having had no return of symptoms since.

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Mélier in this year made a further advance in describing diseases of the appendix with considerable accuracy, believing them to be entirely distinct from cæcal trouble. He even went so far as to say: "If it were possible to establish with certainty the diagnosis of this affection, we could see the possibility of curing the patient by operation. We will, perhaps, some day arrive at this result." This brilliant article of Mélier's appears to have fallen upon barren ground. Most of his contemporaries do not even mention it. Yet it is by all means the most important contribution to the literature of appendicitis prior to the well-known article by Fitz, in 1886. For lucidity of opinion, and near approach to modern teaching it is probably unexcelled.

In 1827 also Wickham reported a fatal case of perforated appendix in a boy, two calculi being found in the appendix.

In 1828 Menière collected thirteen cases of acute phlegmonous tumors in the right iliac fossa, and reviews three such cases already reported by Husson and Dance. He considered all such cases to be due to retro-cæcal cellulitis. He reports also chronic cases (*loc. cit.*, p. 532), saying that in one case he had observed the appendix acquire a circumference of more than four inches, and make one believe in the existence of cancer of the cæcum. Ponceau, he says, reports three examples of these affections of the right iliac fossa.

It is interesting to note that Jobert, in a work devoted exclusively to the surgical affections of the intestinal canal, published in 1829, does not even mention the appendix in his description of the anatomy of the parts, nor does he refer to any lesions to which it may give rise.

In 1830 Goldbeck, at the suggestion of Puchelt of Heidelberg, chose this disease as the subject of his graduation thesis. Following the recent French writers, he considered two distinct affections, one involving the appendix, and the other, perityphlitis, as quite distinct; he stated that in fatal cases of this

latter affection the appendix had been found intact. Bodey, in his Paris thesis of this same year, notes that he had seen five cases of perforation of the appendix, in all of which general peritonitis was for a time prevented by the formation of adhesions, which finally being broken through, allowed death from fæcal extravasation. He gives the details of two cases.

In 1831 Waldron reported a fatal case of perforated appendix, with a concretion; and Ferrall published a monograph, in which he adheres to the view that in phlegmonous tumors of the right iliac fossa the cæcum is the organ primarily involved, and that the retro-cæcal connective tissue is a more important factor in the subsequent course of the case than is either the appendix or the peritoneum. Tumors in the right iliac fossa he thought might be advantageously classified under three heads: (1) Fæcal impaction, without inflammation. (2) Malignant tumor of the cæcum. (3) True phlegmonous or inflammatory masses, proceeding from irritation of the mucous membrane of the cæcum, or from ulceration and perforation of its wall.

In 1832 Iliff reported three fatal cases as follows: in the first, death occurred from a general purulent peritonitis, caused by a foreign body which had ulcerated, but not perforated the vermiform process; in the second, a bean was found in the appendix at autopsy; while in the third, although the pain during life was chiefly on the left side of the abdomen, yet the post-mortem examination showed a calculus lodged in the appendix.

In 1833 Dupuytren published the views which he had been teaching for some years. He asserts that these abscesses in the right iliac region are developed around the cæcum outside of the peritoneum, but are capable of causing inflammation in this membrane. As the most trustworthy symptoms he recognizes pain, resistance, tension, with a palpable mass developing after a time, and tenderness. He thought that abscesses opening through the abdominal wall were nearly always fatal, because drainage was so difficult. Of sixteen cases of abscess, with

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which he was familiar, only one died. He does not mention the appendix in this article, but in the second edition of his "Leçons Orales," published in 1839, he reports a case of perforation of the appendix already recorded by Menière, in which the cæcum and the surrounding parts had "returned" to their normal state, while the appendix, nearly disorganized, communicated with an abscess cavity between the anterior abdominal wall and the parietal peritoneum. Dupuytren adds that inflammations and diseases of the appendix, of which he had seen a fairly large number, had not fixed the attention of authors, but that Méliér had written an excellent article on this subject. Although Dupuytren reports several similar cases, in none other does he recognize the appendix as the true seat of the disease; and it is probably in large measure due to his teachings that an appreciation of the real state of affairs slumbered, in the minds of a few observers only, for the next fifty years.

In 1834 Boyer noted a death following perforation of the ileo-cæcal valve. Petrequin considers this absurd, and calls it a case of perforated appendix. The original report obscures the true condition by inaccuracy of expression and typographical errors.

In 1834 Copland entered upon a study of the diseases of the cæcum in greater detail, and pointed out that inflammation of the appendix might give rise to very serious affections in the cæcal region. He further mentioned "mortification" of the appendix from the lodgement of a foreign body, and said that this might be followed by fatal peritonitis, but does not consider inflammation of the appendix ever a cause of localized suppuration.

In the year 1835 the most important contribution to the subject was a further article from the pen of Louyer-Willermay, who referred again to his earlier cases (1824), and insisted on the appendix as the cause of the disease. He claimed for himself the priority in noting this fact. Ahrt in the same year reported a

case in Berlin, in which he had opened an abscess over the cæcum, which he thought the cause of the disease. He does not mention the appendix. Pierou also reports cases: the first fatal from perforation of the appendix; and the second in a patient who suffered from symptoms of intestinal obstruction in the right iliac region, ending in recovery, after an abscess had pointed in the right ischiatic region. This latter case he diagnosed as one of appendiceal perforation.

In 1836 von Merling published an extremely important monograph on the pathological anatomy of the vermiform process. He gives a very complete review of the cases of diseased appendices hitherto reported, and discusses their lesions under the following heads: (1) Absence of the appendix. (2) Obliteration of its canal. (3) Length and size. (4) Displacements. (5) Adhesions. (6) Foreign bodies. (7) Inflammation without foreign bodies. (8) Ulcerations. In discussing the influence of foreign bodies he recognizes two classes of cases: first, those in which no symptoms were present during life, the offending substances being found only postmortem; and second, those in which the foreign body evidently caused death by the inflammation which it produced. Under the seventh heading he records two cases now reported for the first time: the first, observed by Tiedemann, consisted in cystic degeneration of the appendix, the cæcal opening having become obliterated; the second, observed by Hoffacker, was in the person of a young student, in whom, after death from abdominal disease, the autopsy showed inflammation starting in the cæcum and colon, and extending to the appendix, which was mostly destroyed. Hoffacker's opinion was, says Merling, that an abscess had first arisen, and had subsequently destroyed the cæcum and appendix. Another case here reported was that of an appendix found at autopsy adherent to the large bowel on the left of the abdomen, a probe passing from the cæcum, through the appendix, into the large intestine. The only instances of ulceration of

the appendix without perforation noticed by Merling are two previously reported, where the affection was recognized as tuberculous.

Another important paper on diseases of the cæcum and vermiform appendix appeared in 1837 in England. This was by Burne, who maintained the still prevailing view that most affections in the right iliac fossa, of which he had seen some twenty examples, were due to primary involvement of the cæcum. He reports eight cases, in only three of which did he think the appendix at fault. The cause, he added, was not idiopathic, in any such cases, but generally due to the lodgement in the cæcum of indigestible food. The most reliable symptoms, he held, were pain and exquisite tenderness. About the fifth or sixth day the "turn" of the case occurred, whereupon either recovery ensued, or an abscess formed. In the appendix cases he calls attention to the importance of the position of the appendix in determining the position of the abscess. Slight ulcerations of the appendix from foreign bodies were often found, he says, and caused no particular inconvenience; but if the foreign body should become impacted, gangrene from pressure, followed by perforation, would ensue. In accord with the views of those days in regard to the pathology of inflammation, he asserts that even with ulceration no inflammation arises until the peritoneum is involved, when an abscess will result from local inflammation, or general peritonitis if the inflammation spreads. Two years later Burne wrote a second paper, in which he maintains that the cæcum is of comparatively little importance in affections of the right iliac region. He thinks that practically all cases of cæcal inflammation recover, and that where perforation takes place in the cæcum it is always to be attributed to the existence of disease previous to the acute attack which appears to be the cause of death. Thus if perforation of the cæcum occurs from within he holds that it is due to tubercular or other ulceration; whereas if it occurs from the outer surface it will be found to be caused by disease of the

adjacent vermiform appendix. He reports several new cases, the most interesting being one of "sero-enteritis arising in the peritoneal tunic of the appendix," in which the lumen of the appendix was pervious, and the mucous membrane not diseased, but the coats were much thickened, and local peritonitis was present, with serous exudation and many adhesions. His conclusions are that of affections in the right iliac fossa those of the cæcum are most frequent and least serious; that perforation of the appendix holds second place; perforation of the cæcum coming third; while very rare indeed is inflammation of the appendix without perforation.

While there was nothing particularly new in these papers of Burne, they mark one more authority ranking himself on the side which was constantly gaining recruits, that which recognized the existence of two distinct diseases in the right iliac region, the more serious of which had the vermiform process as its cause.

In 1837 also, cases of perforated appendix were reported by Von Pommer Esche and by Corbin, the latter's patient being a phthisical man, and the lesion of the appendix probably tuberculous. Both patients died. Petrequin, in this year contributed an article in which he notes the function of the omentum in covering in the appendix and localizing abscesses.

In 1838 Albers noted the possibility of the occurrence of disease in the right iliac fossa as the result of inflammation of the vermiform process, but thought that it more often arose in the cæcum. Under the name of "typhlitis" he described four distinct affections:

1. Stercoral typhlitis—irritation from fæcal matter.
2. Simple typhlitis—catarrhal inflammation from any cause.
3. Perityphlitis—extension of the disease from the mucous lining of the bowel to its serous coat and the surrounding tissues.
4. Chronic typhlitis—in which the course of the disease was slow and prolonged

When pus formed and a perforated appendix was found, he considered that the perforation was due to the previous formation of pus.

In 1838 another tuberculous perforation of the appendix was recorded by Hallowell, producing death in about twelve hours from suppurative peritonitis. Hornung also reported a fatal case of perforated appendix.

Grisolle, in 1839 collected in all seventy-three cases of phlegmon in the right iliac fossa, and recognizes perforation of the cæcum or its appendix as an occasional cause of this affection.

From this date on the reported cases of perforation or other disease of the vermiform process become so numerous, that mere mention of all would be impracticable in a work of this kind; therefore all that will be attempted will be a reference to the more important articles, with passing comment on any advances that appear to have been made in the pathology or diagnosis of such affections.

Rokitansky is remembered for having first called marked attention to catarrhal inflammations of the appendix. In his "Hand-book of Pathological Anatomy," published at Vienna from 1841 to 1846, he describes diseases of the vermiform appendix in the following words: "Catarrhal inflammation of the vermicular process is a disease of common occurrence, and very dangerous on account of its consequences. It much resembles typhlitis stercoralis, and is invariably the result of fæcal matters and foreign bodies, especially small fruit stones, having become lodged and hardened in it. The affection has a torpid character, may exist for a long time as blenorrhœa, and is accompanied by thickening of the coat of the vermicular process. After frequent exacerbations it passes into ulceration, which may, if the foreign body remains loose, attack the entire process, or if the former becomes fixed, affect only the point of attachment, or the end of

the vermicular process. . . . Under favourable circumstances . . . the vermicular process . . . shrivels up and forms a . . . ligamentous appendix. In the opposite case the ulceration . . . brings on perforation. . . . This . . . is not immediately followed by general peritonitis, inasmuch as the previous irritation has induced adhesions. . . . The adhesions gradually give way, and general peritonitis ensues." Rokitsansky had also observed cystic degeneration of the appendix, as well as typhoid and tuberculous ulcers causing perforation.

Another good article on the diagnosis and pathology of diseases of the appendix is the editorial in the *Archives Générales de Médecine*, for 1841, in which are included reports of cases by Malespine and by Briquet; the editors review also the articles of Burne, Petrequin, Merling, Grisolle, and others, and apparently recognize the following forms of disease:

1. Peri-appendicular non-suppurative inflammation, which may resolve without pus-formation.
2. Peri-appendicular abscesses, which may terminate by rupture either into the bowels or intra-peritoneally; or may be opened externally.
3. General peritonitis from perforation of the appendix, without any attempt at localization of the process.

As ætiological factors they recognize: (1) Foreign bodies and fæcal concretions. (2) Tuberculous or other ulcerations. (3) Some undefined causes producing inflammation without perforation.

In 1843 Volz published an essay in which he upheld the rather unpopular view that the appendix was responsible for more of the affections of the right iliac fossa than was the cæcum. He reports five cases, and in the first four the diagnosis was confirmed by autopsy, but although his fifth patient recovered he was sure the lesion had been a perforation of the appendix. The symptoms on which he placed most reliance were abdominal pain, which soon became localized to the region affected, and local tenderness. He

Appendicitis.

thought there was not apt to be any fever, and that the pulse rate was not usually accelerated. In this stage of the disease recovery might occur, or on the other hand general peritonitis might supervene, with diffused pain and tenderness, tympanites, intestinal obstruction, small fast pulse, cold extremities and death.

In 1846 Ormerod, although he describes several cases of right iliac abscesses, yet makes no mention whatever of the appendix, which shows that even at this comparatively late date the cause of the appendix was far from being won.

In 1847 Walther said that the catarrhal form of the disease was more severe than that due to foreign bodies, although he thought that perforation was only possible when these were present. He expresses the belief that concretions form in the cæcum, and ultimately press aside the valve of the appendix, and enter its lumen. Cless in 1847 diagnosed a perforation of the appendix, and was confirmed by the autopsy.

Oppolzer, in 1858, made a further advance in the pathology of inflammations of the appendix, when he divided iliac phlegmons into: (1) Extra-peritoneal, and (2) Intra-peritoneal. He thought that inflammation of the appendix must produce the latter variety.

In 1859 Leudet abandoned the idea that inflammation of the right iliac region arose in the cæcum, and contended that perforation of the appendix was more common than perforation of all other parts of the intestine combined; and noted that such perforation may open into the cæcum, rectum, vagina or bladder, or through the abdominal wall. He also considered some cases of abscess of the liver and pylephlebitis as dependent upon this disease. He considered localized suppuration a more common result of perforation of the appendix than general peritonitis.

In 1867 Dr. Wm. Pepper noted the cure of an old lesion of the appendix by conversion of the organ into a fibrous cord.

In 1875 Wilks and Moxon stated that the appendix was

usually at fault in these troubles, but still considered that inflammation of the cæcum, with perforation producing abscess and peritonitis, did sometimes occur, although they expressed the opinion that in severe cases the appendix was the seat of disease. They moreover recognized the fact that perforation was not always necessary to produce suppurative peritonitis.

In 1880 Bierhoff gave a very complete account of the pathology of the appendix, though he makes no marked advance from the teachings of Merling, in 1836. As causes he gives, besides foreign bodies or concretions, and a catarrh which forms part of a general intestinal inflammation: (1) Other acute diseases, as typhoid fever, dysentery, cholera, etc.; (2) neoplasms, as tuberculosis and carcinoma; and (3) parasites, of which the *Ascaris lumbricoides* is the most frequent. A more important contribution in this same year is that of Matterstock who showed that of 146 autopsies in adults with peri-cæcal suppurations, in no less than 132 was the appendix perforated, while among 49 autopsies in children with perityphlitis, this organ was found perforated in 37 cases. But With, of Copenhagen, was probably the first to deny outright that typhlitis could ever itself give rise to peritonitis. He called the disease "peritonitis appendicularis," and recognized three forms: (1) Peritonitis appendicularis universalis. (2) Peritonitis appendicularis localis. (3) Peritonitis appendicularis adhæsiva.

In 1885 Fox first proposed the theory that perityphlitis was strictly analogous to quinsy, an inflammation in the peritonsillar tissues, being led to this idea from a consideration of the resemblance in structure of the appendix and the tonsil, both being very rich in lymphoid tissue; and also because he recognized the fact that in less than half the cases of inflammation of the appendix could foreign bodies be held accountable.

Reginald H. Fitz, beginning in 1886, in a memorable article published in the American Journal of the Medical

Sciences, gave an impetus to the study of affections of the vermiform appendix such as it had never before received, and by showing that the symptoms in 209 cases of typhlitis or perityphlitis were identical with those observed in 257 cases of perforation of the appendix, convinced the medical world of the practical truth of the contention that in all inflammations of the right iliac fossa the "fons et origo mali" was the vermiform process of the cæcum. It seems that in this article the term "appendicitis" is first used; and though many physicians objected to it as "a rather barbarous word," or as "an excessively clumsy term," yet its convenience was recognized by all, and it soon displaced all competitors, such as "apophysitis," "ecphyaditis," "epityphlitis," and "scolecoïditis." Whatever may be said in favour of these various terms, the last of which has greatest claims to consideration on philological grounds (*σκόληξ*, *lumbricus*, a worm), the word appendicitis, so widely in use in America, England, France, and wherever these languages are spoken, cannot be dropped, even were it desirable to do so.

For a number of years after the publication of these articles by Fitz, there were still a few isolated physicians who maintained that there were two distinct diseases met with in the right iliac region, typhlitis and appendicitis; but few if any asserted that the latter was the less frequent of the two.

The greatest of all advances in the diagnosis of appendicitis was that accomplished by McBurney when he described a point one and a half to two inches from the anterior superior iliac spine on a line drawn thence to the umbilicus, as the spot where localized pain and tenderness were almost invariably found in cases of inflammation of the appendix, this being the usual situation of the base of that organ. It was a valuable advance not so much because the pain is in every case just at that spot, but because it put into the physician's or the surgeon's thoughts, in a practical, concrete way, a ready method of excluding nearly every other disease with almost absolute certainty; and though it

is not possible to deny the existence of appendicitis when pain and tenderness are in another place, it is next to an unheard of thing for the signs to be circumscribed in this way and for the affection to be other than appendicitis.

The bacteriology of the appendix next claimed the attention of authors and we find among the first to make such reports of their cases Gouillioud and Adenot in 1891.

In 1894 Senn published an article on "Appendicitis Obliterans," but for the last ten to fifteen years the chief subject of discussion has been the treatment, and the pathology and diagnosis have become more or less firmly established. This is so because operations were constantly being undertaken at an earlier date. By this means it has been shown that foreign bodies play a comparatively insignificant rôle in the causation of appendicitis, that perforation is by no means the only way in which peritonitis can arise, and that an appendix once the seat of inflammation never returns to its normal state, even if the patient can avoid a recurrence of the symptoms by careful diet and regularity of life.

TREATMENT.

To describe in any detail the various remedies recommended by the ancients for colic pains and ileus, would be neither suitable in a sketch such as this, nor particularly edifying. Suffice it to say that any surgical treatment was postponed until the last possible moment, when an abscess was actually pointing; and even in such a case the vast majority preferred to let the matter evacuate itself spontaneously, or to allow the patient to die a peaceful death without subjecting him to the discomfort of the abscess being opened at all, and without laying themselves open to the charge of having killed the patient by the operation. Yet that abdominal abscesses were occasionally incised, is proved by the instance cited by Aretæus in the second century. He opened an abscess "in the colon on the right side, near the liver,

and much pus rushed out, and much also passed by the kidneys and bladder for several days, and the man recovered." It would be too much to assume that he was treating a case of appendicitis, which had ulcerated into the urinary tract, yet the possibility of this, among other greater probabilities, is not to be denied.

In the earlier stages of the disease, the course of treatment was somewhat as follows: Immediate venesection from the veins at the elbow, and, if retention of urine was present, from the saphenous vein at the ankle as well; blood being drawn in severe cases *ad deliquium animi*. Emetics if the pain were above the navel; purgatives, however, should its chief intensity be below; but in cases where there was manifest inflammation, these remedies were not used, evacuation of the bowels being attempted by large and repeated enemata, forcefully injected. Sedatives were given sparingly, because it was thought that obstruction of the bowels was best overcome by purgatives, although they were administered only by enema, as above stated. In cases of inflammatory obstruction, the patient under such circumstances rejecting every medicine from the stomach by the prolonged vomiting. While sedatives were thus not given by mouth, they were directed to be applied locally; and the patient was made to sit in a bath of hot oil in which various drugs were dissolved. A very few of the ancient physicians caused their patients to swallow leaden pills, in the hope that by their weight they might force a way through all obstructions, and finally cause a satisfactory fæcal evacuation.

Later—in the time of Oribasius—it was customary to encourage the opening of an abscess into the bowels by hardening the overlying skin with astringents; and warm and emollient cataplasms were only applied when rupture externally appeared unavoidable. These same methods of treatment were pursued by the Arabian physicians with little change and practically no improvements.

In the time of Paré (sixteenth century), abscesses were opened

without hesitation when they pointed externally; and great reliance was placed in the virtues of quicksilver to overcome intestinal obstruction. Thus Zacutus Lusitanicus informs us that Marianus Sanctus narrates that many were cured of the most deplorable iliac passions by drinking three pounds of quicksilver in hot water, "which even saved them from imminent death." It is curious to find this remedy still in use at so late a date as 1830. Pedrini, moreover, in 1883, reported three cases of "ileus" successfully treated by causing the patients to swallow five or six bullets and four pounds of No. 3 shot, at the same time using prolonged and repeated insufflation of air by the rectum.

Van Helmont, in 1664, boldly pronounces that no one can perish of the iliac passion if he do but swallow musket balls of lead, which by their superincumbent weight may drive forward the obstacle seated in the intestines; and that the larger these balls were, and the greater the number of them swallowed, the more expeditiously would they be useful, especially if the patient could be kept upon his feet and walking about in an erect posture.

Sydenham's favourite application to the abdomen in these cases was the body of a freshly slain puppy-dog, slit open. In those cases where the pain returned after recovery, or where symptoms of abdominal discomfort persisted after an attack of the iliac passion, he recommended constant horseback riding, to jolt the noxious matters out of the cæcum, where they were prone to accumulate.

Riverius in 1668 narrated the following incredible case, quoted from Matthew de Gradi: A girl of twelve years was afflicted with the iliac passion, and reversed peristalsis became so strong, and fæcal vomiting so constant, that not only were ordinary suppositories vomited from the mouth shortly after being placed in the rectum, but even one tied by four strong threads to the thigh was drawn upward, the strings snapped,

and the suppository, with parts of the threads still attached, shortly afterwards rejected from the stomach. Besides giving the usual directions as to treatment Riverius lays great stress on abstinence, allowing only three spoonfuls of broth every day, for four or five days.

Boerhave, the most learned of all medical writers, in 1709 advised the following treatment for cases such as these:

1. Large and repeated bloodlettings.
2. Laxative and cooling clysters, three, four, or more in a day.
3. Similar drinks, with a "prudent interposition of opiates."
4. Fomentations to the abdomen, more especially of living animals that are young and of sound health, split open and applied.
5. Avoiding all things that are acrid, forcing or heating.
6. Holding on in the same course until complete cure is assured, that is, until all symptoms have been absent for three days.

In 1735 is found the first authentic reference to the removal of the human appendix during life. Claudius Amyand, Esq., F. R. S., operated on a boy, eleven years of age, for the cure of a discharging sinus in the right thigh, which evidently communicated with an irreducible scrotal hernia. The hernia had existed from infancy, and for one month there had been discharged from this fistula "a great quantity of an unkindly matter." As it was evident that the cure of the sinus depended upon that of the hernia, "which latter could be obtained by no other operation than that for the bubonocoele," this was agreed to, and the operation accordingly performed on the sixth day of December, 1735. "This operation proved the most complicated and perplexing Mr. A. ever met with, many unsuspected oddities and events concurring to make it as intricate as it proved laborious and difficult." The hernia was found to be chiefly omental, "the size of a small pippin," and in its interior lay the appendix cæci, which had been

perforated by the point of a pin, whose head, covered with much incrustated stone, remained within the appendix, acting as a ball valve, and allowing at most unexpected and inopportune moments a copious discharge of fæcal matter over the field of operation. The long standing inflammation had so knit together the sac of the hernia, the omentum, the appendix, and the testicle and cord, that their dissection was a most intricate and perplexing procedure. Besides all these adhesions, there was the additional difficulty of the sudden and overwhelming discharge of fæces, frequently occurring; the facts that the pin was continually getting in the way of the knife, that the exact whereabouts and form of the gut could not be detected, and that Mr. Amyand could not be sure how it ought to be treated until he could see it. However, the omentum was first dissected loose, cut off close to the abdominal muscles, and the stump allowed to retract into the abdominal cavity without any ligatures, as there did not appear to be any good-sized vessels in it. Having completed this tedious dissection, the gut was next found, loosened from its adhesions, and the aperture from which fæces had all this while been escaping, at last detected. As the pin was withdrawn from the appendix a report was heard like that when a cork is drawn out of a bottle, so tightly did its enlarged head fit the lumen of the appendix. The bowel was now plainly seen to be the appendix cæci, and the consensus of opinion of the physicians and surgeons present was that it would be proper to amputate this gut. "To which end a circular ligature was made about the sound part of it, two inches above the aperture; and this, being cut off an inch below the ligature, was replaced in the abdomen, in such a manner that an artificial anus might be made there, if the patient's case should require it." Then the hernial sac was cut off, as high up as it had been possible to dissect it from the skin, spermatics, etc.; and these, as they appeared in a sound state, were preserved *in situ*. The fistulous tract was pared, and its edges freshened, "the aperture

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11.43

in the (abdominal) muscles, which had been enlarged by incision, was stopped with a tent; and the rest of the dressings and the situation of the patient so ordered, as to remove from the wound all such pressure from within, as might disturb the cure." "It is easy to conceive that this operation was as painful to the patient as it was laborious to Mr. A.; it was a continued dissection, attended with danger on parts not well distinguished; it lasted near half an hour, during which the patient vomited largely, and had several stools, but was soon composed by $\frac{1}{2}$ oz. of diacodium" (syrup of poppies) "and emollient embrocations and fomentations frequently applied warm on the belly; he was blooded, and an emollient carminative oily clyster was ordered to be applied in the evening; but as he was easy, and the belly not tense, that was omitted." On low diet, with an occasional enema, the case progressed favourably. First dressed on the fourth day, the tent was not removed until the eighth; the ligature dropped from the appendix on the tenth day, and no fæcal discharge followed it. The wound then healed uninterruptedly, care being taken to keep strong and constant pressure over it "as well to fence against the intrusion of the viscera into the wound, as by a strong incarnation and cicatrix, effectually to secure the patient against a rupture." The boy was discharged in good health, wearing a truss, in a little over a month from the date of the operation. Unfortunately, owing to neglect of proper use of the truss, a hernia again appeared, about six months later.

In 1757 Mestivier as already noted in the previous section, saw the case of a woman, in whom a fæcal abscess, already fluctuating, and pointing to the right of the navel, was opened by the surgeon-major of the hospital. About one pint of pus, "of bad quality," was discharged; and although the patient did well for a time, she unexpectedly died when the resulting ulcer had nearly healed. This is the first concrete instance known of an abscess appendiceal in origin, as proved

by the autopsy, being opened by incision; all previously reported cases having been allowed to burst of their own accord.

The medical treatment continued practically the same throughout the eighteenth century, and it was not until early in the nineteenth century that an advance in this direction was made, when, under the influence of the teachings of Graves and Stokes, of Dublin, opium in large doses was administered to all patients who presented evidences of peritonitis. This was an advance, we repeat, though it has happily been superseded by a still greater advance—early aseptic removal of the offending organ. It is true that Prescott and a few other practitioners, had employed opium in doses of six to eight grains daily, and apparently prolonged life by so doing; but their object was merely to allay pain, and the routine use of opium to put the bowels at rest, and by so doing to minimize the amount of fæcal extravasation, and encourage the formation of adhesions, though employed as early as 1823 by Graves, was not the universal custom for some twenty years later. The good derived from the opium treatment was undeniable; it was the greatest good except the absolute removal of the inflamed appendix. It encouraged the formation of a localized suppuration (the only intra-abdominal complication successfully amenable to surgical treatment in those days), and even when this end was not attained, it rendered peaceful a death which without its use would have been a lingering agony of torture.

About this same time venesection was more or less completely abandoned for local bloodletting by leeches, which were applied to the seat of pain, and sometimes also to the perineum, in numbers of from thirty to sixty at once, several times daily.

Peri-cæcal abscesses, already pointing, are known to have been opened in 1815 and in 1828 by Dupuytren; in 1832 by Ahrt, and in 1843 by Willard Parker, of New York. Grisolle, in 1839, advised against the usual custom of blindly plunging the bistoury into the abscess in these cases, and urged the importance

of cautiously dissecting down through the overlying tissues, because a coil of intestine might intervene. He never, moreover, would open such an abscess until fluctuation was present, nor until it had become adherent to the abdominal walls.

But in 1848 occurred the greatest surgical advance of the century, when Hancock performed the first deliberate laparotomy for peri-appendicular suppuration, and proposed such treatment for all cases with abscess before pointing or fluctuation had occurred, or even before adhesions to the anterior abdominal wall had formed. This was looked upon by many as a procedure temerarious in the extreme, in spite of the excellent recovery made by his patient. The details of the case are as follows: A woman of thirty years, who had been subject for some years to pains in the right iliac region, had a recurrence of this pain the day after parturition. She was at first treated with sedatives; then an enema; then leeches, with warm fomentations, to the abdomen; and was likewise given opium, calomel, and salines. On the fifth day first could any mass be felt. When Mr. Hancock first saw her, on the eighth day of this attack, the right iliac region was so sore from blistering that the physical examination was unsatisfactory; but he made a diagnosis of trouble around the cæcum or the appendix. Two days later examination was possible, and showed the patient sinking, with symptoms of general peritonitis, and a deep seated mass internal to the right anterior superior iliac spine. There was no evidence of fluctuation. Mr. Hancock thought nevertheless it was probable that pus was present, and advised cutting down on this mass, to evacuate any matter that might exist. Under chloroform anæsthesia, he therefore made an incision four inches in length, from the iliac spine inward, close to Poupart's ligament; and on opening the abdominal cavity evacuated a quantity of excessively offensive, turbid serum, with fibrinous flocculi, mixed with air globules and patches of false membrane. The patient was now turned on her side, to allow a free escape of the mat-

ter; a poultice was applied, and an opiate directed to be administered. After a tedious illness of two weeks, two fæcal concretions were removed from the sloughing sinus. These were faceted, and evidently had been impacted in the appendix and had escaped from it by ulceration. "From this date she got well," adds Mr. Hancock.

Not until 1856 was Hancock's advice repeated. In this year Lewis reiterated the importance of opening abscesses in this situation early, without waiting for fluctuation to appear, since by that time many patients would be dead. He analyzes forty cases of abscesses in the right iliac region. But Willard Parker, in 1866, was the first to again put into practice this method of treatment. He advocated operation between the fifth and the twelfth day, after adhesions had formed, but before the accumulating pus had ruptured them.

Most of these operations were done by Hancock's original incision; and some less daring operators incised down only to the transversalis fascia, and then either allowed the abscess to break through of itself, which it usually did in the course of a few hours; or else they punctured the abscess with trocar and cannula, and subsequently dilated the sinus thus formed. (See Weber, Whitall, Kolb.)

The introduction of the drainage tube by Chassaignac, in 1859, materially aided the cure of these cases. In 1860 Münchmeyer first made a counterincision in the loin to facilitate drainage.

In 1865 Buck opened a perityphlitic abscess pointing in the right groin, below Poupart's ligament; and from this opening in the thigh, a pin was subsequently discharged, being evidently the cause of the disease.

By the year 1883 the number of operators had become so great that Noyes was enabled to find records of no less than one hundred cases where the abscess had been opened by puncture or incision. A curious operation was performed in this

year by Symonds: by a curved incision of four inches in length, close to the iliac bone and Poupart's ligament, working across adhesions, he removed from a chronically affected appendix a calculus, and then sutured his incision into the vermiform process. A large tube was placed down to the wound in the appendix, this organ being evidently adherent to the parietal peritoneum, so that the general cavity was not opened. The patient recovered and had no return of his symptoms. This method of procedure was planned by Dr. Mahomed, and, as will be remembered, carried out a suggestion made by Blackadder as early as 1824.

In 1884 Krönlein first removed the appendix for acute disease. He employed an incision through the linea alba. His patient did not recover.

Homans in 1886 operated on a case of appendiceal abscess, which he opened across the general peritoneal cavity, protecting this from the contact of the pus as well as he was able. He is said by Edebohls to have employed gauze packs for this purpose, but the original article makes no mention of them.

In 1887 Sands successfully closed a perforation of the appendix by suture, while in 1888 Treves did laparotomy for "relapsing typhlitis," and found the omentum adherent to the appendix, which was thus kinked. Treves therefore cut the adhesion, sutured a tear in the peritoneum thus made, bared the convex surface of the appendix of its peritoneal coat, thinking it would thus contract new adhesions with the parietal peritoneum on its outer side, and so be held straight, and closed the abdominal wound leaving the appendix in its new position. Recovery ensued. Being encouraged by his experiences, he next removed the appendix for recurrent attacks, during an interval of quiescence, closing the stump of the appendix with two sutures, and then stitching a flap of cæcal peritoneum over the stump, considering this a much safer method than merely to ligate the appendix before amputating it, as had been done by his predecessors. This was the first operation in an "interval."

In 1889 Tait split open and drained an inflamed appendix, without removing it. His patient recovered. In the same year Schüller first successfully closed an abdomen without drainage after an operation for appendicitis in which the peritoneal cavity was found to contain turbid serum. Each operation is an instance of a custom which has in later years been thought more honoured in the breach than the observance.

Among other surgeons who operated in cases of this kind before 1890 were:

Adams, Bacon, Bailey, Barlow and Godlee, Barret, Beach, Boardman, Bontecou, Briddon, Bryant, Buck, Bull, Burge, Byrd, Cage, Chamberlain, Chaput, Clarke, Clay, Cutler, Deaver, Edebohls, Ely, Freeman, French, Fries, Gibney, Gouley, Grant, Hall, Heath, Hicks, Hoffman, Holden, Howe, Jarvis, Kelsey, Köhler, Kolb, Krockowizer, Leale, Lewis, Maclaren, Mason, McBurney, Merriam, Mikulicz, Miner, Moore, Morton, Mynter, North, Noyes, Partridge, Pierson, Pinckney, Polaillon, Poncet, Pooley, Potter, Post, Raub, Regnier, Stemen, Stiegle, Stimson, Van Buren, Vander Veer, Voss, Walker, Ward, Weber, Weinlechner, Weir, Wey, Whittall, White, and Woodard.

When an abscess was not pointing the usual incision was through the right semilunar line, but in the last decade of the century this custom was rapidly abandoned for either the incision through the right rectus muscle, or for some form of "muscle-splitting" incision, which was at first considered suitable only to chronic cases, or for "interval" operations.

The simple straight incision through the right rectus muscle was modified by Battle in 1895, by Jalaguier, and by Kammerer in 1897, and by Lennander in 1898, each of whom, apparently independently, proposed to draw the muscle toward the median line, after opening its sheath by a longitudinal incision, without separating or dividing its fibres. The original "gridiron," or "muscle-splitting" incision was proposed by McBurney in 1893; and has since been further modified to meet emergen-

cies as they arise. One modification was that of adding a longitudinal incision, upward from the inner end of the gridiron incision, along the semilunar line. A much safer method,³ and one which gives ample exposure of the pelvis, is that proposed in 1900 by Weir, who divides the rectal sheath in the same transverse line as the original McBurney incision, and draws the rectus muscle towards the median line.

The stump of the appendix was, in the earlier operations, merely ligated. Treves, as above mentioned, was the first to suture the stump. Dawbarn introduced in 1894 the method of inverting the stump without ligating it, by a purse-string suture, which may be applied even before the appendix is removed, and tightened afterwards.

The length of the incision has by some surgeons been reduced, in clean cases, to less than one inch; but in suppurative cases the present tendency to the use of gauze for drainage instead of a tube, renders the unsutured part of the incision much longer than formerly.

The two most important articles that have yet appeared dealing with the history and literature of appendicitis are those of Clado and Edebohls, both of which have been freely drawn upon in the preparation of this sketch.

If, then, we review the miscellaneous facts hitherto set forth in rather unpalatable form, we find that the existence of the vermiform appendix was unknown until the sixteenth century; and that from the mere mention of it in anatomical works of that period, a gradually increasing familiarity with its structure is evident, until the beginning of the nineteenth century, when an anatomical knowledge, which may be called modern, had been gained. We find, however, that the symptoms of a disease, which we now know as appendicitis, were described with an amount of accuracy sufficient for recognition at the present day, even by authors of classic times; but that no one except per-

haps Mélier, in 1827, considered disease of the vermiform process as the chief, if not the sole, cause of these symptoms, until Matterstock in Germany, and Fitz in America proved, nearly a generation ago—the former, that practically all right iliac phlegmons were associated with a perforated appendix—and the latter, that in cases of so-called typhlitis, and in cases of appendicitis, the symptoms were identical.

That a knowledge of the pathology of the vermiform appendix slumbered, nay, even hibernated, from the time of Mélier, until the day of Fitz, is one of the most remarkable things in the whole history of medicine; and that it was at last awakened is due in no small measure to those courageous surgeons, like Hancock and Willard Parker, who determined to evacuate perityphlitic abscesses externally before these abscesses could kill the patient by intra-peritoneal rupture; and to all those operators, notably to McBurney, Fowler, Price, Morris, Richardson, and Murphy, who, inspired by their example, determined to remove the offending organ before the inflammatory process had advanced beyond its earliest stages, at a time when the general peritoneal cavity was yet healthy, and when ablation of the diseased organ meant cure without hope of relapse.

ANATOMY.

The vermiform appendix of man is, from an anatomical standpoint, the partly developed lower end of the cæcum, which does not undergo the same degree of growth and distention as does the rest of the cæcum. In the embryological development of the human intestinal tract there is at first no cæcum present, the original tract consisting of a straight tube, which, for purposes of description, has been divided into the fore-gut, the mid-gut and the hind-gut, and is attached to the umbilicus by the vitelline duct, sometimes persisting in the adult as Meckel's diverticulum. This attachment of the gut to the anterior abdominal wall pulls the formerly straight tube into a U-shaped projection, consisting of an upper and lower limb. At the end of the sixth week of intra-uterine life the cæcum is well marked, budding from the lower limb of the primitive intestinal loop, and marking the division between the small and the large intestine. The lower limb of the loop then ascends across the upper, past the umbilicus, to the left hypochondrium, thence across to the right hypochondrium, and finally about the end of the sixth month reaches the right iliac region, though even at birth and in early childhood the cæcum is placed higher than in adults. The cæcum may be arrested at any part of its journey, and when at operation it is not found in the right iliac region it may be looked for in either hypochondriac region, or near the umbilicus. A number of instances are recorded of its position in these abnormal situations, the ascending colon or this and the transverse as well being absent. Byron Robinson in an analysis of autopsies of 300 male and 118 female bodies, found partial non-

descent of the cæcum in 7 per cent. of the former and 3 per cent. of the latter. Lennander mentions the case of a boy, aged sixteen years, in whom the cæcum and appendix were found in the left hypochondriac region, lying against the spleen. In this case the appendix measured nine inches in length.

Some cases are recorded where the appendix is said to have been absent. Byron Robinson figures the condition found by him at autopsy in a woman of fifty years, where both cæcum and appendix were congenitally absent, the ileum opening into the ascending colon without perceptible angulation. I have never found the appendix absent on the operating table.*

Further studies in comparative anatomy support the physiologists' claim that the appendix should be considered as a lymph gland—as the abdominal tonsil. Berry examined the cæcal apex or, when present, the vermiform appendix in the following classes of life: Pisces, Amphibia, Aves, and Mammalia, including Marsupialia, Edentata, Ungulata, Rodentia, Carnivora, Insectivora and Anthropeida. Examination of the skate and the frog was negative; but, with the exception of a few others, all were found to present as their one common characteristic a large amount of lymphoid tissue. In the cat, pigeon and other animals with short cæca, the lymphoid tissue tends to be aggregated in distinct masses; when the cæcum is long, as in the domestic fowl, the pig and the sheep, the lymphoid tissue is diffused throughout the cæcum. In all instances the lymphoid tissue tends to be better marked at the cæcal apex, and to be comparatively wanting in other regions of the intestinal tract. His conclusions are:

1. Lymphoid tissue is the characteristic feature of the cæcal apex. The vermiform appendix of man is, therefore, represented in the vertebrate kingdom by a mass of lymphoid tissue, situated most frequently near the cæcal apex.

2. As the vertebral scale is ascended this lymphoid tissue

*Other instances where the appendix was absent have been recorded by Fawcett (two cases), Ferguson, Schridde, Swan (two cases), Dillard and Dorrance.

tends to be collected together into a specially differentiated portion of the intestinal canal—the vermiform appendix.

3. The vermiform appendix of man is not therefore a vestigial structure. On the contrary, it is a specialized part of the alimentary canal.

Types of Cæcum.—In the adult the cæcum develops as one of four types, and in each class the appendix holds a different position. (Plate III.)

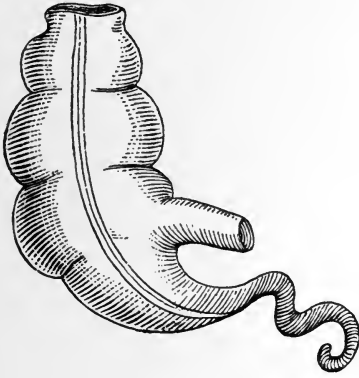
1. In the foetal type the appendix is the narrow inferior end of the conoid cæcum, the apex of the cone being directly continued into the appendix.

2. A second type consists of a cæcum with two equally large sacculi at its inferior termination. The appendix arises from the lower end of the cæcum, between the sacculi, which are separated by the anterior longitudinal band.

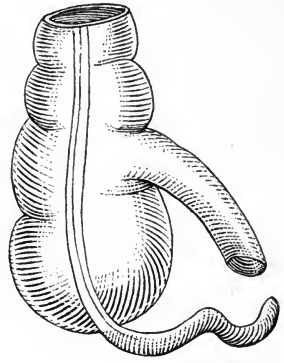
3. In the third class the external sacculus is large, while the internal one is small, thus bringing the base of the appendix near the ileo-cæcal valve. In addition, the anterior wall of the cæcum grows more rapidly than the posterior, so that the root of the appendix is posterior.

4. In the fourth and last class the internal sacculus has disappeared entirely, and the base of the appendix is attached to the cæcum posterior to the receding angle between the ileum and cæcum.

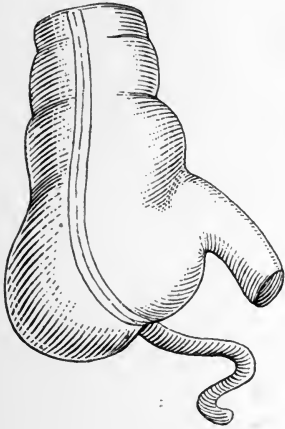
The first type of the cæcum is very rare; the second is not commonly seen; and the cæcum is usually of the third type, or partakes of the character of the third and fourth classes. Woolsey says that type one is found in only 2 per cent. of cases; type two in 3 per cent.; type three in 90 per cent., and type four in 4 or 5 per cent. According to Bryant's statistics, in more than one-half of all cases the appendix arises from the posterior surface of the cæcum about one inch below and to the right side of the ileo-cæcal valve; and in nearly all cases the root of the appendix is upon the postero-internal portion of the cæcum, from



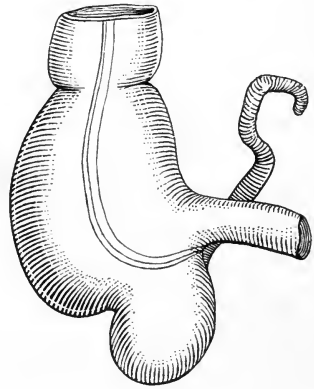
I



II

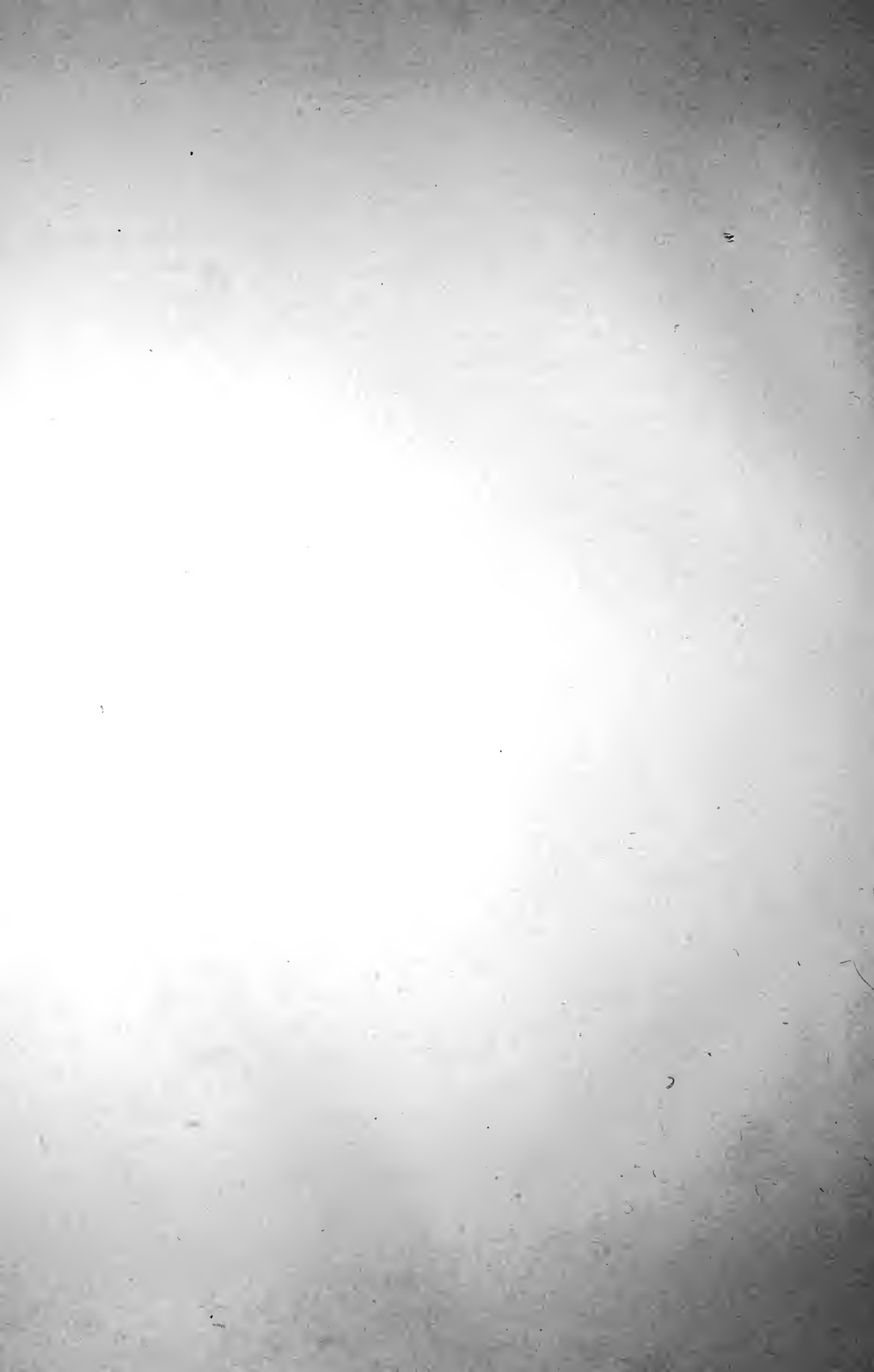


III



IV

THE FOUR PRIMARY TYPES OF CÆCUM.



three-fourths of an inch to one and a half inches from the ileo-cæcal valve. Innumerable observations in the dissecting room and at the operating table, moreover, have proved to the author that the cæcal attachment of the appendix is almost always upon the postero-internal portion of the cæcum. There are, however, rare instances in which the appendix arises from the anterior surface of the cæcum.

In cases of non-descent of the cæcum the appendix holds a correspondingly abnormal position, and under such circumstances it may lie even to the left of the median line.

Length and Diameter of the Appendix.—Although the average length of the appendix is from 8 cm. to 9 cm., its length may vary from 1 cm. to 23 cm. When the appendix is long, the cæcum is, as a rule, somewhat shortened. The diameter of the appendix is that of a goose-quill, or about that of a large earthworm (Holden)—from 3 mm. to 5 mm.

Peritoneal Coat of the Cæcum and Appendix.—The cæcum is usually almost completely covered by peritoneum. Its anterior surface is entirely invested by a serous covering; a small area on the posterior surface, however, is frequently left uncovered by the divergence of the two layers of the proximal portion of the meso-appendix. In rare instances, moreover, the cæcum has been found to be almost entirely retro-peritoneal, the whole ascending meso-colon, indeed, being practically non-existent. In such cases the cæcum and appendix occupy a fairly fixed position; whereas, when the meso-colon and meso-cæcum are long, the cæcum, being free to move, may, with the appendix, be carried by the ileum even into the sac of a left-sided inguinal hernia.

The peritoneum nearly invariably invests the distal portion of the appendix completely, but throughout the proximal half or two-thirds there is usually a meso-appendix; and close to the base of the appendix there is frequently on the posterior or inner surface a small triangular space uncovered by peritoneum. Sometimes the meso-appendix is absent, and the appendix hangs

free in the peritoneal cavity; or, on the other hand, the appendix may be entirely subserous, lying beneath the peritoneum in almost any position. It usually, in such cases, runs up behind the cæcum, either to its outer or inner side, being situated between the layers of the meso-cæcum or of the ascending meso-colon; but has also been found running up the anterior surface of the cæcum, between its muscular and serous coats. Pointing downward it may be beneath the iliac or pelvic peritoneum, lying against the corresponding fascia; in such cases a pelvic abscess may occur, which will be extra-peritoneal, or the pus may burrow along the external iliac vessels, and the abscess point in the thigh, beneath Poupart's ligament.

The **meso-appendix** is a double layer of peritoneum, similar to, but on a smaller scale than the mesentery, from the under or left layer of which it is derived. It is either triangular or quadrangular in outline; when the former, its free edge may be considered to form the base of the triangle, while its apex is at the root of the appendix, and the two sides are formed, one by the appendicular attachment, and the other by its origin from the mesentery. The base, or free edge of the meso-appendix nearly always forms an acute angle with the attachment of the mesenterium to the appendix; and in some cases is continued even to the tip of the appendix as an exceedingly narrow fringe, almost invisible to the naked eye. When quadrangular in outline, the fourth side, at the cæcum, is usually the shortest of all. The meso-appendix usually appears to be too short for the appendix, thus twisting, curving or coiling it as the mesentery does the small intestine throughout its length. The form of the proximal portion of the meso-appendix varies slightly according to the type of cæcum: where this is of the first or second type, the proximal part of the meso-appendix is continued as the meso-cæcum, the left layer of which is continuous above with the under layer of the mesentery of the ileum, and below with the left layer of the meso-appendix; the right layer being continuous

below with the corresponding layer of the meso-appendix, and above forming the right layer of the ascending meso-colon. The upper portion of the posterior surface of the cæcum is usually left bare of peritoneum by the divergence of the two layers of the meso-cæcum; where this is not the case, abnormal mobility of the caput coli and appendix ensues, as was described above. In the third type, or in types which are intermediary between the third and the fourth, the meso-cæcum appears at first sight to be absent; search, however, reveals it, though shortened, still formed by the diverging layers of the proximal portion of the meso-appendix. The more nearly the cæcum approaches the fourth type, the less distinct becomes the meso-cæcum, since in this type the meso-appendix arises entirely from the under layer of the mesentery, and the proximal part of its right layer is continuous with the serous coat of the cæcum, and with the peritoneal lining of the iliac fossa; the junction of the last named two portions of peritoneum forming the outer layer of the meso-cæcum, while its inner layer is so short as to be practically non-existent. As the form of cæcum approaches the first type, the freedom of motion of the appendix increases, so that at operations for their excision, appendices of this type are more easily brought through the abdominal wound than are those of other types, since a longer meso-cæcum is present. Perforation occurring, as it occasionally may, at the small triangular area near the base of the appendix, above described as uncovered by peritoneum; or in the line of attachment of the meso-appendix, would open into the interval between the two layers of the meso-appendix. As a consequence of such perforation, pus may pass into the mesentery and thence to the subperitoneal areolar tissue of the iliac fossa; or, at the proximal portion of the meso-appendix, the pus may enter the post-cæcal areolar tissue, and thence gravitate to the iliac fossa; or, rarely, it may burrow upward behind the colon and simulate perinephric abscess.

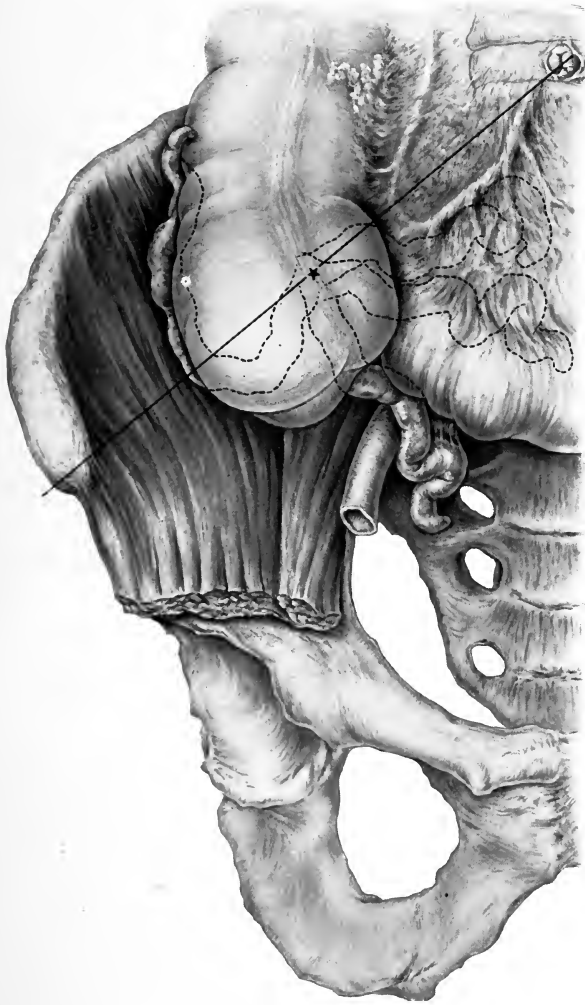
Between the layers of the meso-appendix are found the

arteries, veins, nerves, and lymphatics for the appendix, together with areolar tissue and some fat. In some instances the iliac vessels pass through the meso-appendix, thus accounting for one manner in which collections of pus in the right iliac fossa may find their way beneath Poupart's ligament into the thigh. In the female the meso-appendix sometimes has running to the ovary a prolongation, which is called by Clado the appendiculo-ovarian ligament. It conveys an additional blood supply to the appendix, and will be described in more detail later in connection with that subject. I have myself never met with this structure, and its presence is denied by some excellent authorities.

The meso-appendix acts also as an appendicular ligament, the mobility of the appendix depending, when adhesions are absent, largely upon the width and the length of attachment of the meso-appendix. In the rare cases where the mesenterium is entirely absent, the appendix is freely movable in the abdominal cavity.

At times in the meso-appendix may be found an opening, in which a coil of small intestine has been known to have become strangulated.

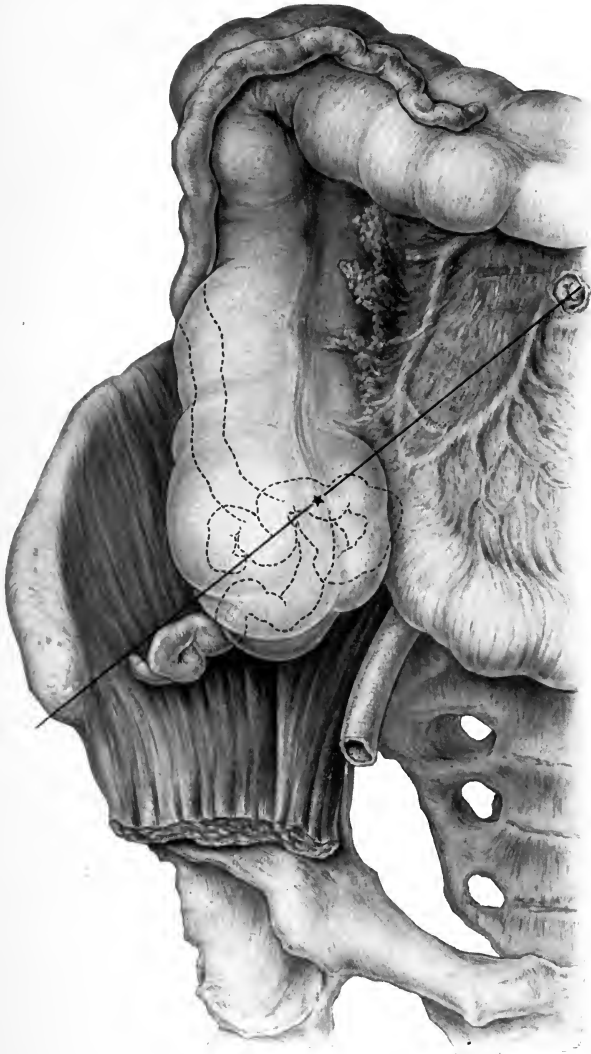
Position of the Appendix.—In the majority of cases the appendix holds one of eight positions. Dr. Bristow suggests a very simple method of classifying these positions and directions. This consists in locating in the right iliac fossa a central point which represents the most frequent position of the attachment of the appendix to the cæcum; from this central point are drawn lines which radiate in eight different directions. To indicate the course of the different lines, Fowler has modified this method by substituting the initial letters of the points of the compass for the numbers used by Bristow. The central point is located by drawing a line from the anterior superior spine of the ilium to the umbilicus; a point on this line, from two to two and a half inches from the anterior superior spine, marks the position of the root of the appendix and is the central point from which the lines are drawn.



POSITIONS OF THE APPENDIX.

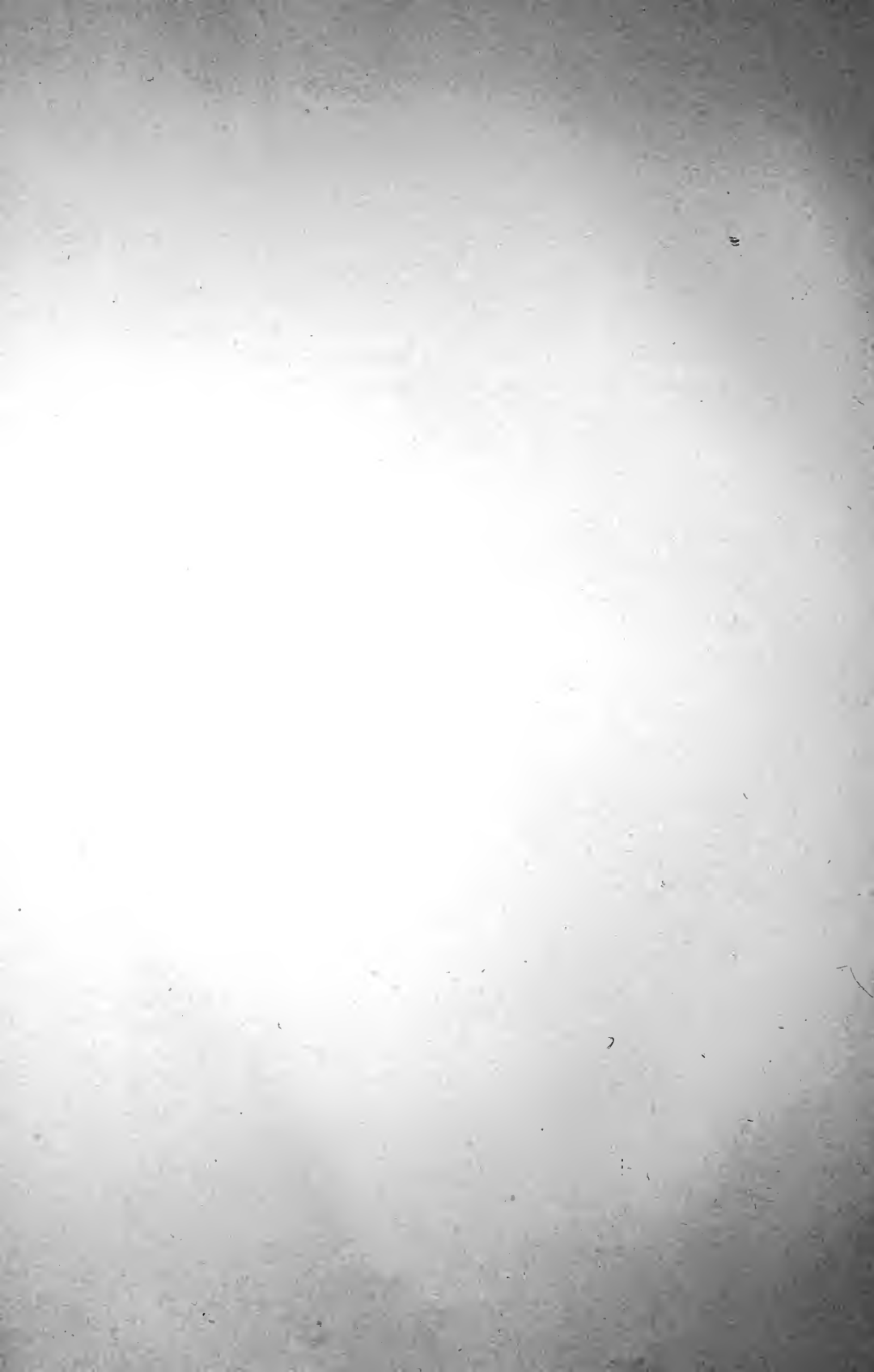
- 1 Under the mesentery. 2. In the pelvis. 3. On outer side of cæcum.





POSITIONS OF THE APPENDIX.

1. Coiled up behind cæcum.
2. Lying down and out on iliacus muscle.
3. Abnormally long appendix extending beyond hepatic flexure of colon.



Although the appendix may occupy any of the eight positions of the points of the compass, it is most commonly found in one of the following: (1) It may lie under the inferior layer of the mesentery, being directed toward the spleen—in the N. E. position; (2) it may lie on the ilio-pectineal line or may project into the pelvis, its course being S. or S. E.; (3) if there be a long meso-appendix, it may lie to the right of the cæcum and the ascending colon, running upward, in a northerly direction parallel with the colon and over the kidney toward the right lobe of the liver; (4) it may lie in front of the colon and cæcum, its course generally being N. or N. E.; (5) it may lie behind the cæcum, holding generally a northerly direction; (6) if the appendix have a long and wide mesentery, it may be directed toward any of the other points of the compass, freedom of motion generally being required in order that it assume any of these positions; (7) when the meso-appendix is short, the appendix may be coiled upon itself.

Abnormally, the appendix may hold a position in either of the ileo-cæcal fossæ; it may lie behind the peritoneum and behind the cæcum and may be in contact with the posterior muscular wall of the latter (see Plate VII), being covered in this position by the peritoneal coat of the cæcum; it may be adherent to the peritoneum along the right border of the cæcum and ascending colon or at any point in the neighbourhood of the cæcum; or it may lie in the inguinal canal.

It seems more simple and practical, however, to classify the positions of the appendix as follows: (1) Upward or upward and outward, lying in front of, behind, or upon the outer or inner side of the cæcum; (2) under the mesentery and directed upward and inward, inward, or downward and inward over the brim of the pelvis; (3) coiled upon itself and lying under the cæcum; (4) downward, lying free in the abdominal cavity under the cæcum; (5) outward, lying in front of or behind the cæcum.

When the appendix is directed upward or upward and out-

ward, and lies behind or upon the outer side of the cæcum or colon, an abscess resulting from disease of this organ frequently produces its local manifestations in the loin and simulates abscess of hepatic or renal origin. When the inflamed organ is directed downward and inward or downward into the true pelvis, the bladder or the ovaries are irritated. The following are from statistics collected by Bryant in the dissecting room from 144 subjects: The appendix held one of the upward positions in relation with the cæcum in 11 cases, or less than 8 per cent.; it was under the mesentery and directed upward and inward, inward, and downward and inward in 92 cases, or about 64 per cent.; it was coiled upon itself under the cæcum in 1 case, or less than 1 per cent.; it was directed downward or downward and outward or lying under the cæcum in 38 cases, or less than 27 per cent.; it was directed outward in 2 cases, or less than 1.5 per cent.

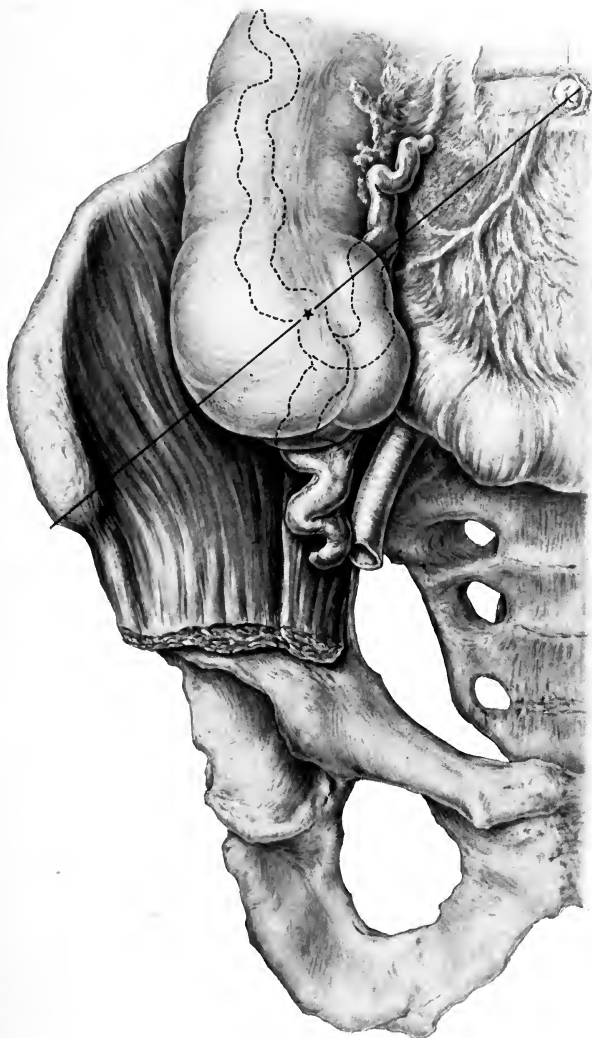
The position of the appendix at autopsies has also been investigated by Monks and Blake, 572 cases; by Boody, 509 cases; and by Byron Robinson, 418 cases. Unfortunately these observers have not classified their experiences in the same way, so that it is difficult to make a synopsis of their observations. Robinson has classified the various positions in which he found the appendix, as regards its relation to the psoas muscle; while the other authors divide their cases into groups where the appendix was found down, down and in, in, up and in, etc. In Robinson's series the results may be presented as follows:

MALES—300 CASES.

FEMALES—118 CASES.

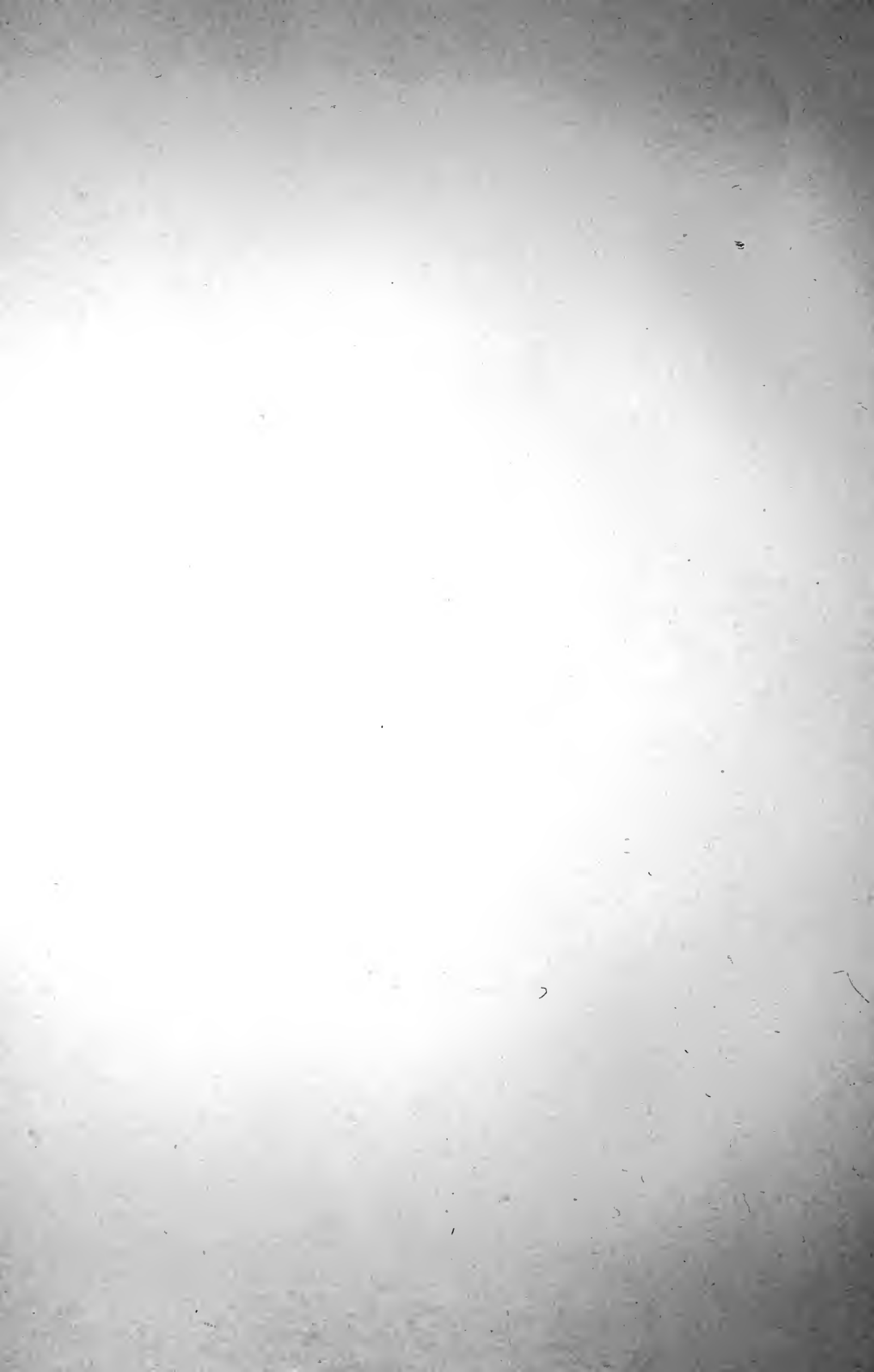
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|--|--------------|
| 37 per cent. hung in the pelvis | 48 per cent. |
| 46 per cent. on the psoas muscle | 20 per cent. |
| 23 per cent. to the left of psoas muscle | 20 per cent. |
| 20 per cent. retro-cæcal | 35 per cent. |
| 18 per cent. to right of psoas muscle | 28 per cent. |

Irrespective of sex, he found that 80 per cent. of the appendices were to the right of the psoas, and 20 per cent. to its left.



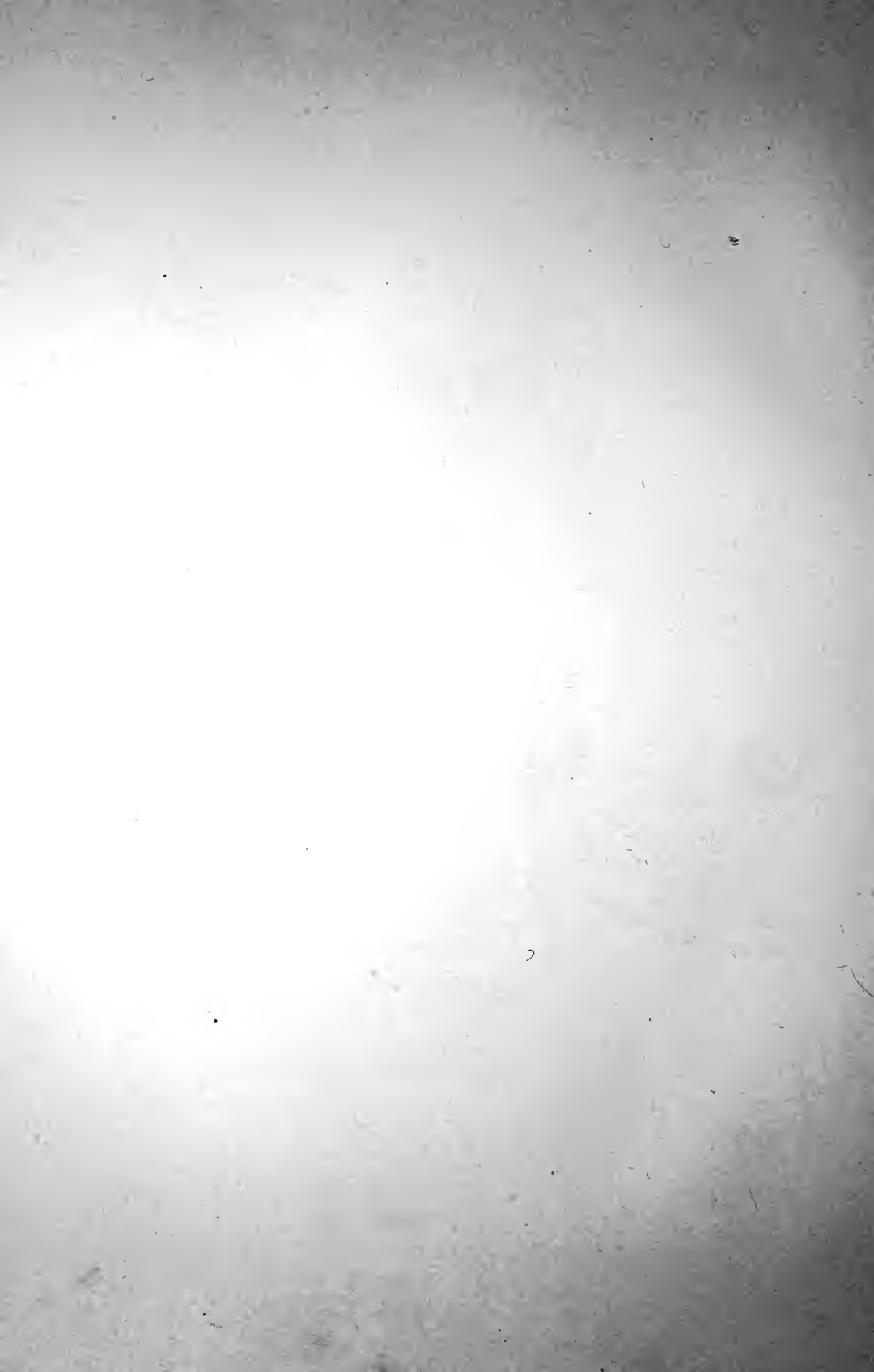
POSITIONS OF THE APPENDIX.

1. Lying on top of mesentery to inner side of cæcum. 2. Lying on outer side of ascending meso-colon, behind cæcum. 3. Pointing directly downward, below cæcum; the tip of appendix in contact with external iliac artery.





AN UNUSUAL POSITION OF THE APPENDIX.
Adherent to the posterior surface and covered by the serous coat of the cæcum.



The results of the two other series of observations may be combined in the following table:

| AUTHOR. | NUMBER OF CASES. | DOWN AND IN. | DOWN. | IN. | UP. | UP AND IN. | UP AND OUT. | OUT. | DOWN AND OUT. | IN PEL-VIS. | BEHIND CÆCUM. |
|-----------------|------------------|--------------|-------|-----|-----|------------|-------------|------|---------------|-------------|---------------|
| Monks and Blake | 572 | 179 | 79 | 62 | 52 | 39 | 29 | 9 | 5 | 14 | 104 |
| Boody | 509 | 64 | 42 | 6 | 43 | 270 | .. | .. | .. | .. | 84 |
| Total | 1081 | 243 | 121 | 68 | 95 | 309 | 29 | 9 | 5 | 14 | 188 |
| Per cent. | | 22.6 | 11.2 | 6.3 | 8.7 | 28.5 | 2.6 | 0.8 | 0.5 | 1.3 | 17.5 |

Thus it is seen that the most usual postmortem positions are up and in, and down and in, the combined percentages of these two positions from the above table being over 51 per cent.; Bryant's figures, quoted above, being about 64 per cent. for these positions. In my own operative experience, the position of the appendix in the great majority of cases has been down and out, lying in the sulcus on the outer side of the psoas muscle; but my observations in the dissecting room confirm the above statistics, that is, that positions of the appendix under the mesentery are most common.

Histology of the Appendix.—Physiologically the appendix has of late years been regarded more and more as a lymphoid structure, some even claiming for it the rôle of a gland, under the name of the abdominal tonsil. Microscopically the resemblance is fairly close, the predominance of lymphoid structures in both organs being obvious.

The coats of the appendix are a mucous, a submucous, a muscular and a serous. Its structure is very similar to that of the cæcum and the lower ileum.

The *mucous membrane lining the appendix* is composed of a single layer of columnar epithelial cells, placed upon a basement

membrane; of tubular glands reaching down to a delicate muscularis mucosæ, which is often absent; and of lymphoid follicles. The tubular glands and the lymphoid follicles are embedded in a delicate retiform connective tissue. The former are about 0.5 mm. in length, and are said by Lockwood, who is the best recent writer upon the subject, to be bifid and sometimes trifid at their extremities, thus giving them the appearance of racemose glands. They do not extend beneath the muscularis mucosæ, as above mentioned, whereas the lymph follicles, some of them, pierce it and enter the submucosa, which is separated, often imperfectly, from the mucosa by the muscularis. The lymphoid tissue in which the tubular and lymph glands are embedded becomes in inflammatory conditions obscured by the round-celled infiltration, which may completely obliterate the retiform structure. Thus the extent to which this delicate connective tissue is hidden by the inroad of the inflammatory cells is a rough index of the intensity of the inflammation.

At the cæcal orifice of the appendix there is sometimes a prominence of the mucous membrane, caused by increase of the lymphoid tissue, forming a small valve, well described by Gerlach. Under certain circumstances this may favour occlusion of the orifice. In a certain proportion of cases, moreover, the appendix enters the cæcum obliquely, as the ureter does the bladder, and thus forms a sort of valve.

The lymphoid follicles are distinctly visible to the naked eye, being about 1 mm. in diameter. In shape they are circular or oval, and are almost entirely within the ring formed by the muscularis mucosæ, only a few being without in the submucous tissues. Lockwood estimates their entire number in the average appendix at from 150 to 200 follicles. In the centre of the follicle, which stains less deeply, the lymph channels are more capacious; while the cortical area stains well, and is quite opaque. The base of the follicle reaches the submucosa, but between them is found a space described as the follicular or basilar lymph sinus,

which communicates freely with the lymphatics of the submucosa.

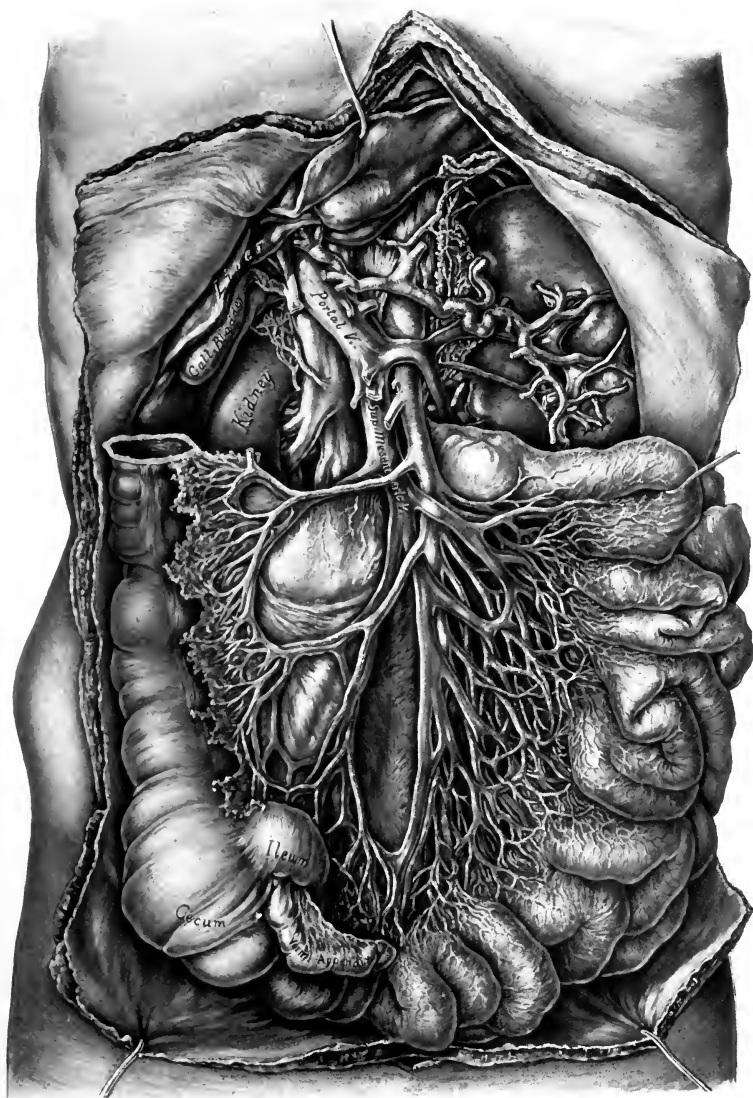
The *submucosa*, beneath the muscularis mucosæ, is formed of fibro-elastic areolar tissue. Where, as is usually the case, the muscularis is absent or at least only imperfectly developed, the separation of the submucosa from the mucosa is very indefinite. The submucosa contains numerous small arteries and veins, which supply the mucous membrane; also lymphatic vessels, a few lymph follicles, and a small quantity of fat. The thickness of this layer is extremely variable.

The *muscular coat* consists of two layers. The inner is a fairly thick layer of circular fibres which at times constitute fully one-third of the entire thickness of the appendicular wall. This layer contains scarcely any connective-tissue cells, and very few blood-vessels; hence it stains deeply. The outer layer is composed of longitudinal fibres, not so thick as the inner layer, and in places nearly absent, being often collected into longitudinal bands, somewhat resembling the analogous arrangement in the cæcum. Between these longitudinal bands are found blood vessels and lymphatics. At certain places gaps may be seen in the muscular coat, allowing the submucous and subperitoneal tissues to come directly into contact with each other, and serving for the transmission of blood and lymph vessels from the meso-appendix to the submucous and mucous coats. Lockwood has called special attention to this *hiatus muscularis*, as he terms it, as the chief avenue of infection from the deranged epithelial lining of the appendix to the subperitoneal tissues and the peritoneum. These gaps, of course, occur only along the mesenteric attachment, and near the cæcal end may frequently be observed with the naked eye.

The *peritoneal coat of the appendix*, like similar membrane found elsewhere, is formed by a fibrous and a serous, or endothelial layer. The former is next the muscular coat, its delicate connective tissue penetrating among the longitudinal bands of the outer layer, and carrying in its meshes minute blood-vessels,

nerves and lymphatics. The endothelium forming the serous surface of the organ is composed of a single layer of large, thin, irregularly-polyhedral connective-tissue plates, between which are found at intervals the *stomata*, which directly or through minute canals lead into the underlying lymph vessels of the subserous tissues. Following the course of these lymph tracts, the approach of infection from the damaged epithelial lining of the appendix, through the hiatus musculares, and out at the stomata on to the free peritoneal surface, is readily understood.

The **vascular supply of the right iliac fossa** is derived from two loops formed by anastomosis of branches of the superior mesenteric artery. One loop is formed by the anastomosis of a descending branch of the colica dextra with an ascending branch of the ileo-colic artery, and the other loop by the junction of descending branches of the ileo-colic with terminal branches of the superior mesenteric artery. From the loop first described arise the ileo-cæcal arteries, known from their relation to the ileum as anterior and posterior. The anterior is the smaller, and, while supplying the anterior surfaces of the cæcum and lower ileum, rarely reaches as far as the appendix. It occasionally, however, sends minute twigs to the base of this organ. The posterior ileo-cæcal artery, on the other hand, is the chief source of the blood supply of the appendix. It passes down behind the ileum, close to the cæcum, sends branches to the back of the lower ascending colon, to the cæcum, to the end of the ileum, and to the appendix. The cæcal branch, mentioned above, coming from the posterior ileo-cæcal artery, runs across the lower inner part of the cæcum, near the origin of the appendix, and gives off one or more branches to the base of the appendix. During foetal life, before the appendix has developed a mesentery, this is the only blood supply, and hence in adult life the most constant; and where no mesentery to the appendix exists is even in adults the sole source of blood supply. But in the majority of individuals the main blood supply of the ap-



VASCULAR SUPPLY OF THE RIGHT ILIAC FOSSA.



pendix is derived from the posterior ileo-cæcal through its appendicular branches, which run between the layers of the meso-appendix. These branches are usually three in number, the largest running in the free edge of the mesenteriolum, and the two shorter branches supplying the body and base of the appendix. It is a well known fact that perforation is prone to occur at the point where the meso-appendix ceases, and that gangrene is especially liable to attack the free tip of the appendix, where it has no mesentery. These facts are sufficiently explained by a knowledge of the blood-supply as above described.

In the female in about one case in ten (Clado) there is an appendiculo-ovarian ligament, prolonged outward from the infundibulo-pelvic ligament to the meso-appendix. Durand identifies it with the superior fold of the mesovarium, or "plica vascularis" of Lockwood. This fold of peritoneum carries a small artery from the ovarian to anastomose with the mesenterio-vascular arteries, thus in some females giving a third source of blood supply to the appendix; as well as by the lymphatics it carries allowing ready transit of infection from the adnexa to the appendix, and *vice versa*. As already remarked, I have not myself met with this structure, either at operations or in the dissecting room; and its existence has been denied by excellent authorities. (See an article by Coe, in the N. Y. Med. Journ., 1904, ii, 254.)

The *veins of the appendix* are the most dependent of the branches of the portal, the sigmoid and hæmorrhoidal veins being excepted. This fact, together with the thinness of their walls and their disproportionately large lumens, explains their proneness to engorgement. These veins arise in the submucous and the subperitoneal tissues. The former pass out with the arteries and lymphatics through the muscular gaps into the meso-appendix, thence to a posterior cæcal vein, from this into the ileo-colic, and so into the portal system. The subperitoneal veins pursue mostly the same course, but a few empty directly into the cæcal veins.

The **lymphatics of the appendix**, arising as has been described in the basilar lymph sinuses in the mucous layer, pass out through the hiatus musculares into the meso-appendix, where some of them pass through the appendicular lymph gland, which is not always to be found. They then pass into a chain of lymph glands lying in the ileo-colic angle, along the inner border of the ascending colon. Some no doubt pass into the mesenteric lymph-glands, but the former is probably the more frequent route. These ileo-colic glands have been found enlarged in malignant disease of the cæcum, and have been excised with the neighbouring intestine. Moreover, some lymphatics from the appendix empty into the glands along the external iliac vessels, and others again are said to pass by way of Clado's ligament to the broad ligament, the pelvic connective tissue, and the internal iliac glands.

The **nerves of the appendix** are derived from the superior mesenteric plexus of the sympathetic nerve, the branches of the plexus which accompany the ileo-colic artery sending filaments to the appendix. One set of branches supplies the peritoneal and muscular coats, while another set pierces the muscular coats at the gaps, and supplies the blood vessels of the mucosa. The small intestine receives numerous twigs from this same plexus of the sympathetic, so that pain from the appendix may be referred over a wide area.

In addition to the knowledge of the intrinsic nerves of the appendix it is of much importance to consider the various nerves of the abdominal wall through which referred pain is felt. This referred pain is, of course, due to the overflow of the stimulation received by the cells in the spinal cord from the appendix. That segment of the spinal cord from which the nerves of the appendix are derived is the same as that whence the eleventh and twelfth dorsal, and the first and second lumbar nerves arise. Where the irritation to the cord from the appendix is severe, overflow may occur even into other segments of the cord; but, as

a rule, according to Sherren, referred pain occurs in the area of distribution of the eleventh dorsal nerve, less often in that of the tenth, and only rarely in that of the twelfth dorsal. Branches of the eleventh and twelfth dorsal nerves pierce the rectus muscle to supply the skin, one of these twigs being at McBurney's point, and thus explaining the very great frequency of pain and cutaneous hyperalgesia at this situation. The first lumbar nerve is distributed to the lower abdomen and upper part of the thigh, but also sends a twig to the tunica vaginalis testis, thus explaining the tenderness of the right testicle that may be met with in appendicitis. The reflex instead of being referred to sensory nerves of the skin may be referred to motor nerves supplying the muscles of the abdominal wall, the erector spinæ, the ileus, and the psoas muscles (viscero-muscular reflex of Mackenzie). As the flat muscles of the abdominal wall are not innervated by a single trunk, but by numerous twigs from different nerve trunks, where the viscero-muscular reflex from the appendix is referred only along one trunk, merely a portion of the muscle will contract; and this ribbon or band-like contraction when in the rectus muscle may readily be mistaken for an indurated and thickened appendix. When the reflex extends to the ileo-psoas muscle, flexion of the thigh is produced, and hip disease may be simulated; while vesical symptoms may be produced by spasms referred to the bladder or to its sphincter, retention or frequency of urination being the result according as the sphincter is or is not affected.

Peritoneal Fossæ.—Through the various angles and projections of the cæcum and the ileum, fossæ are formed by the reflections of the peritoneum associated with these parts of the intestinal tract; and because of their close relation with the appendix, these fossæ may play an important rôle clinically in inflammation of that organ. Lockwood and Rolleston have called special attention to these fossæ and have so carefully described them that I give their description: They are three in number: the ileo-colic, the ileo-cæcal, and the subcæcal.

The **ileo-colic fossa** (Plate IX) is a peritoneal pouch situated in front of the mesentery in the angle formed by the junction of the ileum and colon. The floor is formed by the mesentery and sometimes also by a portion of the ileum. The ileo-colic fold of peritoneum forms the upper boundary of the fossa, and sometimes a partial roof. This pouch is variable in size and depth, and on account of its elevated position, does not play a very important part in appendicitis.

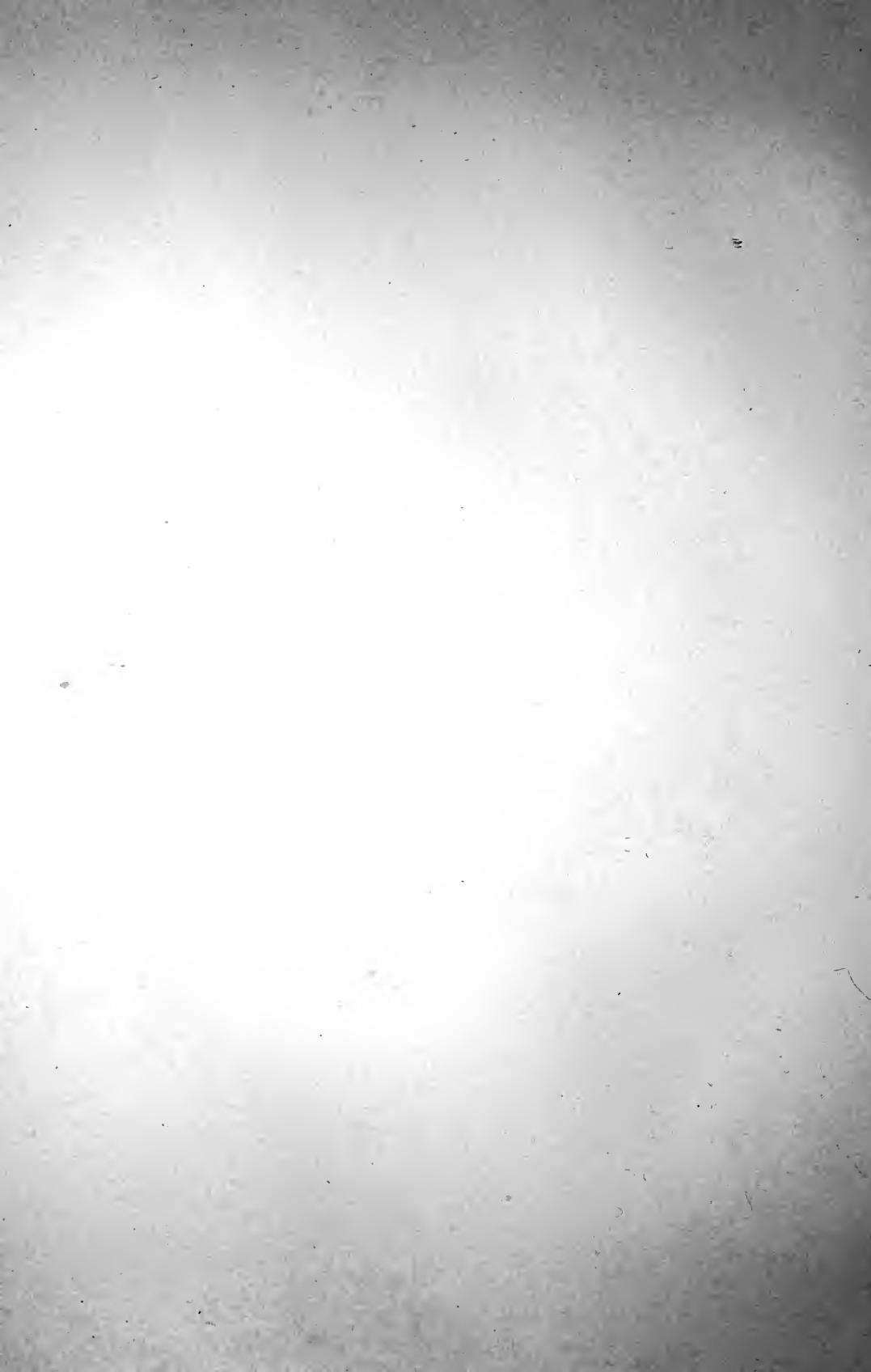
The *ileo-colic fold* is a ridge in the peritoneum of the anterior surface of the mesentery and is formed by a branch of the ileo-colic artery which runs through the ileo-colic fold and passes in front of the termination of the ileum.

The **ileo-cæcal fossa** (Plate X) is a peritoneal pouch situated behind the angle of junction of the ileum and cæcum. To expose it both the ileum and cæcum must be elevated. It is bounded on the right by the mesentery of the ascending colon, and on the left by the mesentery proper. The roof is formed by the *ileo-cæcal fold*, a bloodless fold of peritoneum which extends from the free border of the ileum to the cæcum and finally joins either the surface of the meso-appendix or the under surface of the mesentery near the attachment of the meso-appendix. This fossa may be very deep and long, and at times may extend upward behind the ascending colon as far as the kidney and duodenum. The mesentery of the appendix sometimes divides the fossa transversely, thus forming two fossæ, known as the superior and inferior ileo-cæcal fossæ. The ileo-cæcal fossa is important, as the appendix is usually found in relation with it, thus explaining why this location is often the site of certain products of appendicular disease. Consideration of the description of the meso-appendix and meso-cæcum induces the author to bound this fossa as follows: on the right by the cæcum, meso-cæcum, and meso-appendix; on the left, by the mesentery; and above, by the ileo-cæcal fold and the ileum.

The **subcæcal fossa** (Plate XI), as its name implies, is im-



THE ILEO-COLIC FOSSA.





THE ILEO-CÆCAL FOSSA.

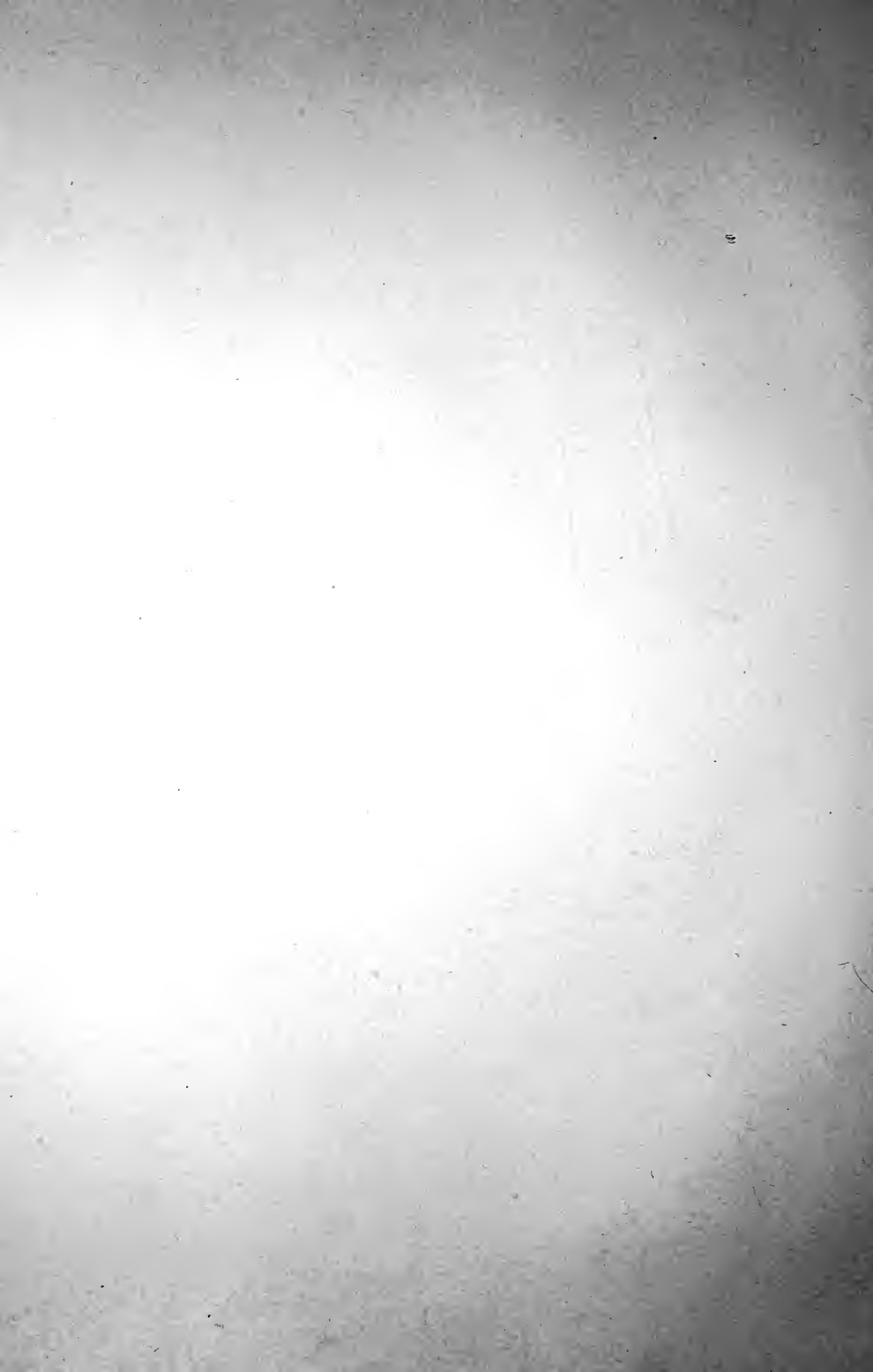
mediately under the cæcum, and this portion of the bowel must be raised in order to view it. It is less constantly present than the other fossæ. Its mouth is found behind the junction of the cæcum with the colon and the fossa here separates the meso-colon into two double folds. On account of its elevated and external position, clinically it does not play a prominent part. If, however, a meso-cæcum were always present, this fossa would be a very important one, as the mouth of the fossa would then be flush with the tip of the cæcum, at the base of the appendix. Lockwood and Rolleston have described this condition as occurring, but I have never seen such a case. I prefer to describe the subcæcal fossa as a depression in the peritoneum situated beneath the cæcum, and below and external to the meso-cæcum and meso-appendix. Berry classifies these fossæ as peri-cæcal and retro-colic. Under the former term he describes the ileo-colic and the ileo-cæcal, while as retro-colic he gives an external and an internal retro-colic fossa, the latter being the more constant of the two, and apparently corresponding to that above described as the inferior ileo-cæcal fossa. It is situated, according to his description, between the inner layer of the ascending meso-colon and the posterior attachment of the mesentery, or the mesenterico-parietal fold. He bounds it thus: (1) In front: The posterior wall of the ascending colon and sometimes the cæcum. (2) Behind: The posterior abdominal wall. (3) Internally: The mesenterico-parietal fold. (4) Externally: The internal parietocolic fold (that is, the inner layer of the ascending meso-colon). His external retro-colic fossa seems to correspond to that described here as the subcæcal.

The appendix may occupy any of these fossæ but it is commonly found in the ileo-cæcal or the subcæcal fossa. On account of the various complications that may arise if the appendix occupies any of these fossæ, the operator may be led to form an incorrect conception of the true state of affairs. Thus, at times the appendix may constitute a retro-peritoneal hernia; or, if the

Appendicitis.

appendix occupy one of these fossæ, and the mouth of the fossa should close over it, the organ might be thought to be absent. Suppuration of an appendix so walled in would be entirely circumscribed.





FUNCTION OF THE CÆCUM AND APPENDIX.

It has been the fashion of late years among surgeons to deny that the appendix has any function, that it is of any use to the human being. The mediæval anatomists and surgeons were unable to claim any very definite functions for it, but, as will be seen from the chapter on the History of Appendicitis, there were none of them so bold as to absolutely deny its use. Only when the great operative furore of the past twenty years commenced and it was thoroughly realized what a pernicious organ the appendix might at any moment become, did the idea gain currency that it was an organ of the utmost uselessness—a mere vestigial structure. The more conservative surgeons, however, while unable to demonstrate by physiological experiment what the function of the appendix was, were nevertheless firm in the belief that it would not have been put where it was unless it subserved some useful purpose—unless, like Lucifer, it laboured “for some good, by us not understood.” It was considered by them most probable that the appendix poured forth into the cæcum at suitable intervals, a sufficient quantity of mucoid secretion to lubricate the fæces, which they thought were prone to collect, stagnate, and to become inspissated in this portion of the intestinal tract. It has been known for a number of years that the fæces in the small intestine down to the ileo-cæcal valve were normally quite fluid, and it was thought that, as soon as this valve was passed, the consistency of the fæcal matters increased, chiefly by absorption of their watery constituents, and that the cæcum was the chosen place for fæcal impaction. As I have pointed out elsewhere, the fæces do not tend to become

impacted in the cæcum, but rather in the descending colon and sigmoid flexure; and the fæcal mass habitually found in the cæcum at operation or necropsy is semifluid.

The observations in comparative anatomy, recorded by Berry, have been referred to in the previous chapter; and it was there seen that his conclusions, in no way unreasonable in their deduction, were to the effect that the appendix of man represents by no means a vestigial structure, but is on the other hand a highly developed part of the intestinal tract, and, as such, is entitled to be classed as a gland. Comparative anatomy shows us further that in herbivora the cæcum is immensely developed, and among solipedes (horses, mules, etc.) is the chief organ of digestion; whereas in carnivora, the cæcum is very much smaller or is entirely absent, and the chief digestion takes place in the stomach. Moreover, as Macewen points out, man, who is practically an omnivorous animal, has, as would be inferred by analogy, both a stomach and a cæcum, each of which may be supposed to contribute its share to the process of digestion.

We are beginning to have less regard for the stomach as an organ of digestion than was formerly the case, and some physiologists would have us believe that the small intestine alone is necessary for the accomplishment of perfect digestion; but these observations of Sir William Macewen's to which I have just now referred, tend to set in their true light the relative importance of intestinal, cæcal and colonic digestion. Macewen has made the most painstaking investigations on the occasional clinical material which has come in his way, and to summarize our knowledge of the functions of the cæcum and appendix, I feel that I cannot do better than abstract his article in all its essential details.

Macewen acknowledges, frankly enough, that such fragmentary and incomplete investigations, as these necessarily have been, are not comparable to direct experiment practised on the lower animals, and warns us that they have the additional dis-

advantage of being viewed through pathological surroundings; yet he claims that "they possess some compensating value from having been made upon man himself." He goes on to show the effects produced upon the patient by fæcal fistulas situated in various parts of the alimentary tract, stating the well-known axiom that the nearer the stomach such a fistula is placed, the more serious is the result. "For our present purpose," he continues, "it is sufficient to look to the effects of the escape of chyme from such openings as may occur toward the distal end of the small intestine, the cæcum and the colon. When openings have formed toward the distal extremity of the ileum of sufficient magnitude to allow the chyme and intestinal secretions to escape freely, the patient suffers from inanition. A somewhat similar result is seen when the artificial opening has occurred in the cæcum of sufficient size and patency to allow of the free escape of the contents. The strength of the patient becomes less and is difficult to maintain, especially when ordinary food is administered.

"In marked contrast to this is the condition of the patient affected with an artificial opening in the descending colon near the sigmoid flexure. He does not lose weight; on the contrary this is often increased, his health and strength are maintained, and he is capable of carrying out his usual avocation with vigour. These facts go to prove that the entire nutriment obtainable from food is not removed during its passage through the small intestine, otherwise there would be no perceptible loss when the chyme is removed at the end of it; whereas it is only when the chyme is allowed to pass along the whole length of the large intestine as far as the sigmoid flexure that the patient derives the full good of the ingested matter. It is further seen that if a large opening be made in the cæcum, not only permitting the contents to escape freely but also interfering seriously with its secreting surface, troublesome diarrhœa is apt to occur, accompanied by a watery secretion from the mucous membrane. This

diarrhœa which is likely to ensue constitutes one of the difficulties in dealing with such cases and arises not only from the interference with the cœcal function but also probably with the influence controlling the ileo-cœcal valve. If the cœcum be entirely removed the patient recovers and maintains fair health so long as special diet be taken, but he is subject to attacks of diarrhœa alternating with constipation on the ingestion of ordinary food. In six cases of this kind operated by me, two had only a tendency to diarrhœa alternating with constipation, and they complained of frequent indigestion, while four others complained of diarrhœa as being of frequent occurrence. Though for months after the operation, which relieved them of their previous pathological condition, these patients improved greatly in strength and weight, yet ultimately they appeared thin and impoverished, the diarrhœa being still apt to occur. In one patient whose cœcum, ileo-colic valve and a large portion of the ascending colon had to be removed the ultimate diarrhœa was an annoying and a marked symptom, commencing, as the patient stated "on the slightest excuse" and continuing for an indefinite period thereafter—often for weeks. This patient likewise became weak and lost flesh and though living for many years after the operation never regained normal weight. (It has been reported that ligation of the cœca in chickens produces diarrhœa with loss of flesh which ultimately causes death from inanition.) These cases illustrate the fact that the arrest of the function of the cœcum results in disturbed digestion manifested in diarrhœa and in lowering of the strength, though these results may be modified by special diet."

Macewen had the opportunity of observing the cœcum through defects in the abdominal wall, and noted that even when physiologically at rest it undergoes certain alterations in form, being sometimes broader, and sometimes elongated, while at times there is a churning movement. These movements he found by constant observation were not in reality erratic, as they

at first sight seemed to be, but were apparently excited by the taking of food and by its passage through the small intestine.

“In some patients immediately upon taking food into the stomach there was a cæcal movement commencing from below upwards as if expulsive. In one instance this seemed to correspond to a peristaltic action of the small intestine, but in others such movement in the small intestine could not be discovered and in them it followed the ingestion of food too quickly to permit of the peristalsis acting through the whole length of the small intestine. It was therefore regarded as probably due to reflex action. Once this movement was excited in the cæcum it traversed the colon and in one instance at least, it reached as far as the sigmoid flexure. Some of these cæcal movements originate in the appendix the undulating movement running upward from the appendix and causing the contraction of the cæcum. There were other movements in the cæcum the point of origin of which was not ascertained.”

Not only were such peristaltic movements noticed, but “observations on the interior of the cæcum seen through the defects in its walls showed that there were differences in the amount and fluidity of the secretion exuding from its mucous surface. When irritated mechanically the flow of exudate was greater and more fluid. At a variable interval after a meal—one or two hours—peristaltic effects in the colon ensued resulting in the extrusion of its contents, and shortly after a clear thick fluid was poured from the secreting cæcal surface and in several instances was seen to exude in considerable quantity from the appendicular orifice. As far as could be ascertained there was no cause for this flow other than a reflex action, possibly stimulated by the presence of food and the exudation from the upper part of the small intestine.

“In a case where the anterior wall of the cæcum had been removed (by an explosion), the ileo-cæcal valve and the appendicular orifice being exposed, after recovery from the shock several observations were made. First it was seen that there was a

considerable flow of glairy mucus from the appendix and cæcal surface which did not constantly exude or at least did so to a greater extent shortly after food was introduced into the stomach and to a marked extent just before food began to pass through the ileo-cæcal valve. On one occasion quite a stream of fluid poured from the appendix just before the chyme began to pass through the ileo-cæcal valve. When chyme passed through this valve it did so in small quantities at a time and there were occasional pauses in which the ileo-cæcal valve seemed to close—probably by a reflex action. This fluid from the cæcum and the appendix was invariably alkaline. This patient, who was very observant, took quite a philosophic interest in his condition and was rather proud that his misfortune could be made of service. It was seen that his will power had no effect upon either the secretion or on the control of the ileo-cæcal valve; but one day when he was much disturbed by the reception of ‘bad news’ which could not be kept from him, and after which he said he had indigestion or was ‘bilious,’ the secretion in the cæcum was at first very watery and then the surface became drier than at any previous time and apparently the contents of the small intestine were more quickly evacuated and overflowing gave rise to smarting and irritation on the sides of the wound. The chyme was acid, the cæcal secretion being scanty was not sufficient to neutralize it. Usually the flow from the ileo-cæcal valve was slow the material passing into the cæcum in small quantities which slide over the orifice of the appendix and get smeared by the exudation therefrom, as well as mixed with the exudation from the general cæcal cavity.

“It seems as though there were a control over the ileo-cæcal valve regulating the amount of material which passes from the small intestine into the cæcum. If the valve by any means be rendered patent the contents of the small intestine flow quickly into the cæcum and a troublesome escape of semidigested material ensues—material which has missed the cæcal digestion. One

of the troubles of operation in this region consists in the arrest of the control of the ileo-cæcal valve and the flow of the fluid contents from the small intestine into the cæcum at a rate greater than the cæcum and appendix can deal with. Is this regulation of the flow into the cæcum due to reflex action induced by the impression on the nerves of the mucous membrane of the cæcum and appendix brought about by the quantity and quality of the contents of the small intestine which are received into the cæcum? Such is a probable solution. Attempts were made to stimulate artificially the exudation from the cæcum and appendix. The passage of the finger lightly over the cæcal surface from the ileo-cæcal valve downwards towards the base of the cæcum did not succeed in increasing the exudation. A camel's-hair brush moistened in the chyme issuing from the ileo-cæcal valve and drawn several times downwards over the mouth of the appendix was followed on several occasions by an increased exudation, while oftener it had no such result. The fold of mucous membrane about the orifice of the appendix has been seen to close and to cover the orifice and in the same patient has been seen to recede and to expose the opening. Artificial means were not successful in bringing the folds of mucous membrane over the aperture by inducing reflex action."

Macewen then goes on to discuss the innervation of the appendix and cæcum, and comes to the conclusion that the nervous apparatus of the appendix may easily "initiate the larger movements of the cæcum by first inducing movements in the appendix" and that "inhibition of these movements may cause cæcal disturbance. The same agency by control of the vascular supply will regulate the exudation from the appendix and that in accordance with the impulse received from the small intestine." He then proceeds to show that mental states have some sort of an effect on the appendix, just as they have through the vagi on the small intestine, sometimes exciting peristalsis and sometimes delaying it. He refers again to the instance al-

ready quoted of the result of mental disturbance on the cæcal secretions; and cites two examples of mental action affecting the secretion of the salivary glands. We all know that the mouth may water at the sight or smell of certain articles of diet, and that it may become dried when the mind recollects the sensation of eating persimmons or other astringent fruits; but Macewen had the opportunity of observing two patients in whom the duct of a salivary gland had formed a communication with the skin on the cheek, while the natural opening into the mouth had closed. In these patients it was possible to produce an astonishingly free flow of saliva by the mere suggestion of foods, especially of acid fruits, "while one patient had to beg of his friends not to introduce food topics into their conversation in order that he might be relieved from mopping up the flow. While his mind was fully occupied, as when he felt cornered in chess, there was cessation of the salivary flow."

The close resemblance of the histological structure of the appendix to that of the cæcum has been referred to in the chapter on the Anatomy of the Appendix, and from these characteristics common to both organs Macewen draws a further inference as to their function. He refers especially to the glands of Lieberkühn, which are "far more numerous and better developed in the upper part of the colon, the cæcum and the appendix, than in the small intestine," and expresses the opinion that the succus entericus elaborated by them is a most powerful adjuvant to the completion of digestion, and that as a consequence "the secretion of the appendix viewed alone in this sense would be a valuable aid to digestion."

The action of the micro-organisms normally present in the appendix and cæcum is another factor, Macewen thinks, "in the final disintegration of pabulum poured into the cæcum." He thinks it possible that "the cells and nuclein of the solitary follicles in the appendix have a controlling action on the organisms," and that "one of the functions of the appendix may be to

maintain cultures of these organisms in a fit state to perform their function on the pabulum poured into the cæcum. On the inhibition of this function the germs may be capable of damaging the coats of the cæcum and appendix which have been thereby lowered in vitality. When a purgative action has produced its effects and cleared out most of the germs from the cæcum and colon, those in the appendix will still maintain a fresh culture for renewed action.”* Thus from a study of the physiology of the cæcum and appendix we are led by imperceptible steps to a better conception of their pathology. On this subject Macewen speaks as follows: “The bacillus coli communis, which is the surgeon’s terror, serves in its proper place a beneficent purpose in effecting the disintegration of some of the undigested matter, but when uncontrolled by the healthy organs and their exudations is apt to cause ravages in the tissues and to produce toxines which are lethal. If from inhibition of the appendicular and cæcal movements or the want of exudation of the succus entericus, or if the cæcum receives material which the succus entericus cannot digest a stasis occurs in the contents of the cæcum and the constipation which is so often a feature of the appendicitis ensues. At a later stage fermentative disintegration of the fæcal contents with absorption of toxines and damage to the wall of the parts are apt to ensue. These are followed by diarrhœa which is sometimes curative.”

“Doubtless the appendix and cæcum are affected together but just as pyogenic organisms affecting the throat spread by continuity of structure to the middle ear and mastoid cells and produce serious damage there long after the throat has healed, so the appendicular inflammation once started may continue to produce serious effects within the appendix after the cæcum has recovered from the primary effect.”

Finally, I may quote in closing the following words of this

*It is interesting to compare with this theory the views of Santorini, referred to at page 7.

eloquent address, which well express my own convictions on this subject:

“For many years I have believed that the cæcum and appendix are of value in digestion. The facts pointing in that direction have accumulated slowly and are not all garnered. Many require still to be investigated.”

CLINICAL ÆTIOLOGY.

The ætiology of appendicitis may be appropriately divided into the clinical ætiology and the pathogenesis; the latter will be discussed in the chapter on the pathology of the affection. From the clinical point of view, the ætiological factors are either predisposing or exciting, or both.

Of the *predisposing causes*, the most important are age, sex, nationality, season, previous attacks of appendicitis, and certain other diseases. Of the *exciting causes*, the most important are exposure, disturbance of digestion, traumatism, and certain other diseases. Under different circumstances, some of the latter may act as both predisposing and exciting factors.

Age is a predisposing cause of moderate importance. Although appendicitis is most common in individuals between ten and thirty years of age, about 15 per cent. of all cases occur in persons under fifteen years. The youngest patient in whom I have encountered the disease was less than one year old; the oldest, over seventy years. A case of gangrenous appendicitis found at autopsy on a seven weeks' old infant, is reported by Blumer and Shaw. Manley mentions as the youngest patient operated on a baby aged sixty-one days.* The marked susceptibility of young adults to appendicitis is dependent, in the first place, upon the numerous disturbances of the gastrointestinal tract, due to dietary indiscretions, that occur during this period of life; and, secondly, to the proneness to inflammation of the adenoid tissues throughout the body during adolescence. Analogy is found in the predominance of lesions of the tonsils and of the cervical and mesenteric lymph glands

* Jackson, Am. Jour. Med. Sc., 1904, cxxvii, 710, has recorded a case of supposed *prenatal* appendicitis.

during the period of development. Reason for the relative exemption from inflammation of the appendix during advanced life is found, not only in a more judicious mode of life, but also in the atrophy of the adenoid tissues of the appendix. This in the majority of cases, commences at about the thirtieth year. It may, however, begin earlier or may be postponed until a later period.

Sex is a predisposing cause of considerable importance. Appendicitis was formerly thought to be very much more common in males, but recent observations tend to show that this is not the case. In a paper by Dr. Floyd W. McRae the following statistics are quoted: Einhorn, in 18,000 successive autopsies, found perforating appendicitis in 55 per cent. of males and in 57 per cent. of females; Robinson in 128 autopsies found evidences of past peritonitis on and about the appendix in 68 per cent. of female, and in 56 per cent. of male bodies. Bland-Sutton, however, is quoted as stating that appendicitis is three times as frequent in males as in females. In previous editions of this work it was stated that about 80 per cent. of all cases of appendicitis occur in males—that is to say, that it is four times as frequent in males as in females. This ratio is probably too high,* but we cannot accept autopsy reports as final in the records of any disease, since there are undoubtedly some cases that do not come to autopsy even if the patients die. Dr. O. Hermes is quoted in the above paper as stating that in 671 cases gathered from various sources 27 per cent. were in women; that Sonnenberg found that 40 per cent. of his cases were in women; and that of Talamon's cases 35 per cent. were in females. Hermes calculated, moreover, that of 1577 cases of appendicitis occurring in Berlin 40 per cent. were in females. McRae calls attention to the liability of abdominal pains in

* In the last three thousand cases of appendicitis in adults operated on by myself there were 61.87 per cent. males, 38.13 per cent. females. In the last two hundred children operated on 178 were males and 22 females, being 89 per cent. boys and 11 per cent. girls.

THREE THOUSAND OPERATIONS FOR APPENDICITIS.

| I. | SEX. | ACUTE. | CHRONIC. | TOTAL. |
|-----------------------|------|--------|----------|--------|
| Males, | | 1146 | 710 | 1856 |
| Females, | | 559 | 585 | 1144 |
| Total, | | 1705 | 1295 | 3000 |
| Per cent. Males | | 67.21 | 54.89 | 61.87 |
| " Females, | | 32.79 | 45.10 | 38.13 |

| II. | AGE. | ACUTE. | CHRONIC. | TOTAL. | PER CENT. |
|----------------------------|------|--------|----------|--------|-----------|
| Ten to twenty | | 561 | 270 | 831 | 27.70 |
| Twenty-one to thirty..... | | 646 | 599 | 1245 | 41.50 |
| Thirty-one to forty..... | | 314 | 290 | 604 | 20.13 |
| Forty-one to fifty | | 112 | 99 | 211 | 7.03 |
| Fifty-one to sixty..... | | 59 | 27 | 86 | 2.88 |
| Sixty-one to seventy..... | | 10 | 9 | 19 | 0.63 |
| Seventy-one to eighty..... | | 3 | 1 | 4 | 0.13 |
| Total, | | 1705 | 1295 | 3000 | 100.00 |

| III. | MONTHS. | ACUTE. | CHRONIC. | TOTAL. | PER CENT. |
|------------------|---------|--------|----------|--------|-----------|
| January, | | 137 | 118 | 255 | 8.50 |
| February, | | 110 | 96 | 206 | 6.86 |
| March, | | 146 | 134 | 280 | 9.34 |
| April, | | 118 | 129 | 247 | 8.24 |
| May, | | 142 | 104 | 246 | 8.20 |
| June, | | 155 | 110 | 265 | 8.84 |
| July, | | 159 | 90 | 249 | 8.30 |
| August, | | 171 | 98 | 269 | 8.94 |
| September, | | 157 | 120 | 277 | 9.24 |
| October, | | 168 | 120 | 288 | 9.60 |
| November, | | 132 | 113 | 245 | 8.17 |
| December, | | 110 | 63 | 173 | 5.77 |
| Total, | | 1705 | 1295 | 3000 | 100.00 |

| IV. | SEASON. | ACUTE. | CHRONIC. | TOTAL. | PER CENT. |
|---|---------|--------|----------|--------|-----------|
| Spring (March, April, May), | | 406 | 367 | 773 | 25.76 |
| Summer (June, July, August), | | 485 | 298 | 783 | 26.14 |
| Autumn (September, October, November)... | | 457 | 353 | 810 | 27.00 |
| Winter (December, January, February), | | 357 | 277 | 634 | 21.14 |
| Total, | | 1705 | 1295 | 3000 | 100.00 |

women being referred to the sexual organs under the vague caption of "inflammation of the tube or ovary," and he asserts that in almost all his cases the attack of appendicitis occurred at or near the menstrual period. In 15 operations for appendicitis in females, which he reports, he observed 4 cases, over 25 per cent., in which there was also distinct disease of the right tube and ovary.

The greater attention which has recently been paid to the anatomy of the right iliac region has, moreover, convinced some surgeons that extension of inflammation from the appendix to the adnexa or from the tube and ovary to the appendix, by way of Clado's ligament and its contained structures, is considerably more frequent than was formerly supposed. Coe thinks that appendicitis in females is coincident with, or a consequence of, adnexal disease in 30 per cent. of such cases.

In view, therefore, of all these facts, it will be well perhaps to modify the statements formerly made as to the relative immunity of the female sex, and, while not, on the other hand, admitting as some would claim, that the disease in question is actually more frequent in women, to say that appendicitis occurs nearly as often in females as in males; but that it is apt to be overlooked in the former, being attributed frequently to some menstrual disturbances, or even at operation being thought secondary to tubo-ovarian infection.

Heredity.—Forcheimer has called attention to the influence of heredity in appendicitis. He reports three series of observations—in the first, of 25 members of a family, 5 had appendicitis; in the second, 17 per cent. of a whole family of 52 members and 3 generations had appendicitis; and in the third, 7 cases occurred in a family of 22 members.

It seems more likely that such instances are an example of exposure to a common cause, rather than that there is any distinctive physical or physiological condition which renders members of the same family prone to acquire this disease.

Nationality is not so important an ætiological factor as it was presumed to be some time ago. It seems, however, to be of some importance; or perhaps what we consider nationality in this connection is mere environment. For a time it seemed that appendicitis was disproportionately common in the United States, the number of cases recorded in this country far exceeding those reported in Great Britain and Continental Europe. Recently, however, in France, Germany and Austria, and to a less extent in Great Britain, the early stages of the affection have received deserved attention, and the disease is now recognized as of common occurrence. It seems, nevertheless, to be especially common in this country, and this is probably due to well-known and widespread dietetic indiscretions, particularly hurried eating and insufficient mastication. Whether those of foreign birth residing in this country who practise temperate habits of eating are less predisposed to the disease than those actively participating in all the phases of hurried American life is not definitely determined.

Season exerts little influence as an ætiological factor. Appendicitis is probably more common in summer and autumn than it is in winter and spring. The differences, however, are slight, and those that do exist are probably due to the greater frequency of intestinal disorders in summer and autumn than in winter and spring.

Of other diseases that predispose to appendicitis may be mentioned constipation, gastro-enteritis, dysentery, typhoid fever, influenza, rheumatism, saturnism, etc.

Constipation does not play a very important rôle in the causation of appendicitis. Observations of large numbers of cases indicate that the majority of the patients have had a normal condition of the bowel movements prior to the attack of appendicitis. In some cases of long-continued and marked constipation, however, it is possible that the increase in the virulence of the bacterium coli commune that has been encountered in that condition may be remotely connected with the development of

the affection. Constipation is more often a predisposing cause in females than in males.

Gastro-enteritis with diarrhœic attacks is probably of more importance than constipation in the ætiology of appendicitis. Indeed, in many cases attacks of indigestion seem to be the direct exciting cause of the disease. The subacute or more chronic gastro-enteritis is probably of significance in that the appendix is prone to participate in morbid conditions that implicate the general intestinal tract. Catarrh of the intestinal mucous membrane may, and probably often does, spread to the lining of the appendix; but such is the mildness of the pathological alterations that they do not engender any clinical manifestations. At times, however, they may progress, either of their own accord or following the advent of some exciting cause, and an acute attack of appendicitis may supervene. Under other circumstances catarrhal changes of mild degree persist, and lead to chronic catarrhal or interstitial appendicitis, with or without clinical symptoms. At all events, in many cases of chronic appendicitis careful inquiry into the past history of the patient will elicit symptoms of chronic intestinal catarrh, which either may have inaugurated, or may have been inaugurated by, the appendicitis, and which does not subside until after excision of the offending organ.

Dysentery is also of ætiological significance, because of the predisposition of the appendix to participate in lesions of the intestinal tract. These lesions, of course, consist mainly of ulceration, and it is the consequent cicatrices that are of such extreme significance in the subsequent development of appendicitis. The significance of these cicatrices will be dealt with in the section on the pathogenesis.

Typhoid fever is one of the remote causes of appendicitis, and, at times, also one of the direct causes of the affection. It has been proved conclusively that lesions of the appendix are of common occurrence in typhoid fever. For the most part these consist of catarrhal alterations, and of swelling, congestion, and

œdema of the adenoid follicles of the organ. Not uncommonly, however, ulceration occurs, and runs a course precisely similar to analogous conditions in other portions of the intestinal tract; that is, the ulceration may go on to perforation; or regeneration, organization, and cicatrization may follow the ulcerative process. As a consequence of the resultant cicatrix, more or less occlusion of the lumen of the organ may supervene, and, as will appear later, this is one of the most important factors in the subsequent development of appendicitis. In certain cases of chronic appendicitis a history of previous intestinal disorder can readily be elicited. This may consist of intestinal indigestion, vague pains in the abdomen, etc., the origin of which can often be traced to an attack of typhoid fever that may have occurred months or years previously.

This is illustrated by the following case:

Miss I. M. W. was first troubled with a mucous discharge from the bowel in the summer of 1889. At this time she had an illness which was attended by frequent watery and sometimes bloody stools, and which was called typhoid fever. She was confined to bed for three weeks and made a tedious recovery. Since that time she has been the subject of attacks of catarrhal enteritis, which come on at intervals, the longest interval being four months. These attacks, which seem to be induced by exposure to cold, unusual exertion, sea-sickness, etc., were less frequent in the autumn and early winter, after change of air and rest during the summer, than at any other season. During the interval she was well. In June, 1893, she had an attack that lasted three weeks. When seen for the first time, vague pains were present in the right iliac fossa and a distinctly enlarged and tender appendix could be palpated. At operation there were no peritoneal adhesions, but the appendix was indurated and contained pus. The mucosa and submucosa were thickened and presented evidences of chronic catarrhal inflammation. Recovery was prompt and uneventful, and was followed by the entire disappearance of the symptoms previously complained of.

Influenza seems to exert a predisposing influence in the production of appendicitis, probably because of the intestinal lesions to which it gives rise. These changes may extend to the mucous

membrane and lymphoid structures of the appendix; or such may be the swelling of the appendicular orifice produced, that drainage is effectually prevented and appendicitis results; or the influenza bacillus, gaining access to the appendix, may directly excite inflammation of this organ. Adrian found influenza bacilli in a peri-appendicular abscess. The prevalence of this disease as a pandemic may account, in part, for the great number of cases of appendicitis in recent years. Observations tending to confirm this statement have recently been recorded by Marvel, who showed that influenza and appendicitis have of late years increased almost *pari passu*. He quotes a number of authors, including Finney and Hamburger, Winternitz, Adrian, Perer, Lucas-Championnière, Schultes, and Sonnenburg, all of whom considered influenza an efficient cause of certain cases of appendicitis.

Tonsillitis.—Kelynack is said to be the first author to report a case of fatal appendicitis following tonsillitis. Apolant, in a patient who recovered from an attack of appendicitis, thought he observed a causal relation between a preceding tonsillitis and the attack of appendicitis. Kretz records two cases of appendicitis, in the first of which, in a young woman, he obtained streptococci from both the appendix and the tonsils; and in the second case, in a young man, he recovered streptococci from the appendix, and influenza bacilli as well as streptococci from the tonsils. Weber has reported three cases of appendicitis following angina; and, in reviewing the literature, refers to similar cases recorded by Brazil, Routier, Simonin, Schnitzler, and Rudolph, as well as by the other authors mentioned above. Mayer has recently recorded a case of gangrenous pharyngitis followed by appendicitis.

Some two years since the following case came under my observation:

A girl, aged seven years, had been taken sick ten days previously with sore throat, difficulty in swallowing, high fever and so forth. The attending

physician the day following the onset found patches upon the throat which, when examined bacteriologically, showed the diphtheria bacillus. The patient recovered under the administration of antitoxine, when at the end of a week she was seized with acute abdominal pain followed by abscess formation in the appendiceal region. Three days later I saw the girl in consultation and advised simple evacuation of the collection, which presented well toward the crest of the ilium. This was done under ether anæsthesia, from which the patient reacted very satisfactorily. At the end of the second day the patient died suddenly, death being attributed to diphtheritic paralysis of the heart.

Rheumatism has been assumed by some to be a causative factor in the production of appendicitis and several cases of rheumatic appendicitis have been reported. As the evidence at hand seems to indicate that rheumatism is either an infection or an intoxication, it is not unlikely that the organism provocative of the articular alterations may inaugurate disease of the appendix. The probability of this is further enhanced because of the predilection of the rheumatic infective agent for certain adenoid tissues, such as those of the tonsils, and by analogy also the tissues of the appendix. Personally, however, I have never encountered a case in which rheumatism and appendicitis were associated.

Goodhart mentions a frequent stomach-ache as a "feature of the rheumatic child." Sutherland notes the association between appendicitis and rheumatic symptoms in two cases of boys of eight and nine years, respectively. Sir James Grant reports a case of appendicitis following persistent pains in the feet and followed by acute rheumatic fever. Haig reports cases of rheumatic typhlitis, which he apparently considers the same as retrocedent gout. He found that salicylates had a marvelous effect in allaying the pain. Yeo and Brazil each report a similar case, of appendicitis associated with rheumatism. Sutherland considers the association of the two diseases commoner in children than adults. Besides the cases referred to above, he here adds 6 more, in children from six to twelve years, who had attacks of

appendicitis accompanied by acute rheumatic fever, endocarditis, or tonsillitis. Other cases of like nature are those reported by Poynton, and by Finney and Hamburger. The latter authors refer also to a case reported by Pribram. Adrian, Goluboff, and Gagnières have contributed further articles to the literature of appendicitis considered as a local manifestation of a general disease.

Various Infectious Diseases.—Jalaguier saw appendicitis follow measles, chicken-pox, scarlet fever, and mumps, as well as typhoid fever and acute articular rheumatism. Tripier and Paviot observed perforative appendicitis following, and in their opinion caused by, an infected bullet wound of the forearm.

Purpura hæmorrhagica has been held responsible for the onset of symptoms of appendicitis, in a case recorded by N. Jacobson. He cites other cases of purpura hæmorrhagica with intestinal hæmorrhage. Box and Wallace observed a case mistaken for typhoid fever, because of the intestinal hæmorrhage, but found at autopsy to be one of suppurative appendicitis, with no lesions in other parts of the intestinal tract. There was no evidence here of purpura.

Lead-poisoning has also been assumed to be an agent of some significance in the causation of appendicitis, and some cases of the concurrent existence of the two affections have been reported. It is presumed that the lead so affects the appendix as to favour infection, or that, of itself, it acts as the irritant to excite inflammation of the organ.

The most important predisposing cause of appendicitis is the fact that the appendix has already been the seat of **one or more attacks of the same affection**. The reasons for this will be discussed more in detail in the section on the pathogenesis. Clinically, the fact is well established that those who have had one attack of appendicitis are most likely to suffer from others. Among my own cases, a history of a previous attack could be obtained in nearly 85 per cent.

Of the **exciting causes of appendicitis**, from the clinical point of view, **disturbances of digestion** are the most important. Such is the pre-eminence of these in the ætiology of appendicitis, and with such constancy have they been observed, that it is unhesitatingly asserted that appropriate inquiry will elicit a history of such disturbances in almost all cases. The alterations induced by or causing the acute indigestion may spread to the appendix, and, causing swelling of the mucous membrane, may prevent drainage and lead to appendicitis. On the other hand, it is most likely that the diarrhœa which accompanies such attacks results in the conveyance to the appendix, from the upper portion of the intestinal tract, of bacteria that are more virulent than those normally situated in the region of the appendix. And, again, in such attacks of diarrhœa the bacteria throughout the intestinal tract increase in virulence. Bacteria of great virulence are, of course, able to engender morbid processes in the appendix more readily than are less malignant bacteria.

That **exposure to inclement weather** and to other deleterious influences acts as an exciting cause of appendicitis cannot be doubted. The connection between the exposure and the developement of the appendicitis is most clear and direct, and must be accepted as clinically important.

The same is also true of **traumatism** in a limited number of cases. Appendicitis has been known to follow traumatism in the region of the appendix with such frequency that its ætiological significance cannot be ignored. Yet it is quite possible that in those cases in which it is found operative, it meets with an appendix predisposed to, if not already the seat of, inflammation. This question may assume importance from a medico-legal point of view. Byron Robinson has endeavoured to show that appendicitis is in the majority of instances caused by traumatism by the underlying ilio-psoas muscle; but external injury is a more important cause. Traver reported a case of traumatic appendicitis, and refers to other cases recorded by Fowler, Mc-

Nutt, Curtis, Mynter, and Hawkins; Jüngst has recently added another to this list, and Turner mentions several cases. Turner is apparently of the opinion that trauma is much more often a predisposing than an exciting cause, or that, in other words, the appendix is previously diseased, but would not perhaps have given rise to acute symptoms at that time unless it had been injured. I have not myself observed a case in which trauma could be considered the cause of appendicitis.

Of other diseases that act as exciting causes of appendicitis may be mentioned typhoid fever, dysentery, tuberculosis, actinomycosis, etc. The ordinary lesions of the appendix in **typhoid fever** have already received attention. The ulceration may progress, and may lead, with or without perforation, to appendicular peritonitis, and, as a consequence, to the ordinary manifestations of appendicitis with peritonitis. Such are the diagnostic difficulties presented by some of these cases that the question of the presence of typhoid fever or appendicitis, or of one as a complication of the other, cannot be decided without recourse to operation.

Dysentery rarely leads directly to the development of acute appendicitis, but the possibility of its occurrence should be borne in mind. The relation of **tuberculosis** and **actinomycosis** to the development of appendicitis will be discussed in the section on Pathology.

Intestinal parasites have been held responsible for attacks of appendicitis by Metchnikoff, who mentions four cases in which recurrent attacks of appendicitis ceased after lumbricoids had been expelled by the action of vermifuges. He refers to Becquerel, who, over sixty years ago, found at autopsy an appendix perforated by lumbricoids. Other cases, Metchnikoff says, have been reported by Natale, Brun, Guinard, and Girard. Bloodgood reports a case of appendiceal abscess from perforation by round worms, the abscess being localized between the layers of the ileac mesentery; while Rammstadt observed a case of appendicitis caused by the presence of the oxyuris.

PATHOLOGY.

In discussing the pathology of inflammation of the vermiform appendix it seems appropriate, in the first place, to describe accurately the lesions detected upon examining a large number of diseased appendices; and, secondly, from a study of these, to deduce conclusions relative to their pathogenesis. This latter may be accomplished best by comparing diseased appendices with presumably normal appendices, and by bearing in mind not only the factors ordinarily provocative of inflammation in other portions of the body, but also certain anatomical and physiological peculiarities that pertain to the appendix itself. A just conception of the nature of appendicitis, as of other diseases, is, of course, not possible from a study of the pathological characteristics of its terminal stages alone; to be reliably informed of its pathogenesis especial attention must be directed also to the alterations that occur in the very inception of the disease. It is to the infrequency of death in the early stages of appendicitis, to its nonoccurrence in mild cases, and the consequent lack of opportunity for the study of the early and mild pathological conditions, that the older and erroneous views with regard to the affection then recognized as typhlitis, peri-typhlitis, etc., may be attributed. It is only at a comparatively recent date that the true nature of inflammations of the right iliac fossa has been determined, and this largely through the investigation of diseased appendices removed by early operation. The lesions herein described and the opinions formulated are founded primarily upon a systematic and detailed

examination of 577* appendices removed by operation by Dr. John B. Deaver, at the German Hospital. Furthermore, a considerable number of additional appendices have been examined (some in a detailed manner, many more or less cursorily); various necropsies have been performed upon subjects dead of appendicitis and its complications; and about fifty presumably normal appendices, removed at necropsy from subjects dead of affections other than disease of the appendix, have been investigated. While the following, therefore, is largely a recital of personal views, the observations of other investigators have not been ignored.†

The classification of appendicitis has long been a moot sub-

* Since this chapter was written for the second edition of this book I have examined a considerable number of additional appendices, but I have not continued the systematic examination of all the appendices removed by Dr. Deaver. For this reason I have elected not to alter the numbers and percentages in this revision—my conviction being that a continuation of the systematic examinations would not have materially changed the percentages.—A. O. J. KELLY.

† The routine examination to which, in general, each appendix was subjected consisted in carefully photographing it; weighing it; measuring its length, its exterior diameter, the thickness of its wall, and the diameter of its lumen throughout its extent; noting its macroscopical appearances; hardening and embedding it, and cutting and staining sections from at least three regions of each appendix and studying their microscopical appearances; and bacteriological investigations of the contents of the lumen of the appendix, of the exudate upon its peritoneal surface, of pus from abscesses, of free pus in the peritoneal cavity, and of drainage-fluid subsequent to the operation. Specifically, the number of appendices photographed was over 350; the number weighed was 532; the length was measured of 532, the exterior diameter of 544, the thickness of the wall of 320, the diameter of the lumen of 320; the macroscopical appearances of 577 were noted; the number embedded, and of which microscopical sections were cut, stained, and studied, was 556; the number examined bacteriologically was 286. It has been deemed inadvisable to overburden this chapter with a mass of statistics that refer to the weight, length etc., of the appendices examined, as these add practically nothing to our knowledge of the pathology of inflammation of the organ. Mention is made, however, of features of especial interest that were met with.

My thanks are due to M. I. Wilbert, Ph.G., director of the Laboratory of Photography and Radiography and chief apothecary of the German Hospital, for all the photographic work and for a considerable proportion of the measurements of the appendices, and to Drs. C. W. Wille, J. F. Sinclair, U. J. W. Peters, J. W. Curry, E. K. Moore, and A. A. Uhle, resident physicians of the German Hospital, for the preparation of microscopical specimens.

ject. Naturally it must vary with the basis of classification adopted—ætiological, anatomical, or clinical. Ætiologically appendicitis is an infectious process—the consequence of bacterial infection of the appendix. One may well doubt that a case of appendicitis ever occurs independently of the operations of bacteria; even in cases following trauma, animal parasitic invasion of the appendix, interference with the blood supply (by means of twists, angulations, or adhesions), etc., bacteria are active agents in causing the inflammatory lesions. An amplification of the ætiological classification suggests such terms as bacterium coli infection, streptococcic infection, staphylococcic infection, pneumococcic infection of the appendix, etc. Doubtless in some cases these different infective agents give rise to varying clinical manifestations, but at present these are scarcely susceptible of clinical differentiation. It is likely, however, that the future may enable us to make such differentiation—by means of certain at present ill-observed clinical manifestations, by serum reactions and other laboratory methods, etc. For the present, however, all that can be said is that ætiologically appendicitis is an infectious process.

Anatomically, as well as clinically, two varieties of inflammation of the vermiform appendix may be recognized—an acute and a chronic appendicitis. Like inflammation elsewhere in the body, the inflammatory manifestations in the appendix may commence acutely or chronically. If the former be the case, the acute manifestations may subside after a greater or less interval of time, and the pathological alterations may persist as a chronic inflammation. Thus, chronic inflammation may be the residual manifestation of a previous acute inflammation, or the condition may begin as a chronic inflammation. Of the acute and chronic forms of appendicitis, several varieties may be distinguished, and for purposes of anatomical and histological study it is deemed advisable to adopt some rational classification. The following pathologico-anatomical classification, based upon the

Appendicitis.

results of this investigation, but which does not differ essentially from several that have already been proposed, is suggested:

Acute Appendicitis:

1. Catarrhal.
2. Interstitial.
3. Ulcerative.
 - (a) Nonperforative.
 - (b) Perforative.
4. Gangrenous.

Chronic Appendicitis:

1. Catarrhal.
2. Interstitial.
3. Obliterating.

This classification, which is anatomically well founded, as it indicates the nature of the lesions of the appendix, is not in contravention of the clinical course of the disease. It must be candidly admitted, however, that we are not always able to distinguish clinically the different pathologico-anatomical varieties of appendicitis. In other words, the different pathologico-anatomical varieties of the affection may present analogous clinical manifestations. Again, the severity of the clinical manifestations of an individual attack of appendicitis frequently bears no relation to the seriousness of the lesions of the appendix, nor is the number of attacks always a trustworthy index of the condition of the appendix. And, further, it may be said that often the different varieties of both acute and chronic appendicitis are but stages of a single pathological process. An inflammation of the appendix, originating as a catarrh, may, in a given instance, progress to the interstitial variety. This in turn may be succeeded by ulceration which, depending upon a variety of circumstances, may or may not lead to perforation of the organ. Gangrenous appendicitis may also follow in such a train of events, though it not infrequently arises in a totally different manner. Similarly, chronic interstitial appendicitis may follow that process which

began as a chronic catarrh, and not the least interesting, if not the most common, form of this chronic inflammation of the appendix is the obliterating variety. Again, an appendix that for a longer or shorter period of time has been the seat of chronic inflammation may suddenly suffer an acute exacerbation, and may present the most intense degrees of acute interstitial inflammation, with suppuration, ulceration, or gangrene, and well-marked and fatal peritonitis. On the other hand, a severe attack of appendicitis may be partially recovered from, and may be succeeded by several much milder attacks. Indeed, an acute exacerbation of the lesions of a chronically inflamed appendix is one of the most likely of events. The majority of cases of chronic appendicitis are those in which the appendix has been the seat not only of a chronic inflammation, but also of recurring attacks of more or less acuteness—cases designated clinically as recurring or relapsing appendicitis. In addition, the inflammatory phenomena in different appendices vary with respect to the situation and extent of the lesions and the rapidity of their progress; and these are not uninfluenced by the possibly persisting consequences of previous inflammation. Furthermore, the most diverse peritoneal lesions may be associated with different cases of the same variety of appendicitis.

The foregoing classification, based, as it is, upon the nature and character of the lesions occurring in the several varieties of appendicitis, seems more appropriate than those which comprise such terms as "simple," "mild," "perforating," "infective," etc. "Simple" and "mild," as a rule, are used merely to indicate the severity of the clinical manifestations, and, as already stated, this is often no index to the seriousness of the lesions of the appendix, although, of course, "mild" lesions do occur. "Perforative" merely indicates an accident that may or may not happen in the course of ulcerative and gangrenous appendicitis. The reservation of the term "infective" to designate certain cases only of appendicitis is inappropriate; for,

as has been stated and as will be seen later, all cases of appendicitis must be attributed to the pathogenical activities of bacteria.

Of the 577 appendices, removed by operation, that were investigated, 21 were not examined microscopically and 9 were removed from persons who presented no clinical symptoms of appendicitis, but who were operated upon for some other condition, the appendix being removed at the same time. Of the remaining 547, there were 239 instances of acute appendicitis, 305 of chronic appendicitis, 2 were instances of primary carcinoma and 1 of endothelioma of the appendix.* The last-mentioned presented, in addition to the endothelioma, mild interstitial inflammatory alterations; and the other two cases of tumor of the appendix, in addition to the carcinoma, showed intense interstitial inflammation with ulceration. Of the 239 acute cases, 9 were of the catarrhal variety, 38 of the interstitial, 142 of the ulcerative (68 nonperforative, 74 perforative), and 50 of the gangrenous variety. Of the 305 chronic cases, 6 were of the catarrhal variety and 299 of the interstitial variety—6 of the latter being of the obliterating subvariety. Many of the chronically inflamed appendices presented, in addition, evidences of more or less acute exacerbation.

The pathology of inflammation of the vermiform appendix will be discussed as follows:

1. *The Lesions of the Appendix.*
2. *The Peritonitis and its Consequences.*
3. *The Bacteriology.*
4. *The Pathogenesis.*

* Since the foregoing was written another case of carcinoma of the appendix has been encountered. This constitutes a total of four malignant tumors of the appendix detected in a detailed and systematic examination of 706 appendices removed by operation.

THE LESIONS OF THE APPENDIX.

ACUTE APPENDICITIS.

ACUTE CATARRHAL APPENDICITIS.

By acute catarrhal appendicitis is understood that variety of acute inflammation of the appendix in which the pathological alterations are wholly or almost wholly confined to the mucous membrane, the other coats of the organ presenting but little or no deviation from the normal. In this connection the term catarrhal is employed strictly within its pathological significance. Implying, as it does, a superficial inflammation limited to the mucous membrane, it is certainly incorrect to apply it, as has been done, to inflammatory conditions of the appendix in which the lesions involve the deeper layers of the wall of the organ.

That this variety of appendicitis does occur there can be no question. It is not true, as has been held by Talamon and others, that in every case of inflammation of the appendix all the coats are involved, or that, at least, the inflammatory alterations extend to and implicate the muscular coats. Nor can I agree with Kelynack and others who consider the term catarrhal most open to objection because of its suggesting a superficial inflammation—they thereby implying that such a condition does not occur in the appendix.

Acute catarrhal appendicitis is probably not uncommon. It doubtless often gives rise to but few clinical manifestations, and, most likely, under some circumstances to none at all, as, for instance, if the lumen of the organ be of good calibre. This opinion is borne out by the many instances of catarrhal inflammation of the appendix disclosed by systematic examination of a large number of appendices removed postmortem from those who during life presented no clinical manifestations of such disease. In many of these cases the lesions are strictly

confined to the mucous membrane. That this variety of appendicitis, however, is infrequently met at operation is indicated by the fact that of the 239 cases of acute appendicitis that were investigated, but 9 were of the catarrhal variety. It is quite likely, nevertheless, that if many of the appendices which when deranged give rise to very mild clinical symptoms were examined microscopically, they would reveal evidences of catarrhal inflammation. It is likely, also, that this variety of appendicitis constitutes the early stage of many cases of the more severe varieties of acute inflammation, and it is doubtless commonly the starting-point of many of the chronic cases.

Macroscopy.—In this variety of appendicitis, to the naked eye the general configuration and external appearances of the organ are not appreciably altered, although it may feel a little stiffer or firmer to the touch. The mucous membrane is swollen, hyperæmic, and œdematous. The lumen of the organ may be partially or completely occluded at one point or at several points, and this is the more likely to be the case, the narrower the lumen prior to the attack of inflammation and the more intense the inflammation. The mucous membrane is covered with a secretion that partly or completely fills the lumen of the organ if it be patulous. This secretion is variable in amount and character. It may be abundant or meager, depending to a considerable extent upon the intensity of the inflammation (and whether or not the catarrhal alterations are associated with more widespread lesions). In character it may be clear and mucous, turbid, grayish or yellowish-green, or brownish and purulent; or sanguinolent; or a combination of any of these. The contents of the appendix vary, depending upon whether they consist solely of such secretion, or of such secretion combined with more or less fæcal matter. They may be fluid or semi-fluid, or they may approach the consistency of inspissated fæcal matter. In this variety of appendicitis I have not encountered any true appendicular calculi. The odour of the contents

is also variable. It is commonly distinctly fæcal in character, with different degrees of malodorousness. Occasionally the lymphoid follicles appear enlarged. The crypts of Lieberkühn can usually be detected, being distinctly distended, commonly with a grayish or a grayish-yellow secretion. If the inflammation be rather intense and, as is the rule, the lesions extend beyond the mucosa, the secretion is likely to be distinctly purulent; hence the designation, *purulent catarrhal appendicitis*. Under such circumstances slight superficial erosion and desquamation of the epithelium of the mucous membrane may supervene, and if the inflammation be still more intense, rupture of minute vessels in the lowermost layers of the mucosa may occur. The hæmorrhagic foci that thus ensue have led to the designation *hæmorrhagic catarrhal appendicitis*. These various lesions may extend uniformly throughout the length of the appendix, or they may be relatively intense in one portion and comparatively inconspicuous in others. Indeed, certain regions may be entirely unaffected.

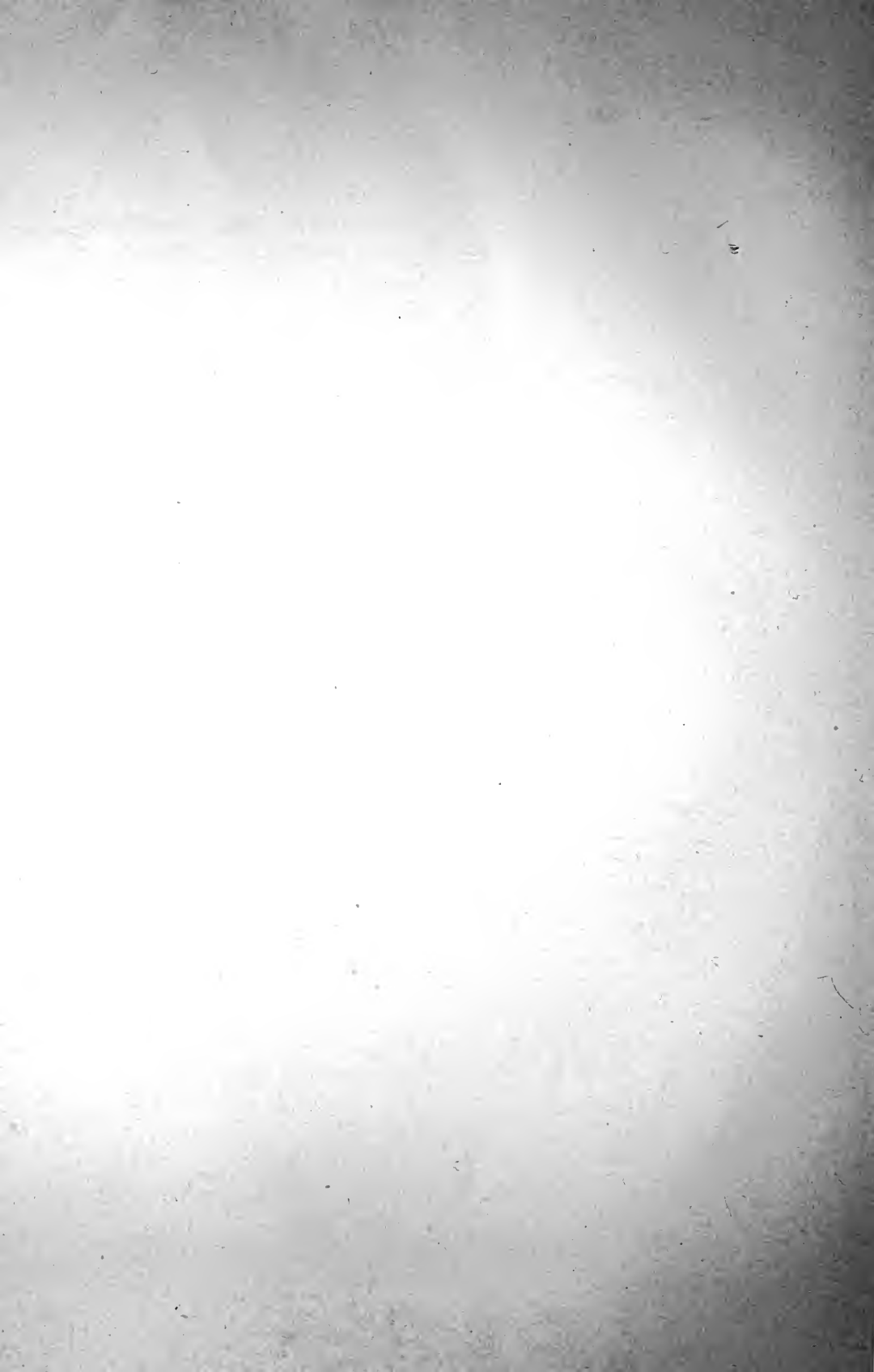
Microscopy.—Upon microscopical examination of such appendices (Plate XII) the crypts of Lieberkühn are found distended to a variable degree. Usually the contents are of the well-known mucous nature; occasionally, however, they are muco-purulent, purulent, or hæmorrhagic—in the event of which the lesions usually extend beyond the mucosa. The individual epithelial cells of these crypts, as well as those of the surface epithelium, are swollen, distorted, and occupied by a clear, translucent, spheroid, or ovoid droplet which, situated toward the free extremity of the cell, displaces the cell protoplasm and the nucleus downward or somewhat to one side. This droplet reveals the characteristics of mucin generally, and is commonly elaborated without destruction of the cell body. After the discharge of this droplet the cells reveal the characteristic goblet appearance, and subsequently they may assume their normal configuration and appearance. Some emigrated leuko-

PLATE XII.

ACUTE CATARRHAL APPENDICITIS.—The section shows the mucous and submucous coats of the appendix. The crypts of Lieberkühn are much distended and their lining epithelial cells, as well as those lining the lumen of the organ, are occupied by clear droplets of mucin that displace the nuclei toward the bases of the cells. In addition there is serous and a small amount of cellular infiltration of the mucosa. At *a* there is a rather large lymphoid nodule. In the lowermost portion of the submucosa there are two blood vessels that are distended with blood, and about which there is a slight amount of round-cell infiltration. Hæmatoxylin-eosin preparation. $\times 250$.



ACUTE CATARRHAL APPENDICITIS.



cytes are usually visible between the epithelial cells, and the entire mucosa is the seat of more or less serous infiltration. Besides these alterations and some congestion of the vessels of the mucosa and submucosa the mild forms of this variety of inflammation of the appendix may present no noteworthy pathological features. If, however, the inflammation be more intense, in addition to the foregoing changes there are noticeable a more marked congestion of the vessels of the mucosa and submucosa, a greater degree of serous infiltration, a more marked infiltration of the retiform tissue of the mucous membrane with emigrated leukocytes, some cellular proliferation and desquamation of the epithelial cells of the crypts of Lieberkühn and of those lining the lumen of the appendix. The difference between this and acute interstitial appendicitis is one of degree only, and all gradations are encountered. In some of the severer cases the cellular exudate becomes more excessive, and gives rise to marked swelling of the mucous membrane and to pressure upon the crypts of Lieberkühn. Partly because of this, and also because of the desquamation of their epithelial lining, some of these crypts become obliterated. Under such circumstances the cellular exudate reaches the surface of the lumen, and being cast off, commingled with desquamated epithelial cells, excessive mucus, and granular debris, constitutes the microscopical evidence of what has been termed *purulent catarrhal appendicitis*. The contents of the lumen are composed of similar matter. The desquamation of the epithelial cells may occur slowly or rapidly, and the cells desquamated may be in a good state of preservation or they may be already partly or completely necrotic, or the seat of serous or mucous infiltration. If the inflammation be still more intense, the alterations already described become more marked, and there may occur some diapedesis of erythrocytes. Indeed, in a small number of cases minute hæmorrhagic foci may be detected—*hæmorrhagic catarrhal appendicitis*. In all cases of catarrhal appendi-

citis, excluding possibly the very mildest forms, there is some swelling, congestion, and serous infiltration of the lymph nodules.

The further course of such catarrhal appendicitis is one of three: In a very few instances it is possible that, if the lesions be very slight, a complete restoration of the mucous membrane to its former condition may take place. The contents of the appendix are discharged into the cæcum, the congestion and swelling of the mucous membrane subside, the leukocytic infiltration and the cellular exudate are absorbed, and desquamated and eroded epithelial cells are replaced by newly formed cells. The likelihood of such *restitutio ad integrum* is influenced by the cause of the inflammation, the free and thorough drainage of the organ, and the character and virulence of the microorganisms present. Analogy and some facts warrant us in supposing that such mild catarrhal appendicitis is more common than is generally thought, that clinical manifestations are often slight or entirely absent, and that in some such instances the appendices return to their previously normal condition. However, in the majority of cases in which the lesions are sufficiently intense to give rise to clinical manifestations, and in all cases in which the previously detailed pathological alterations are at all marked, the return of the appendix to its normal condition is not possible. The acute manifestations either partly subside and become chronic, or they become more intense, more generalized, and lead to some of the severer forms of appendicitis. This latter is a very likely event, not only because of the natural tendency of the disease, but also because of the liberal lymphatic supply of the appendix, whereby the noxious agents provocative of the lesions of the mucous membrane readily gain access to, and implicate the deeper layers of, the wall of the organ.

ACUTE INTERSTITIAL APPENDICITIS.

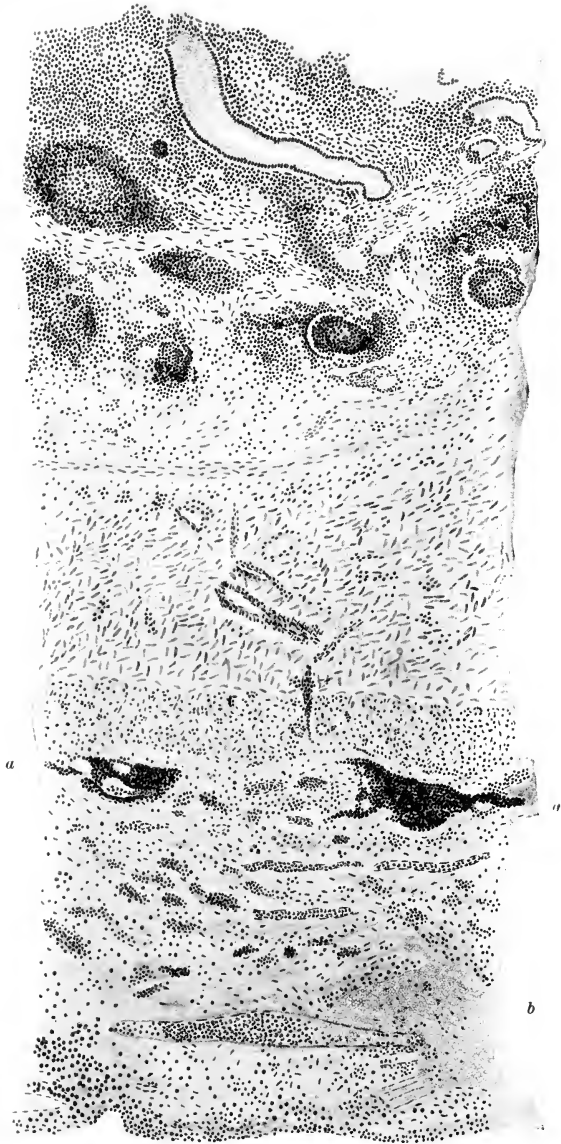
By acute interstitial appendicitis is understood that variety of acute inflammation of the appendix in which the pathological

alterations extend throughout and involve all the coats of the organ. An inflammation of the appendix may implicate all the coats of the organ from the outset, but, as already stated, it is not unlikely that catarrhal alterations inaugurate the process in a considerable number of cases. The extensive lymphatic supply of the organ furnishes a ready means for the rapid dispersion of the agents causing the inflammation, thus engendering the generalization of the process. That this form of appendicitis is more common than the catarrhal variety, or at least gives rise to clinical manifestations more frequently is indicated by the fact that of the 239 cases of acute appendicitis examined, 38 were of the interstitial variety. In this form the pathological alterations are commonly more intense in one coat than in others, and they vary also in different regions of the same coat.

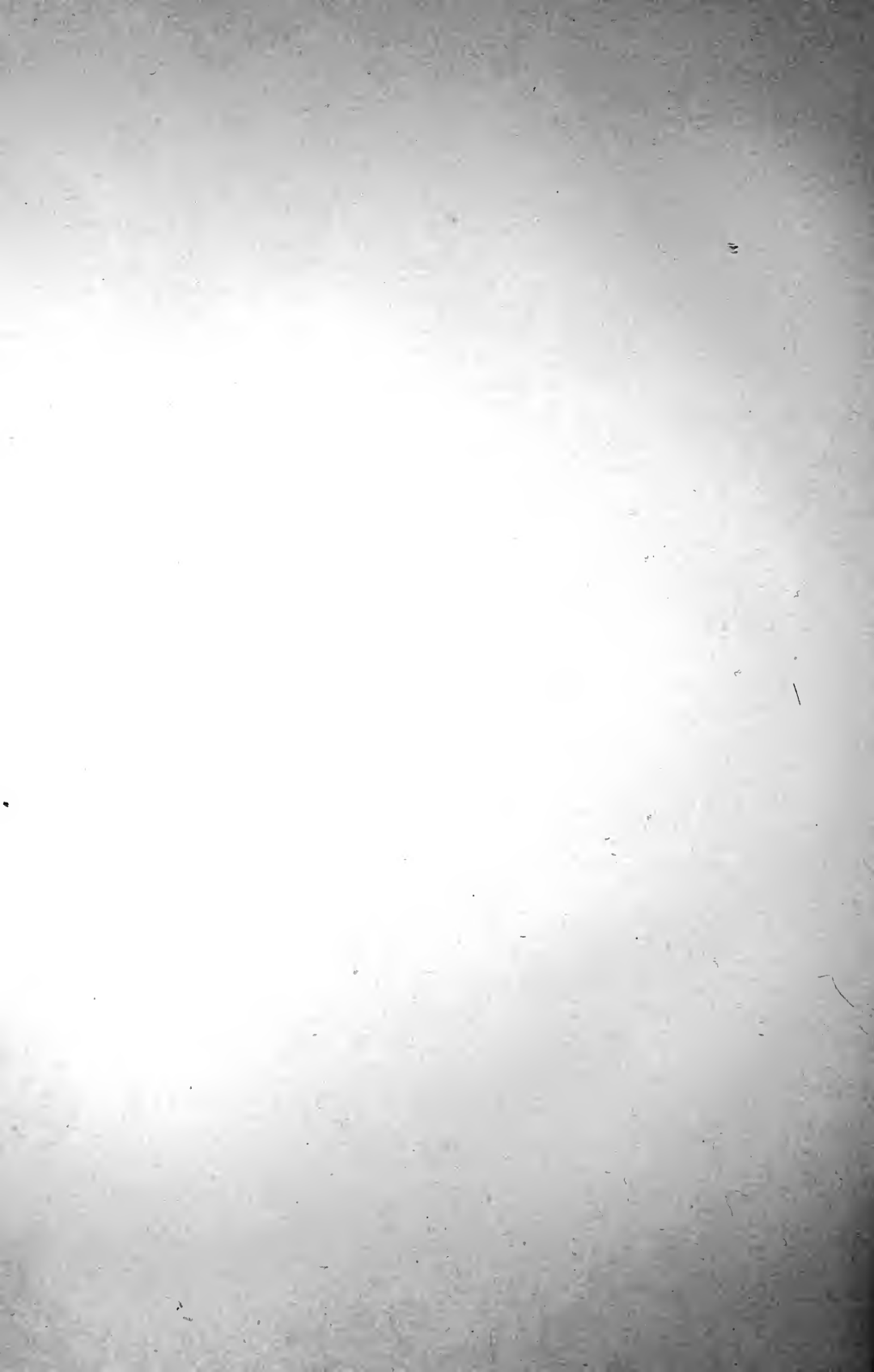
Macroscopy.—To the naked eye the appendix appears swollen, œdematous, and reddened; and injection of many of the vessels beneath the peritoneal covering can commonly be distinctly detected. If the inflammation be of minor grade, the organ is quite firm to the touch; but if it be either moderate or intense, the appendix often seems softer than normal. The mucous membrane is swollen, hyperæmic, œdematous, and softened, and the entire wall of the organ appears thicker than normal. The mucous membrane is more likely to reveal minute hæmorrhages than in catarrhal appendicitis. Occlusion of the lumen in one or more places is common. If it be patulous, the contents are muco-purulent, purulent, or hæmorrhagic and they are more likely to be the last named, and also to be very malodorous, in this than in the catarrhal variety. The other macroscopical appearances do not differ materially from those described in connection with the catarrhal variety (with which it is usually associated), though the swelling of the lymphoid follicles is more likely to be conspicuous. Appendicular calculi were found in 2 (6.2 per cent.) of 32 of the appendices examined.

PLATE XIII.

ACUTE INTERSTITIAL APPENDICITIS.—The section is through the entire wall of the appendix. There is some erosion of the mucous membrane and loss of the surface epithelium. The mucous glands are distended and their epithelial cells are occupied by clear droplets of mucin that displace their nuclei toward the bases of the cells. In addition to serous and cellular infiltration, which are most marked at the surface, the mucous membrane presents several lymphoid nodules. In the submucous and muscular coats the blood-vessels are much dilated, and there is a varying amount of round-cell infiltration. At *a* there are several large collections of round cells, most of which are polynuclear, constituting interstitial abscesses. At *b* there is an area of hæmorrhagic infiltration. Hæmatoxylin-eosin preparation. $\times 250$.



ACUTE INTERSTITIAL APPENDICITIS.



Microscopy.—Upon microscopical examination (Plate XIII) the pathological alterations described in connection with the microscopy of catarrhal appendicitis are evident. They are, however, commonly more marked in degree. The crypts of Lieberkühn are often almost completely obliterated, there is dense cellular infiltration of the retiform tissue of the mucous membrane, and the latter is not infrequently represented by a dense aggregation of small round cells which extend to the free edge, and in which remnants of degenerated epithelial cells and crypts of Lieberkühn are discernible. In addition, the pathological alterations have extended to, and more or less extensively involve, the submucous, muscular, and subserous coats. Throughout the submucous and muscular coats there are a variable amount of dilatation of the blood-vessels, some serous infiltration, and a more or less dense collection of small round cells. At times these small round cells infiltrate more or less diffusely one or all of the layers of the wall of the appendix, causing separation of the fibrillar and muscular bundles and constituting a veritable *purulent* or *phlegmonous infiltration* or *suppuration of the appendix*. On the other hand, these small round cells may be congregated into smaller or larger masses, forming circumscribed abscesses—*interstitial abscesses*—in various regions of the organ. While the diffuse infiltration is more likely to predominate in the muscular layers, the small, circumscribed abscesses show a predilection for the submucous and subserous layers. No definite rules, however, can be laid down for these. The leukocytic infiltration is especially conspicuous about the blood-vessels, but evidences of productive inflammatory alterations are common elsewhere. In cases of moderate and more intense inflammation hæmorrhagic foci are relatively common. At times these are small; at times, however, they are very extensive, and give rise to more or less wide-spread destruction of tissue.

A conspicuous feature of this, as well as of the more severe

varieties of appendicitis, is the involvement of the lymphoid elements. These are commonly swollen and are generally the seat of serous infiltration. The capillaries and lymph spaces appear distended—the former filled with blood corpuscles, the latter with lymph corpuscles, leukocytes, and sometimes erythrocytes—and into their lumens there project proliferating endothelial cells. At times the latter desquamate, and thus assist in occluding the distended spaces. There also occur an infiltration of the nodules with leukocytes and an active proliferation of the cells of the reticulum. In the immediate vicinity of these lymphoid follicles there are often small collections of lymphoid cells; these should not be confounded with the results of productive inflammation, which also abound. In the more advanced stages of the inflammation these lymphoid follicles undergo various retrograde changes. They commonly become necrotic, the necrosis arising in one of two ways: it may commence in or about the centre of the follicle, and more or less rapidly involve the entire nodule; or small scattered foci of necrosis may simultaneously, or almost simultaneously, arise in different portions of the follicle, and, finally, either become confluent or remain discrete. It has seemed to me that the latter form of necrosis is the more common. At first the nuclei of the lymphoid cells, and later those of the reticulum, refuse to stain well. They appear indistinct and blurred, and their edges become ragged. Subsequently hyperchromatosis chromatolysis, or karyorrhexis supervenes, and plasmolysis follows or occurs coincidentally. Finally, the focus undergoes complete liquefaction. Neighbouring areas become similarly affected, and several adjoining foci may become confluent and form larger ones. The exudated polynuclear leukocytes participate in the process and speedily become liquefied. The reticulum, sometimes at first homogeneous, later becomes granular and liquefies. There thus develops within the wall of the appendix, without of necessity any solution of the continuity of

the mucous membrane or of the serous coat developing, a focus or several foci of softening which, in the later stages at least, consist largely of purulent matter—*follicular abscess*. This commonly ruptures into the lumen of the appendix, and there is thus produced a form of ulcerative appendicitis, of which mention will be made subsequently. Hæmorrhage sometimes occurs into these foci of softening, and around them, at times, various deposits of blood pigment are discernible.

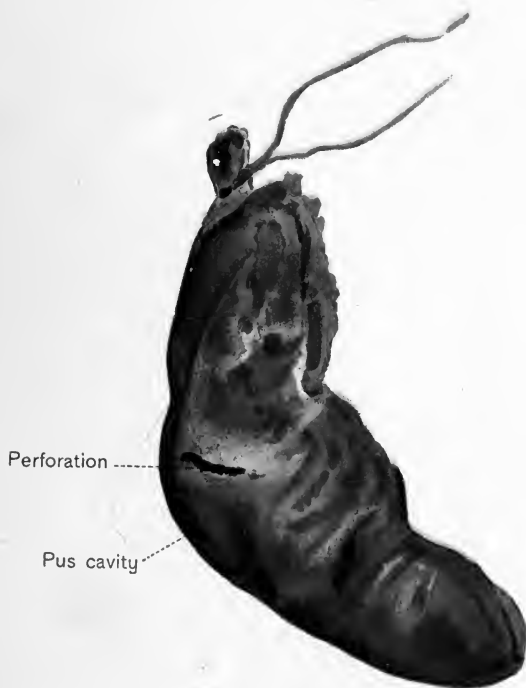
The pathological anatomy of this, as well as of the ulcerative, form of appendicitis varies somewhat, depending upon the possibly persisting consequences of previous inflammation. At times, as a result of previous acute or chronic inflammation, strictures, angulations, or flexures may have formed, obstructing the lumen of the organ. Under such circumstances the appendix may be divided into two or more compartments, and each of these may present pathological alterations different from the others. One portion may reveal only catarrhal inflammation; another, in addition to this, rather marked interstitial inflammation; while, under some circumstances, another portion may be practically unaffected. The proximal portion is the most likely to present no deviations from the normal. The tip, on the other hand, is not infrequently seriously involved, being distended and filled with clear or turbid fluid or with pus. The contents of the distended portion may be purulent from the commencement of the inflammation, or there may occur a purulent metamorphosis of previously clear fluid. This condition, in which the lumen of the appendix has been converted into a closed cavity and is filled with pus, is spoken of as *empyema of the appendix*. (Plates XIV and XV.) Under these circumstances the wall of the appendix constitutes the wall of the empyema or abscess cavity. The development of an empyema of the appendix presupposes a stenosis or complete occlusion of the lumen, and this may be brought about by twists or angulations of the organ, internal cicatrices resulting from previous

PLATE XIV.

ACUTE ULCERATIVE APPENDICITIS (EMPHYEMA OF THE APPENDIX) WITH PERFORATION.—M. T., aged twenty-one years, a theological student, was admitted to the German Hospital, December 11, 1895, with a history that one week prior to admission he had been suddenly seized with violent cramp-like pains in the abdomen, severe vomiting, and fever, his temperature being 102° F. Examination revealed marked tenderness in the right iliac region, rigidity, and distention. One year prior to admission he had had a similar attack, and another in June, 1895.

The operation, performed December 12, 1895, revealed the appendix markedly swollen and distended with a considerable quantity of malodorous pus. It was the size of an adult finger, very friable, covered with plastic exudate, embedded in an abscess wall, and perforated near its middle. An appendicular calculus was found in the abscess cavity. Gauze drainage was employed.

The patient made a good recovery.



Acute ulcerative appendicitis—empyema of the appendix—with perforation.

inflammation, or external cicatrizing bands of adhesions. The stenosis or occlusion of the lumen may occur at any point along the appendix, and in consequence the empyema may involve the entire organ or only part of it. We thus speak of a partial or complete empyema, as the case may be. The empyema may develop slowly or rapidly, and it may be rather small or may attain a considerable size. It commonly occurs in connection with acute inflammation, but that it also develops in association with some cases of chronic inflammation (a few of them possibly tuberculous), and with acute exacerbations of chronic inflammations, is well established. Although in its initial stages this condition of empyema may be present without appreciable ulceration of the appendix—that is, it may be associated with catarrhal and interstitial appendicitis, with intact basement membrane—from its very nature it forms a transition stage to ulceration of the appendix, and is commonly found in connection therewith. If such an appendix be not removed by operation, there occur serous and cellular infiltration and necrosis of the wall of the organ, excessive distention, perforation, and peritonitis. The final process is similar to ulcerative appendicitis.

It is not possible for the interstitial variety of appendicitis to eventuate in the restoration of the organ to its previous healthy condition. If the pathological alterations are slight or moderate in degree, and if there are productive connective tissue changes rather than polynuclear leukocytic infiltration, the acute manifestations may subside and a variety of chronic appendicitis may result. It is much more likely, however, if the appendix is not excised or the patient does not die, that the pathological changes will progress to necrosis and ulceration.

ACUTE ULCERATIVE APPENDICITIS.

By acute ulcerative appendicitis is understood that variety of acute inflammation of the appendix in which there occurs a

PLATE XV.

CHRONIC INTERSTITIAL APPENDICITIS—EMPHYEMA OF THE APPENDIX.—
H. C. D., a physician, has presented the following report:

On July 20, 1894, I was awakened by a feeling of discomfort in the abdomen, located chiefly around the umbilical region. It gradually grew worse until I had severe pain in this region. I took $\frac{1}{4}$ of a grain of morphine, which gave me relief. I was able to get up and attend to my work two hours afterward. There was some soreness, discomfort, and tenderness on deep pressure over the region of the appendix. In four or five days I was feeling much better.

I remained apparently well until September 20th, when I had a similar attack, which was more severe, and confined me to bed for six hours; vomited freely, principally bilious matter. After being purged freely by citrate of magnesium I was relieved, but the soreness over the appendix remained for one week.

For three months I had perfect health and gained in flesh. On December 30th I had another attack, accompanied by severe pain and distress in the abdomen; vomited freely without relief. Stomach was irritable for thirty-six hours after this ceased. I took a dose of castor oil, which acted in four hours. After the first bowel movement I felt greatly relieved. Temperature ranged from 99° to 101.5° F. The attack was due to cold. After this attack I was not well. Had more or less soreness over the appendix, attended by obstinate constipation and dyspeptic symptoms. At times I had a great deal of pain in the right testicle.

At operation, performed March 26, 1896, the appendix was found markedly distended. Upon incising it, there were found two cavities containing pus, and separated from each other by an area of constriction. The distal third of the lumen was entirely obliterated and the remainder of the wall was greatly thickened.

Recovery was uneventful.

Fig. 1

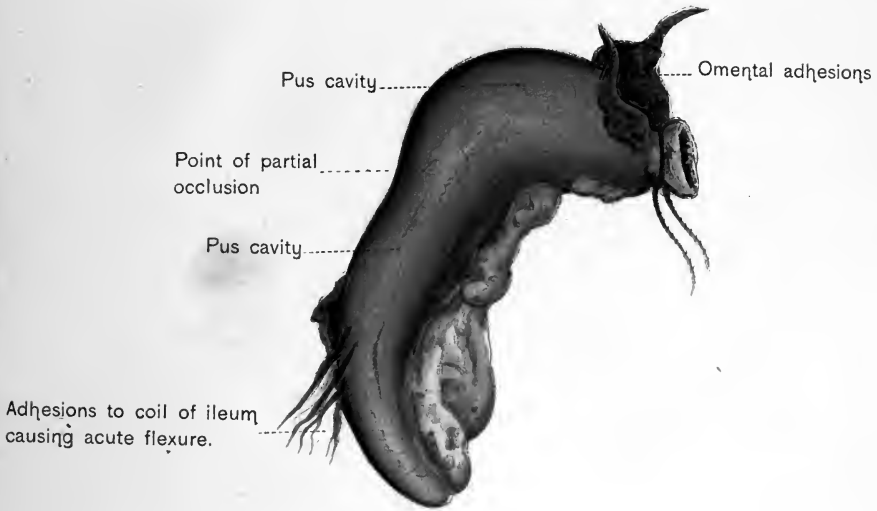
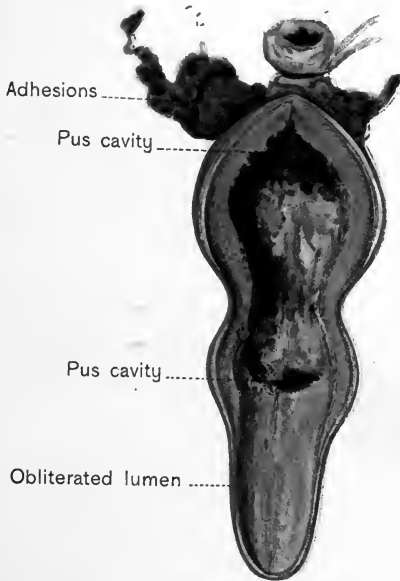


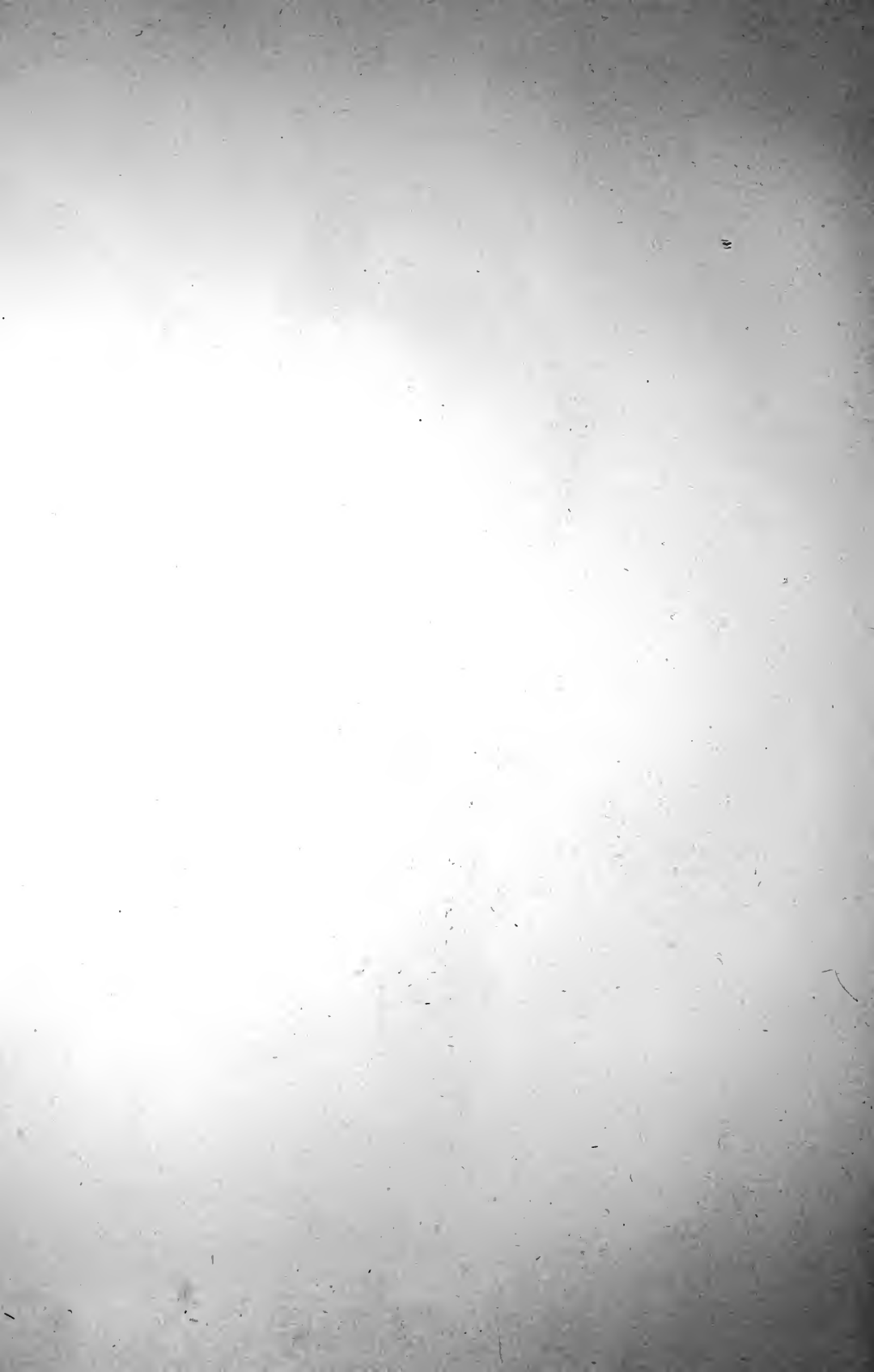
Fig. 2



Chronic interstitial appendicitis—empyema of the appendix

FIG. 1. External aspect of the appendix illustrating the excessive and irregular distention of the organ.

FIG. 2. Internal aspect of the appendix illustrating two pus-cavities with an intervening area of constriction of the lumen, and entire obliteration of the distal third of the lumen.



liquefaction necrosis of the inflammatory exudate and of more or less of the wall of the organ in communication with its lumen. This is naturally but an aggravation of the previously described forms of appendicitis, and both the catarrhal and interstitial varieties may present gradual progression to it. It is possible, however, for ulcerative appendicitis to arise without previous catarrh; it may be due to septic infection, typhoid fever, dysentery, etc. Two forms may be distinguished—a nonperforative and a perforative. One is but an aggravation of the other—perforation being an accident that may or may not occur in the course of the affection. That this variety of appendicitis is relatively common is indicated by the fact that of the 239 cases of acute appendicitis examined, 142 were of the ulcerative variety—68 being nonperforative and 74 perforative.

Macroscopy.—To the unaided eye (Plate xvi) the appendix is swollen, œdematous, excessively congested, and may seem a little firmer to the touch than normal, in consequence of the tension of the peritoneal covering. In the event, however, of perforation, or of perforation being imminent, the area of such impending or actual perforation can readily be distinguished by its being softer than the surrounding tissue. The swelling and œdema vary in different portions. Usually, they are very irregularly distributed, being more marked in one region than in another. In places the seat of serious disease the appendix may be as thick as a finger or thicker, whereas other portions may be not thicker than a lead-pencil and almost normal in appearance. Certain regions may present merely dilatation of the blood-vessels, the larger ones being distinctly distended, while those ordinarily invisible to the unaided eye are readily perceptible. In other portions there may be a diffuse redness, varying in shade from an intense bright redness to a deep reddish-blue or purplish colour. If perforation be imminent, the area involved is usually of a brownish-green or blackish-green colour, and is softer and more prominent than the adjoining

PLATE XVI.

ACUTE ULCERATIVE APPENDICITIS.—Miss B., aged twenty years, was admitted to the German Hospital, November 16, 1895, with a typical attack of acute appendicitis. At operation, which was performed immediately, it was found that the appendix and meso-appendix were highly inflamed, and the appendix was thickened and firm to the touch, from the tenseness of the serous covering. Upon incising the appendix the contents were found to be mucopurulent and of a disagreeable fæcal odour. The mucous membrane was roughened, of variegated colour, and necrotic.

Recovery was rapid and uninterrupted.

Fig. 1

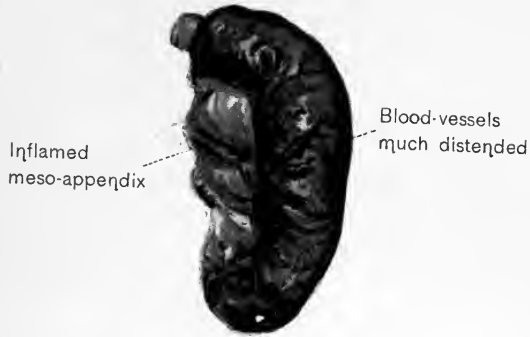
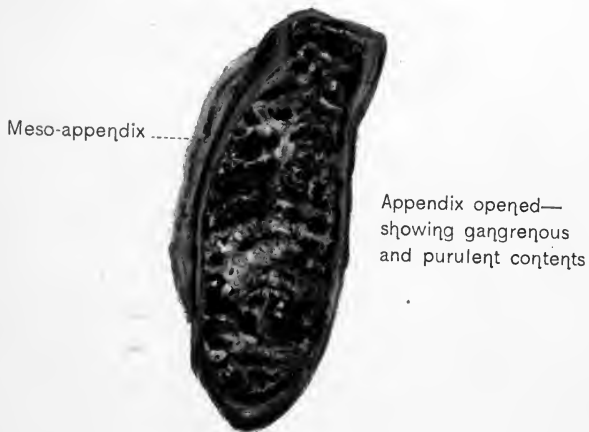


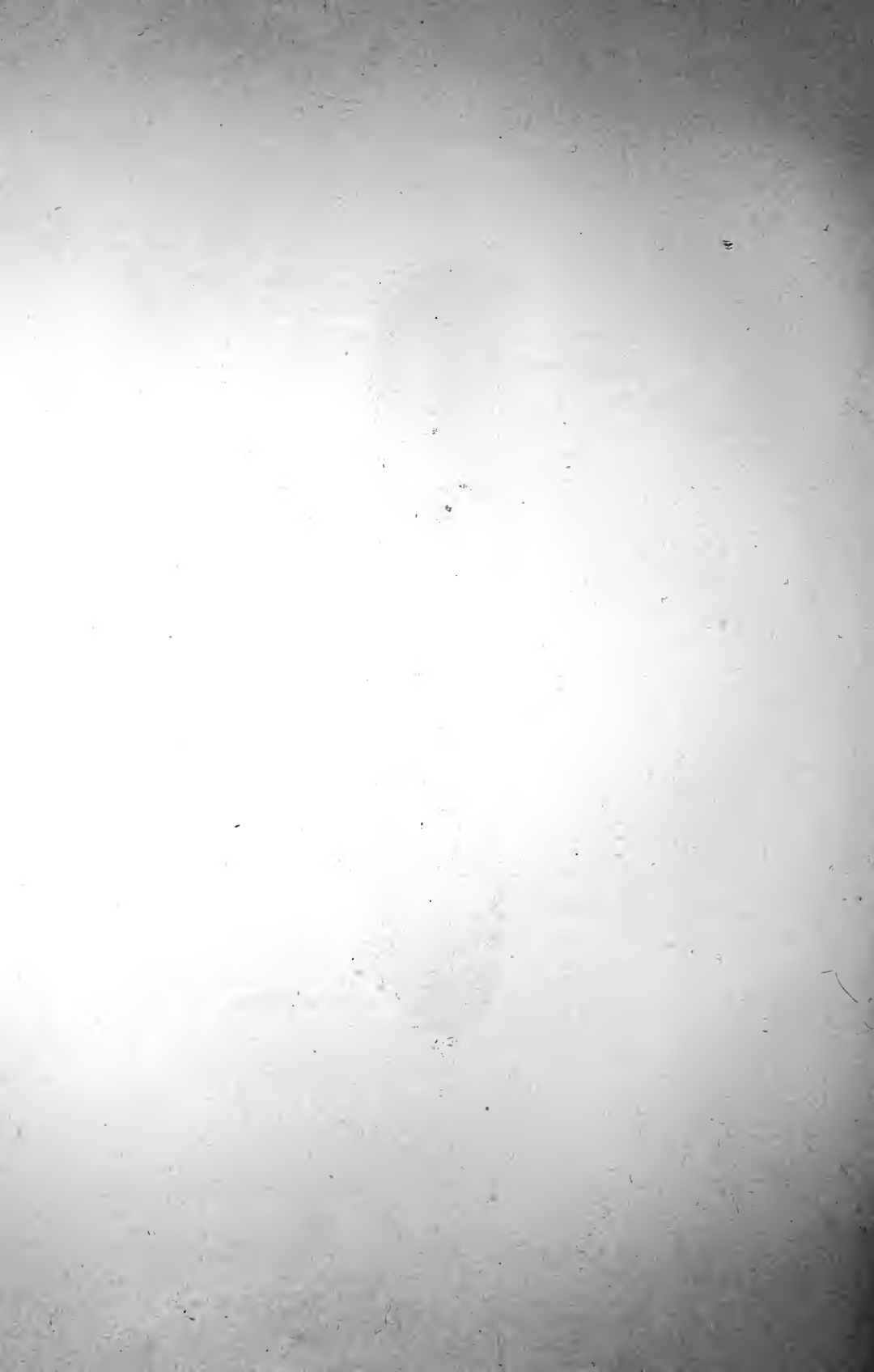
Fig. 2



Acute ulcerative appendicitis

FIG. 1. External aspect of the appendix illustrating the increase in the size, the diffuse redness, and the marked engorgement of the blood-vessels of the organ.

FIG. 2. Internal aspect of the appendix illustrating the muco-purulent contents and the ulceration and necrosis of the lining membrane.



region. It is closely surrounded by an area of intense bright redness, and is usually covered by some discoloured exudate. There may be only one of these spots of impending perforation or there may be several of them, and they may be situated anywhere along the course of the appendix. Such spots are most frequently found opposite the attachment of the meso-appendix. Not uncommonly, however, they are near the attachment of the meso-appendix, and sometimes they are encountered between the two layers of this structure. Several of these may apparently coalesce to form larger areas. Under such circumstances perforation of the wall of the appendix is most likely to ensue. The perforation may be exceedingly small—scarcely perceptible; or it may be large enough to admit a straw or a goose-quill; or, exceptionally, it may be upward of a centimetre in extent. Perforations more than a centimetre in size are very uncommon, unless as a result of circular amputation or of widespread gangrene of the organ. There may be only one perforation or there may be several, varying in size and situation. They may be close together or quite removed from one another. Although, as a rule, the perforation occurs in the centre of the previously mentioned spot of discolouration, such spots may individually reveal several perforations. The perforation is usually round, but it may be ovoid, elongated, or without definite outline. If irregular, it may course in the direction of the long or transverse axis of the organ or diagonally. The edges are usually very ragged.

Perforation of the appendix is considered to have occurred when communication has been established between the exterior of the organ and its lumen. In contradistinction to this, if not infrequently happens that a circumscribed abscess in the wall of the appendix ruptures externally—that is, through the serous coat—without a communication being established with the lumen. In the event of true perforation, conditions are favourable for the escape of fæcal matter from the lumen of

the appendix into the peritoneal cavity; in the other variety of perforation, or rupture of a portion of the wall, such an accident does not occur.

The contents of the lumen in ulcerative appendicitis vary but slightly; they may be muco-purulent, though they are commonly distinctly purulent, with more or less admixture of fæcal matter, and very malodorous (Plate xvi). On the other hand, if perforation have occurred, the lumen may be practically empty. The wall of the appendix is thickened, especially at the seat of most manifest disease. On the inner aspect marked alterations of the lining membrane and a variable number of ulcers are seen. That portion of the mucous membrane which is not ulcerated is much swollen, congested, softened, and commonly presents minute hæmorrhagic foci. Often, however, the entire mucous membrane is yellowish-green, much discoloured, and resembles a false membrane. At times there is a single ulcer; at times several that vary in size and situation. The ulcers may be situated anywhere along the length or circumference of the organ. They usually correspond in location to the areas of discolouration visible on the external aspect, though some ulcers, particularly if they be superficial, may reveal no external indications of their presence. They are rather common opposite the attachment of the meso-appendix, probably because in this situation the blood supply is poorest. These ulcers may be round, ovoid, elongated, or irregular in outline. They may involve one, two, three, or all of the coats of the appendix. They usually have sloping edges, in that the greatest destruction of tissue is at the surface—the mucous membrane. At times, however, and not infrequently in the early stages, excessive swelling and œdema of the tissues obscures or completely effaces this character of the ulcer. It is merely a question of the severity of the pathological lesions, and to some extent also of the duration of the disease, whether the ulcerative condition goes on to perforation or not. Many cases of

nonperforative ulcerative appendicitis in which the appendix is excised early would, if operation were deferred, progress to perforation. The surface of the ulcer is usually intensely red. Not uncommonly, however, it is of a greenish-yellow or greenish-black colour, and is covered with discoloured purulent or purulent faecal matter; when this is removed by irrigation, the surface of the ulcer is seen to be the seat of hæmorrhagic suffusion. If perforation has occurred, the ragged edges of the opening are also visible. In the neighbourhood of the ulceration—or, more particularly, of the perforation, if this has occurred—an appendicular calculus may be detected. Not infrequently this will be found occupying a site directly over the ulceration; often enough, however, just above, and less commonly below, the latter. Exceptionally, it will be found within the perforation, partly or completely occluding it; and in a fair proportion of cases of perforation diligent search will often be rewarded by the discovery of the calculus in the exudate or pus surrounding the appendix.

Although it is generally held that appendicular calculi—otherwise spoken of as faecal concretions—are common in this variety of appendicitis, statistics differ widely as to the frequency of their occurrence. They were found in 28 (22.3 per cent.) of 120 of the cases that I examined. Of these 120 cases, 56 were nonperforative, and calculi were found in 9 (16 per cent.); 64 were perforative, and calculi were found in 19 (29.8 per cent.). There can hardly be much question, however, that they are more frequently present than these latter figures indicate. The foregoing statistics include only those cases in which the calculus was detected in the appendix when it was examined in the laboratory.

Reference has been made to the fact that in certain cases of ulcerative appendicitis with perforation the calculus may have escaped from the appendix before the time of operation or necropsy; in these cases its presence may be undetected at the

subsequent examination. There is thus no doubt that the foregoing figures do not indicate the exact frequency of calculi in ulcerative appendicitis with perforation. On the other hand, it is believed that more or less inspissated fæcal matter has been classed by some surgeons as fæcal concretions, and that this fact serves to indicate in their statistics a greater frequency of calculi than is actually the case. Such inspissated fæcal matter is quite common, but in this statistical study of the subject has been ignored, only well-formed calculi being considered.

Perforation of the appendix results from the direct necrotic action of bacteria and their toxins, or from the mechanical action of calculi, or from the combined action of both. Exceptionally, it results from the bursting of an empyema, but under such circumstances the rupture is not unconnected with the activities of bacteria. Perforation of the organ is favoured by anæmia, due to withdrawal of the proper blood supply. This may be the consequence of twists, flexures, or angulations of the organ; of the action of external cicatricial bands of adhesions; of thrombo-arteritis or thrombo-phlebitis; or of a combination of any of these factors. Predominance in causing perforation of the appendix must, however, be accorded bacteria. Calculi, nevertheless, are of considerable significance; but it is not warrantable to state that they must have been operative in all cases, assuming in those cases in which they were not found that they must have been overlooked or must have become disintegrated in the pus or exudate. They are often of decisive importance in determining the *site* of the perforation.

Perforation of the appendix, in the majority of cases, occurs into preformed peritoneal adhesions, and gives rise to a circumscribed peri-appendicular abscess. If, however, the perforation ensue very early in the course of the affection, before the peritoneum has had time to set up reactive adhesions, the contents of the appendix are evacuated into the general peritoneal cavity,

and there results a general peritonitis, of which mention will be made subsequently. Again, perforation may occur into the meso-appendix, and the contents of the appendix, liberated and dissecting up the two layers of this structure, may eventually reach the retro-peritoneal connective tissue and there produce a retro-peritoneal abscess. Under some circumstances the appendix has formed attachments with various organs, and, in the event of perforation of the appendix, the ulcerative process may continue also into these. If the organ in question be hollow, the ulcerative process, invading first the superficial layers of the appendix, finally its serous coat, then the serous coat of the hollow organ (intestine), until ultimately its mucous coat is perforated, produces a *bimucous fistula*. As it is the cæcum with which the appendix most frequently forms adhesions, so also is it the cæcum that is most frequently perforated in this manner. But cases have been reported in which perforation occurred into the duodenum and other portions of the intestinal tract. In addition, Keen and Bossard report cases in which perforation occurred into the bladder. In Keen's case the appendix became permanently adherent to the bladder, and a urinary fistula resulted; in Bossard's case a calculus was evacuated from the appendix into the bladder and formed the nucleus of what later became a good-sized vesical calculus.

It must be borne in mind that even deep ulceration and gangrene do not of necessity lead to immediate perforation of the appendix. In many such cases there results first either a more or less circumscribed or generalized peritonitis, with slight or well-marked intoxication, and the patient dies, or the appendix is removed by operative measures before perforation has ensued. Naturally, however, under such circumstances it is but a question of time when perforation occurs.

In all cases of *typhoid fever* in which morbid alterations occur in the large intestine it is very probable that examination of the appendix would reveal similar changes; and it is likely,

Appendicitis.

also, that in some cases in which the lesions in the large intestine are inconspicuous those in the appendix may be quite marked. Catarrhal alterations are usually well developed, and during the acme of the disease lesions of the lymphoid tissues are prone to be conspicuous. At times these assume such predominance as to give rise to concurrent appendicitis—*typhoid appendicitis*. Rarely, perforation may ensue, and a circumscribed or diffuse peritonitis may result. The sequels of such typhoid ulcerations—such as strictures, etc.—are often of considerable moment in the subsequent production of an attack of appendicitis.

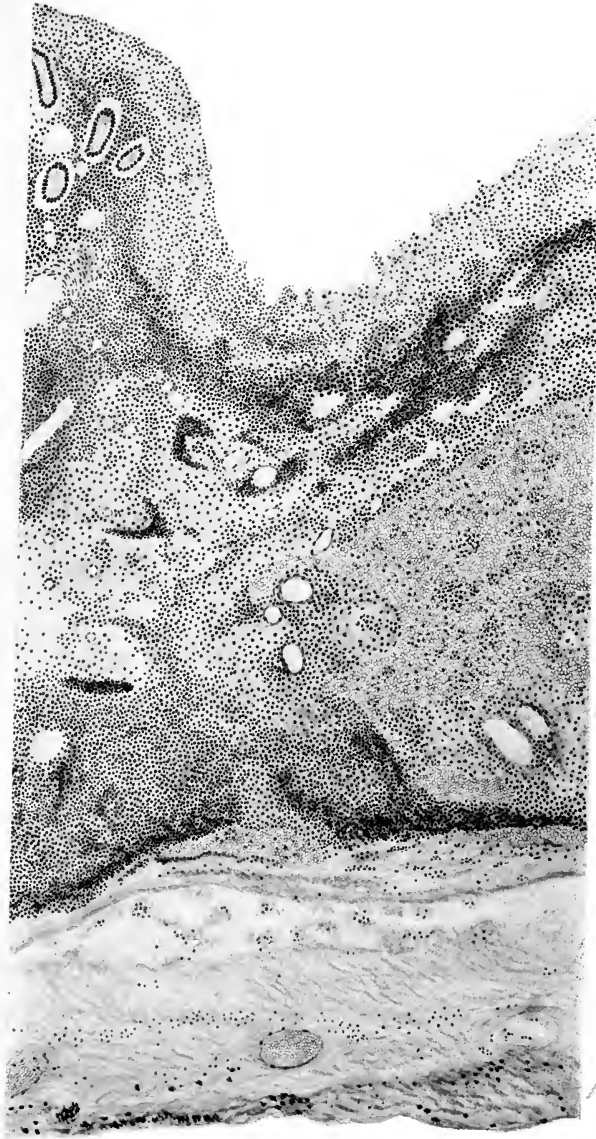
Microscopy.—In ulcerative appendicitis (Plate xvii) the pathological alterations already detailed in connection with catarrhal and interstitial appendicitis are present, but in much exaggerated degree. There are excessive dilatation and overfilling of the blood-vessels, and marked serous, cellular, and hæmorrhagic infiltration of the coats of the appendix. In the cellular exudate polynuclear leukocytes predominate, and many of these present all gradations of retrograde metamorphosis. The necrosis may result in one of two ways: It may commence by erosion and necrosis of the mucous lining of the organ, and, having involved and destroyed the basement membrane of the latter, may successively invade and destroy the subjacent coats—the submucous, muscular, and subserous tissue—until finally the peritoneal covering may be implicated, perforation ensuing. Less commonly, as detailed in connection with the interstitial form of appendicitis, an abscess situated beneath the unbroken mucous membrane develops. It may be situated in the submucous, the muscular, or the subserous coat, and, depending upon its situation, the subsequent events vary. If it be situated in the submucous coat, as it increases in size it at first encroaches upon, and finally occludes, the lumen. The epithelial cells of the mucous membrane already participating in the inflammation become deprived of their proper nutritive supply, and as a consequence of this, and also of pressure from

the abscess, they degenerate. The abscess finally ruptures into the lumen of the organ and an ulcerated surface remains. This ulceration may then progress until all the coats of the appendix are involved, and perforation, as in the aforementioned case, may eventually ensue. This submucous abscess may develop in the submucous connective tissue by liquefaction necrosis of the inflammatory exudate, or it may result from necrosis of one or more of the lymphoid follicles, as previously stated. If, on the other hand, the interstitial abscess be situated near the peritoneal covering, increasing in size, it may finally perforate externally: that is, into surrounding fibrinous exudate or into the general peritoneal cavity. Under such circumstances, as stated in connection with the macroscopy, there ensues a perforation or rupture of the wall of the appendix without any communication being established between the lumen and the exterior of the organ—no opportunity is afforded for the escape of fæcal matter into the peritoneal cavity. The process of ulceration thus inaugurated may progress, and a communication with the lumen may be subsequently established.

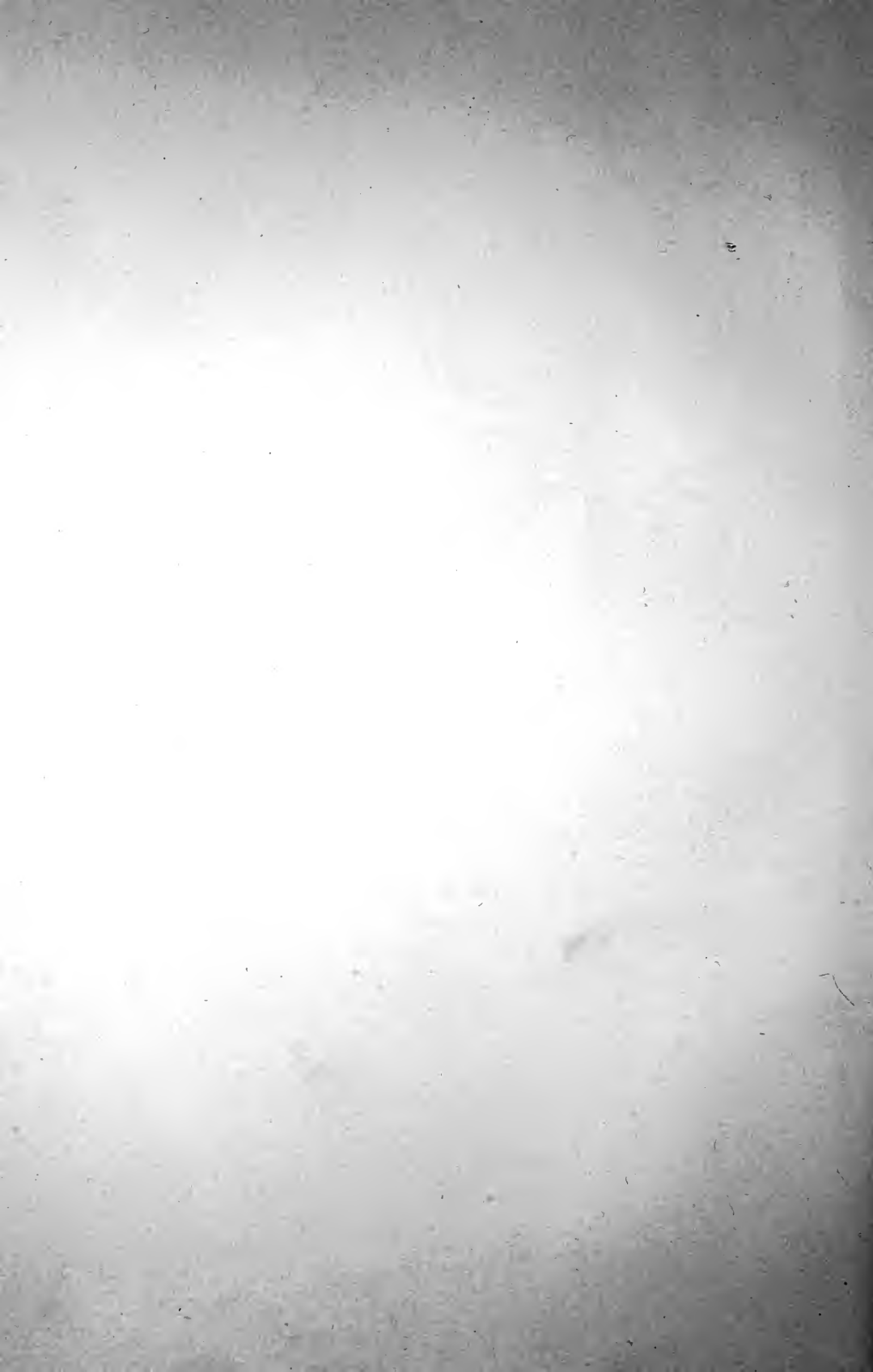
The liquefaction necrosis of the inflammatory exudate and of the appendicular tissues may be quite extensive, having developed rapidly, before there is any evidence of it macroscopically. The cell nuclei no longer stain well; they present chromatolysis, karyorrhesis, or hyperchromatosis; the cell protoplasm, plasmolysis; and, finally, the entire area becomes a mass of granular débris. To this fluid is added and the focus disintegrates entirely and is discharged into the lumen of the appendix, leaving usually an extensive ulcer. At times the process of ulceration is not so rapid; the necrotic tissue maintains some connection with the underlying tissues, and much resembles, upon superficial examination, a false membrane. In all cases of ulcerative appendicitis hæmorrhagic foci are a conspicuous feature. At times these are quite small—microscopical. Again, they are extensive, evident to the unaided eye, and lead to the

PLATE XVII.

ACUTE ULCERATIVE APPENDICITIS.—The section is through the entire wall of the appendix. To the left there are the remnants of a few mucous glands; to the right, the floor of the ulcer. The entire wall of the appendix presents marked distention of the blood-vessels, and serous and cellular infiltration. In the cellular exudate polynuclear leukocytes predominate, and many of them present all gradations of retrograde metamorphosis. The ulceration and necrosis have involved the mucous, the submucous, and a portion of the muscular coats, but such are the alterations that it is impossible to recognize with certainty, in the section, any of the coats of the organ. At *a* there is a very large hæmorrhagic focus. At *b* there is a large quantity of fibrinous exudate on the external surface of the appendix. Hæmatoxylin-eosin preparation. $\times 250$.



ACUTE ULCERATIVE APPENDICITIS.



utmost destruction of the appendix. Entire layers of the several coats are separated by the infiltrating blood, and excessive disturbance of the topographical relations ensues. At times the blood is found to be in a good state of preservation; again, it is more or less disintegrated, or is represented by blood pigment. Proliferation of the endothelial lining of the blood-vessels is evident in a certain proportion of the cases (Plate XVIII).

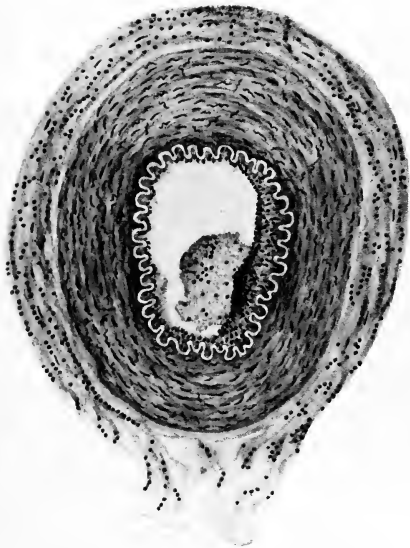
GANGRENOUS APPENDICITIS.

By gangrenous appendicitis is understood an inflammation or infection of the appendix attended by gangrene. This variety of appendicitis has often been referred to as infectious, under the mistaken apprehension that it only, in contradistinction to the other varieties, is due to bacterial infection. The frequency of this variety of appendicitis is indicated by the fact that of the 239 cases of acute appendicitis examined, 50 were of the gangrenous variety.

Gangrenous appendicitis, or gangrene of the appendix, may arise in one of several ways. In the first place, as before indicated, any of the previously described varieties of inflammation of the appendix may progress to gangrene. While this eventually may ensue in the course of an inflammation that commenced as a catarrh, be it acute or chronic, it is much more likely to follow the severer forms of inflammation of the organ. In fact, in the event of gangrene we are usually justified in assuming a sudden severe infection in an appendix already the seat of disease. On the other hand, a sudden severe infection, by virulent bacteria or their toxins, of a previously healthy appendix may occur. This infection may be so intense and so overwhelming as to lead to rapid and fatal gangrene, possibly of the entire appendix, before an opportunity has been afforded the tissues to set up counteracting inflammation. Exceptionally, infection may be so intense as to lead to the death of the patient before necrosis has become marked or peritonitis has

PLATE XVIII.

PROLIFERATIVE ENDARTERITIS.—The artery is from an appendix the seat of acute ulcerative appendicitis. The proliferation of the intima to the right is very evident. There is also thickening of the media. In the lumen there is a thrombus attached to the proliferating intima. Hæmatoxylin-eosin preparation. $\times 200$.



PROLIFERATIVE ENDARTERITIS.

developed. It is, however, merely a matter of time until the necrosis becomes absolute and peritonitis of a virulent type supervenes. Again, gangrene of the appendix may be caused by sudden and complete withdrawal of the blood supply from the entire organ or from part of it. This may be induced by twists, angulations, etc., or may follow thrombo-phlebitis or thrombo-arteritis consequent upon interstitial or ulcerative appendicitis.

Macroscopy.—If the gangrene occur in the sequence of ulcerative appendicitis, the naked-eye appearances detailed in connection with that variety of appendicitis are considerably exaggerated, both in degree and extent. A quarter, a third, a half, even the entire organ, may assume a dirty greenish-black colour; it may become swollen, malodorous, and softened, and may finally become detached from the remainder of the organ or from the cæcum (Plate XIX), as the case may be. The gangrenous area presents the appearance of moist gangrene generally. That region from which the gangrenous area has become separated by ulceration is reddened, raw, hæmorrhagic, and the seat of newly formed granulations. The remainder of the appendix, if the entire organ is not gangrenous, presents the appearances detailed in connection with the macroscopy of interstitial and ulcerative appendicitis.

If the gangrene be the result of sudden acute infection, at the end of a short time—from twenty-four to forty-eight hours—the entire organ or a portion of it may be completely deprived of its vitality. The same thing may happen if the blood supply be withdrawn. The portion of the organ affected is distinctly greenish-black in colour; it is increased in bulk, much softened, and of a characteristic gangrenous odour. It may still be attached to the remaining portion of the appendix or to the cæcum, and if but a portion be affected, the remainder is in a high state of interstitial inflammation, and is separated from the gangrenous area—at least, after the condition has existed for some time—by a more or less well-developed line of demarcation.

PLATE XIX.

GANGRENE OF THE APPENDIX WITH A LARGE APPENDICULAR CALCULUS. CIRCULAR AMPUTATION OF THE APPENDIX AT ITS ATTACHMENT TO THE CÆCUM.—The patient, aged thirty-six years, formerly a student and an athlete, had always enjoyed good health. On November 15, 1895, after a long ride in a cold damp wind, he was suddenly seized with what seemed at first to be a severe attack of indigestion. Within a few hours the pain became intense; there was tenderness on pressure over the region of the appendix; abdominal distention soon followed, and was associated with constipation. Calomel and one ounce of Rochelle salts by the mouth, and two ounces of Epsom salts in hot water as an enema, were soon followed by copious evacuations of the bowels. These led to subsidence of the pain and tenderness. In a few days, though not entirely well, he was able to attend to business.

On December 15th, after a hearty meal, a second attack occurred. This also subsided after free purgation, but the patient remained in his previous condition of poor health.

On January 7th, there occurred a third attack, which did not entirely subside. Surgical interference was then decided upon.

The operation was complicated by a very fat and muscular abdominal wall. The appendix pointed north and lay behind the cæcum, which was bound down. There was a very long and fat omentum and meso-colon. The appendix, which contained a large appendicular calculus, was enlarged, swollen, and gangrenous, and much resembled the fundus of the gall-bladder. It had been circularly amputated at its attachment to the cæcum, revealing a large perforation. This was closed under most unfavourable circumstances. The meso-appendix contained a small collection of pus. Iodoform gauze drainage was carried down to and covered the sutures in the cæcum in order to provide drainage in case the sutures should not hold. In protecting the general peritoneum and in the technique of the peritoneal toilet ninety pieces of gauze were used.

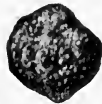
Recovery was uninterrupted. The case is rather exceptional in that the gangrene occurred to the proximal side of the appendicular calculus.



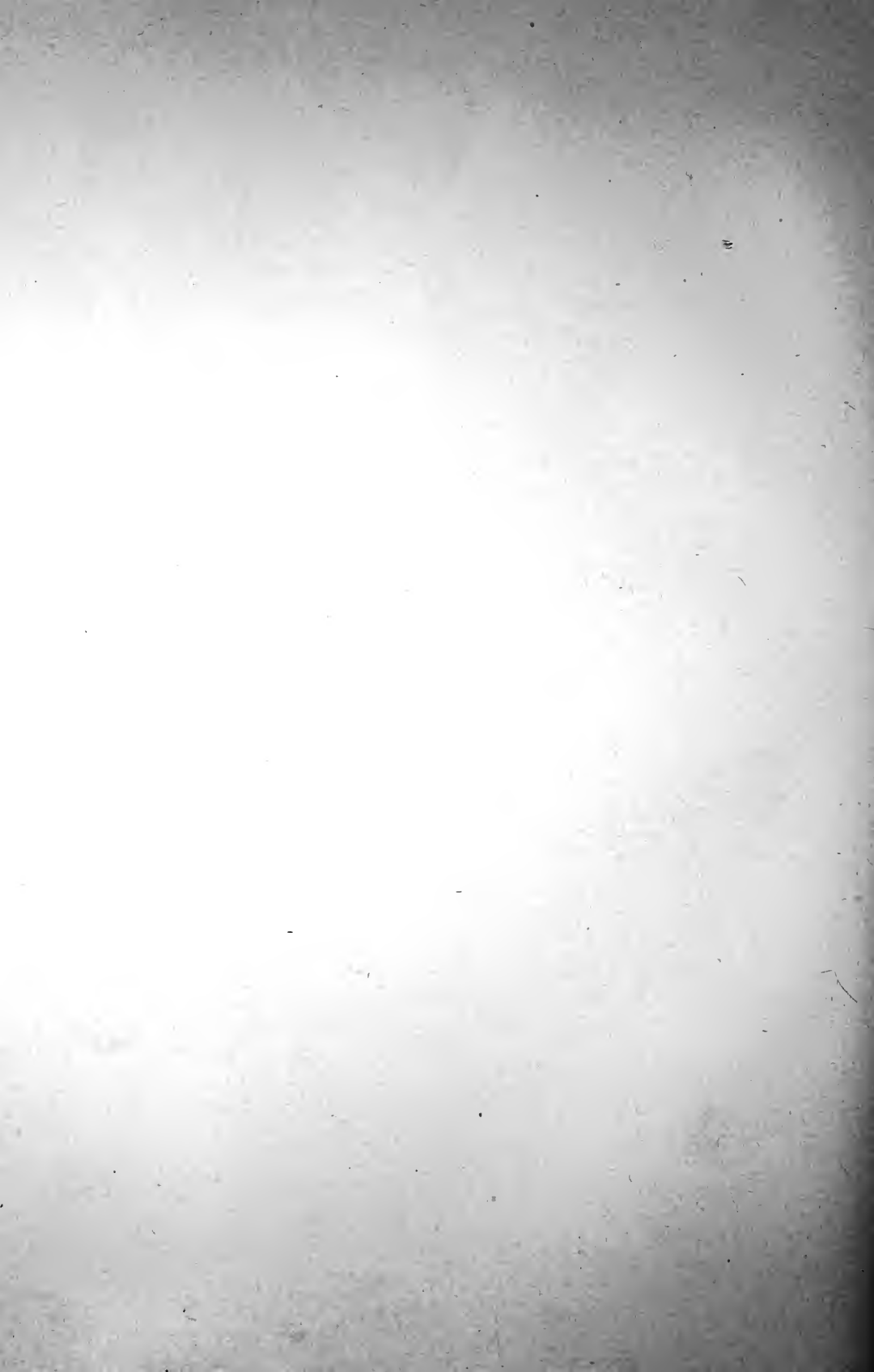
Circular amputation of the appendix from the cæcum.



Tissue at the lower end exceedingly friable, slight pressure causing it to break with extrusion of the appendicular calculus.



GANGRENE OF THE APPENDIX WITH LARGE APPENDICULAR CALCULUS.
In the cæcum is seen the point of circular amputation of the appendix.



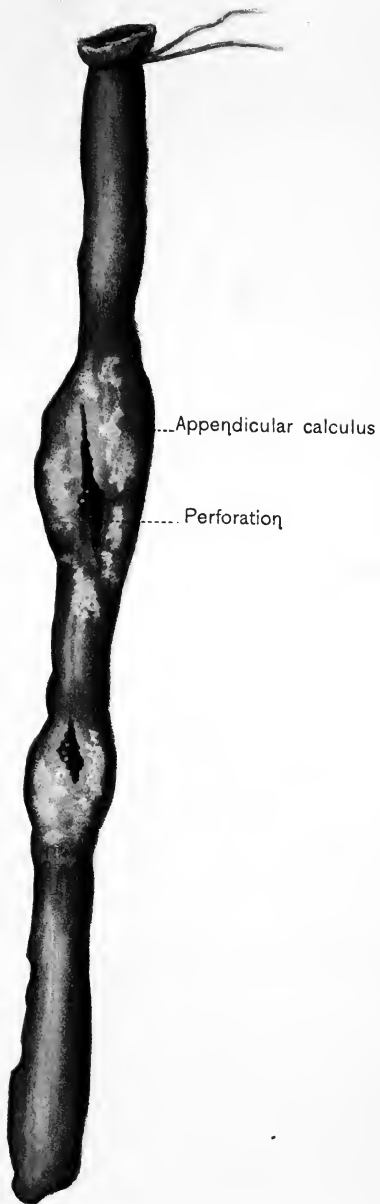
In this variety of appendicitis the pathological alterations and the clinical manifestations may develop with such rapidity as well to merit the designation *fulminating appendicitis*. There may occur within a short time a complete circular amputation of the entire appendix (Plate XIX) or gangrene of a considerable portion of it—conditions that have been spoken of as *sloughing of the appendix*. In some such cases sufficient time has not elapsed for the formation of peritoneal adhesions, and thus—in contradistinction to the other varieties of appendicitis, in which the organ is commonly surrounded and more or less fixed by adhesions—the appendix may be found to be totally gangrenous, completely detached from the cæcum, and free in the peritoneal cavity. In other cases it may be found separated from the appendix and free in a circumscribed abscess.

The matter exuding from the opened lumen of such gangrenous appendices is usually pus. At times appendicular calculi may be found (Plate XX), either in the lumen, projecting from it, or in the surrounding purulent matter or exudate. In 49 of the cases of gangrenous appendicitis examined they were found in 5 (10.2 per cent.). Doubtless others, however, at the time of operation had already escaped from the appendix and were not detected in the surrounding exudate or pus.

As already indicated, the gangrene may affect the whole or a portion of the appendix. There may occur a circular amputation anywhere, or but a portion of the circumference may be involved. Most unusual and remarkable conditions are sometimes encountered. An instructive instance is the case illustrated in Plate XXI, in which, at a secondary operation for the cure of two fistulous tracts persisting after a primary operation, the appendix was found to consist of the tip connected with the proximal half by a band of the meso-appendix. The opening in the appendix was in communication with the two fistulous tracts. Jopson reports a somewhat similar case: A fistula—from which there was a profuse mucous discharge,

PLATE XX.

GANGRENE OF THE APPENDIX WITH PERFORATION.—The patient, aged fifty-six years, was taken ill suddenly on the evening of July 23, 1895, with severe abdominal pain. There was a history of similar attacks, which had been treated as ordinary colic. Examination by his attending physician disclosed a distended abdomen and tenderness in the right iliac region. The pain and tenderness, both of which persisted, were especially marked over the site of the appendix. I saw the patient on the evening of the second day, and advised operation, which was delayed for two days. The operation, when finally performed, revealed a very long and gangrenous appendix, situated post-cæcal and post-colic. It was perforated, was surrounded by pus, and contained several appendicular calculi. There was also pus in the pelvis. Glass and gauze drainage were employed. The patient was the subject of chronic interstitial nephritis. For two days following the operation vomiting and hiccup were persistent. Recovery eventually ensued.



Gangrene of the appendix with perforation, illustrating the result of occlusion of the lumen beginning at a point other than the tip.



giving the chemical and microscopical reactions for mucin—persisted after an operation at which the appendix was not located. At a secondary operation the stump of the appendix was found in communication with the sinus; it was entirely separated from the cæcum and was removed a considerable distance from it. Its mucous membrane was preserved, accounting for the mucous discharge. It had received its nutritive supply from vessels coursing in the numerous adhesions in which it was embedded. Frankfurter records a case in which circumscribed gangrene affected a portion of the wall of the organ, which disappeared. A bridge of tissue—remnants of the wall at the site of the gangrene—united the distal and proximal portions of the appendix. Roux records a case in which the appendix, amputated at its middle, was embedded in peritoneal adhesions. The amputated distal portion, which had become converted into a fibrous cord and was much distorted, was nourished by an artery, evidently newly formed, coursing in a band of adhesions springing from the region of Poupart's ligament. The proximal portion was nourished, as originally, by a branch of the appendicular artery coursing in the remnants of the meso-appendix. Fowler relates the case of a patient, aged eighteen years, who developed general peritonitis on the seventh day of an apparently ordinary attack of appendicitis. At the time of operation nothing was found of the appendix except the mucous membrane, forming a closed sac in which there was a fæcal concretion. The remaining coats had become gangrenous and disintegrated. Despite the presence of the concretion, perforation of the mucous membrane had not taken place. The peritoneal cavity contained sero-purulent fluid. Many other curious cases have also been reported.

Microscopy.—Those portions of the appendix actually the seat of gangrene naturally present no structure that can be identified with certainty. Other portions of the organ present all gradations from moderate interstitial inflammation and

PLATE XXI.

GANGRENE OF THE APPENDIX.—The patient, aged seventeen years, suffered with acute appendicitis. His condition being extremely precarious at the time of operation, it was considered wise to evacuate the abscess only. Instead of the abdominal wound healing completely, there remained two fistulous tracts, from which fæcal matter escaped. Ten weeks later operation for the removal of the appendix was undertaken. It was found that, with the exception of the tip, but the upper half remained, these two portions being connected by a band of the meso-appendix. The openings in the appendix were in communication with the two fistulous tracts.

Recovery followed.

Fig. 1

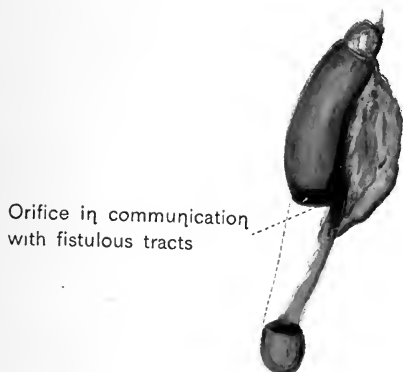


Fig. 2

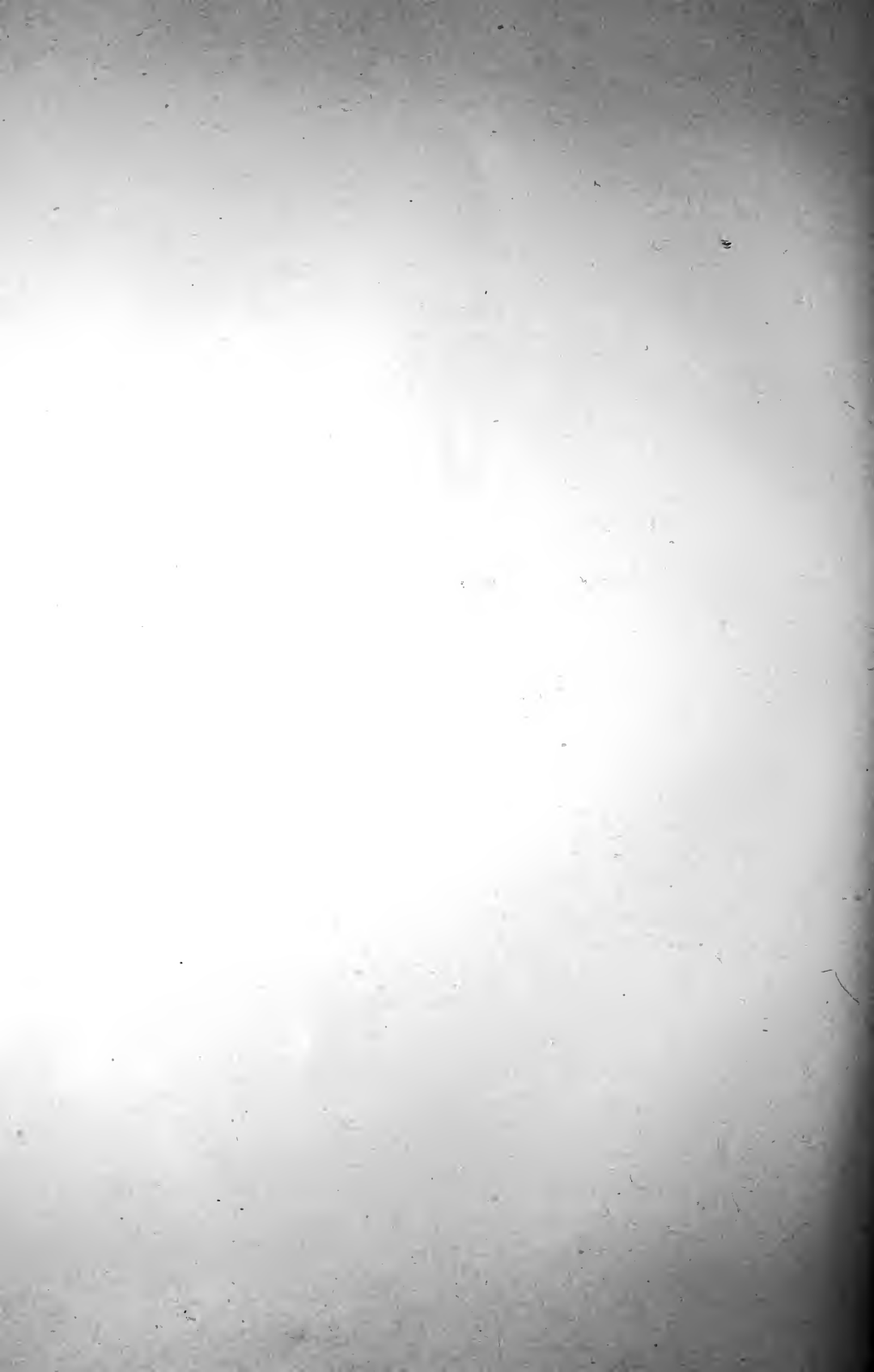


Granulations surrounding fistulous tracts

Gangrene of the appendix

FIG. 1. Complete gangrene of a portion of the appendix—the remaining portions connected by a bridge of the meso-appendix.

FIG. 2. External orifices of the fistulous tracts in communication with the lumen of the remaining portions of the appendix.



ulceration to actual gangrene. If gangrene follow catarrhal or interstitial inflammation with ulceration, in certain regions—unless the entire appendix is already gangrenous—there is more or less extensive destruction of the surface epithelium, and to some extent also of the protecting basement membrane. It is not improper to assume that this latter structure is of considerable importance in protecting against infection. The exposed and unprotected mucosa and submucosa afford a congenial soil whence infection of the entire wall is a matter readily accomplished. In addition, there are noticeable high grades of interstitial inflammation, with abundant round-cell infiltration, suppurative foci, larger and smaller areas of hæmorrhage, and more or less extensive necrosis. The individual cells present plasmolysis, chromatolysis, karyorrhexis, and hyperchromatosis. Adipose tissue becomes converted into free fat and fatty acids, muscle fibres become indistinct and dissolved, and the entire tissue breaks down into a granular and semi-fluid débris. Hæmorrhages ensue, either from erosion of the vessels or, not uncommonly, from the result of the direct action of the bacteria and their toxins on the vessel walls. If a line of demarcation have formed, it presents, on the one hand, all the evidences of liquefaction necrosis until the sphacelus is cast off; and, on the other, the ordinary evidences of inflammatory reaction—commonly, however, with but slight manifestations of regeneration. If the gangrene be the consequence of sudden severe infection with very virulent bacteria, or of the sudden and complete withdrawal of the blood supply consequent upon twists, flexures, thrombo-phlebitis, or thrombo-arteritis, the entire appendix or a large portion of it presents evidences of very diffuse gangrene without manifestations of reactive inflammation. Under such circumstances the gangrene affects a large portion of the appendix uniformly, and does not appear to have been the result of the progression of the other varieties of inflammation of the appendix. The deeper layers of the organ are quite as much involved as the superficial.

CHRONIC APPENDICITIS.

In some presumably diseased appendices, particularly in some of those removed from patients presenting clinical evidence of chronic appendicitis, histological alterations are not especially conspicuous. In a few instances they are not more marked than are those sometimes detected in appendices removed at necropsy from subjects who during life presented no definite indications of appendicitis. In some cases the only tangible and unmistakable evidences of disease are peritoneal adhesions binding the appendix to various tissues or organs. Thus, the query naturally arises: When is the appendix to be regarded as pathological? It need hardly be stated that in a number of cases, especially of chronic appendicitis, a microscopical examination of the organ must be made before a trustworthy opinion as to its condition can be formulated.

In many instances disease of the appendix has been detected postmortem in subjects who during life manifested no noteworthy clinical evidences of such deviations from the normal. Thus, Kraussold states that one-third of all adult bodies reveal diseased appendices; Toft found the appendix diseased in 100 out of 300 subjects upon whom he performed necropsies; Hawkins detected evidences of past or present disease of the appendix in 16 out of 100 subjects. Personally, I believe that careful macroscopical and microscopical investigation will reveal indications of disease in at least one-third of presumably normal appendices removed from adults. Kelynack, on the other hand, believes that the statistics of Ransohoff—who found diseased appendices in 8 out of 60 subjects—represent more nearly the usual proportion. In many of these cases there can hardly be any question that the patients did not present any evidences of serious disease; on the other hand, the appendix can not be regarded as normal. It is not likely that the lesions began acutely; rather, they commenced chronically, insidiously, and

it is but fair to assume that, had the patients lived long enough, or had an appropriate infection occurred, they would inevitably have suffered the evil consequences of these morbid changes. In other cases the patients complain of various indefinite abdominal symptoms that are referred to disease of one or another of the abdominal organs. At times, however, the affection is recognized as chronic appendicitis, and the good effects attending operation for the excision of the offending organ sufficiently attest that even minor pathological alterations of the appendix may give rise to more or less aggravated and persistent clinical symptoms. Many of these cases doubtless belong to the class that Ewald has incorrectly designated *appendicitis larvata*. Rather should they be termed cases of appendicitis difficult of diagnosis. They should not be confounded with those cases that Nothnagel, among others, has described under the caption of hysterical mimicry of appendicitis. The hysterical nature of a case of suspected appendicitis should not be especially difficult of recognition.

Many patients not in the least hysterical suffer severely and repeatedly from more or less aggravated attacks of recurring appendicitis; and still, in some instances, the appendix, when excised, presents but minor pathological alterations. Sonnenburg reports a case in which, extending over a period of years, there occurred thirty attacks (some of them severe) of appendicitis, and yet when the appendix was removed it was pale, white, and soft. No details, however, are given of any microscopical examination. Doubtless in some cases the inflammatory phenomena subside with greater or less rapidity, and in the absence of extensive histological evidence of disease, it is not always warrantable to assert that the removal of a given appendix was not justified. It must further be admitted, in view of the difficulty sometimes experienced in distinguishing between the results of inflammatory disease and certain developmental anomalies and retrograde alterations, that, in certain isolated cases,

the clinical history is of decisive importance. All of the foregoing, however, are exceptional cases. Ordinarily, there is no difficulty whatever in recognizing the lesions of chronic appendicitis.

CHRONIC CATARRHAL APPENDICITIS.

By chronic catarrhal appendicitis is understood a chronic inflammation of the appendix in which the pathological alterations are wholly or almost wholly confined to the mucous membrane, the other coats presenting little or no deviation from the normal. This is a very uncommon variety of appendicitis, for the reason that the causes inducing the inflammation, from their very nature, entail consequences that render the limitation of the pathological alterations to the mucous membrane extremely unlikely. There can, however, be no question that cases of catarrhal appendicitis do occur. They are cases that clinically pursue a mild course, being, possibly, now and then subject to minor acute exacerbations. The clinical history of some cases of appendicitis indicates the existence of appendicular disease for a considerable period of time, and yet examination of the excised appendix reveals only catarrhal lesions. The occurrence of such cases has been indicated by various observers from time to time. In particular, Siegel reports a case in which, clinically, there had been severe pain, extending over periods of years, and in which, outside of catarrhal inflammation, the appendix exhibited neither macroscopical nor microscopical evidences of disease. Of the 305 chronic cases that I examined, 6 were of this variety.

Macroscopy.—Macroscopical examination shows the appendix to be a little thicker, stiffer, and firmer than normal. On incising it, the mucous membrane is found to be of a grayish colour and somewhat thickened. The crypts of Lieberkühn are moderately distended and the mucous membrane is covered with a layer of rather thick mucus. This mucus may also fill

more or less completely the lumen of the organ. There is, however, commonly associated with the mucus, some faecal matter, or, rarely, a calculus. The calibre of the lumen may vary somewhat at different levels, usually as a result of previous attacks of inflammation. If to such chronic catarrhal inflammation there be added an acute exacerbation, the evidences of the latter, as already narrated, will be manifest.

Microscopy.—The crypts of Lieberkühn are more or less distended with mucus, and some mucous droplets are also seen in the epithelial cells lining these crypts and the lumen of the organ. Naturally, these are not so conspicuous as in the acute variety. In the mucosa there are a few round cells and spindle cells and connective-tissue hyperplasia. At times the vessel walls of this region are thickened, and there may be some foci of blood pigment.

It is extremely improbable that in chronic inflammation of the appendix the lesions will remain indefinitely localized to the mucous membrane. They tend to become diffuse, constituting chronic interstitial appendicitis.

CHRONIC INTERSTITIAL APPENDICITIS.

By chronic interstitial appendicitis is understood a chronic inflammation of the appendix in which all the coats of the organ are involved. In certain instances one or more coats exhibit pathological alterations out of proportion to those of others, but usually deviations from the normal, more or less conspicuous, may be detected in all. This is the common variety of chronic appendicitis. In fact, excepting those relatively rare cases in which the lesions are strictly confined to the mucous membrane, and others due to certain specific micro-organisms,—such as the tubercle bacillus, etc.,—all cases of chronic appendicitis are of the interstitial variety. These are the cases clinically spoken of as chronic appendicitis, relapsing appendicitis, recurring appendicitis, etc. Clinically and pathologic-

ally, it suffices to designate them chronic appendicitis. Of course, an acute exacerbation may develop at any time. Of the 305 cases of chronic appendicitis examined, 299 were of the interstitial variety, 6 of these, however, being of the subclass designated obliterating appendicitis.

Macroscopy.—The naked eye appearances (Plate xxii) vary considerably in different cases. The simplest form is that in which the condition follows the subsidence of a minor grade of acute inflammation, or in which the process commences as a chronic inflammation, the lesions not being limited to the mucous membrane. The organ is thicker, stiffer, and firmer than normal, and is noncollapsible. The appearances of its mucous membrane and contents do not differ especially from those described in connection with chronic catarrhal appendicitis. At times the lumen is much reduced, varies in calibre in different regions, and contains one or more calculi. Of 252 of the chronic cases examined, calculi were noted in 39 (15.5 per cent.). Whether the lesions are confined to the mucous membrane, or are distributed throughout all the coats, is at times determinable only upon microscopical examination. Again, however, the walls are excessively thick, and justify the inference that the lesions are widespread. In a great number of cases I have found the external diameter of the appendix to be from 12 to 14 mm. and more, and the lumen less than 2 mm.

Reference has been made to the frequency of erosions and ulceration of the appendix in cases of acute inflammation, and it was stated that if the inflammation were not very intense, the acute manifestations might subside, the process becoming chronic. Under such circumstances certain important results ensue. That portion of the wall of the appendix which is the seat of erosion or ulceration is replaced by newly formed connective tissue, which like all newly formed connective tissue, tends to contract and to form cicatricial tissue. As a consequence the lumen becomes contracted. If there have been

several points of ulceration, there will also be several points of stenosis of the lumen. Depending upon the situation, size, and shape of these cicatrices, there results either a transverse narrowing of the lumen, or, particularly if the cicatrix be longitudinal rather than annular, there will ensue a shortening of the organ along one side—a curling-up of the appendix, or an angulation, flexure, twist, etc. If there be several cicatrices, the utmost distortion of the appendix may be produced, and the lumen of the organ may be represented by several cavities separated from one another by areas of constriction. It is in those portions of the lumen limited by stenosis that appendicular calculi are particularly liable to be encountered. Not infrequently they give rise to chronic erosion and ulceration. It must be borne in mind that such ulceration may also be due to causes other than calculi, as, for instance, tuberculosis, bacterial toxins, acute exacerbations of inflammation, etc.

On the other hand, there may be complete obliteration of the lumen of the appendix at one or more points along its length. It is readily conceivable that in the event of annular ulceration, granulating surfaces being everywhere opposed to granulating surfaces, these adhere, and, as the processes of regeneration and organization go on, become permanently united by means of newly formed connective tissue. Such obliteration of the lumen may be circumscribed or generalized. In the latter case obliterating appendicitis results; in the former, merely a local obliteration. The latter may be situated anywhere, and not uncommonly gives rise to a condition known as *cystic dilatation, retention cyst, hydrops, or mucocele* (Féré) of the appendix (Plate XXIII). This is a condition in which that portion of the appendix distal to the obliteration becomes distended and filled with fluid. It was first recognized by Virchow, who spoke of it as colloid degeneration of the appendix. Depending upon the site of the obliteration, a portion of the appendix or the entire organ may be affected. Commonly, the dilatation is con-

PLATE XXII.

CHRONIC INTERSTITIAL APPENDICITIS.—The patient, aged thirty years, had always been rather delicate, but enjoyed comparatively good health except for mild chronic intestinal dyspepsia, with occasional acute exacerbations. In May, 1895, she had an attack of what was believed to be intestinal dyspepsia of more than usual severity. The attack was accompanied by diarrhœa and pain, referred to the region of the appendix, but recovery followed in a few days. On December 7, 1895, she was suddenly seized with acute agonizing pain in the abdomen, which was followed by diffuse tenderness and rigidity of the entire abdominal wall, and by nausea and vomiting. This condition yielded to the administration of laxatives and hot applications locally. The nausea and vomiting subsided and the tenderness became localized in the region of the appendix. The temperature never rose above 102° F. On the tenth day a slight exacerbation of the pain was caused by dietetic indiscretion. Two hypodermic injections of morphine and copious enemas were administered. Rectal feeding was carried out until the stomach became retentive. Although recovery was progressing satisfactorily, operation was decided upon, and was performed January 18, 1896.

The appendix was enlarged, congested, and firm to the touch. Its mucous membrane was congested and indurated, and presented slight superficial ulcerations. The lumen of the distal third of the organ was completely obliterated.

Recovery was uninterrupted, and was followed by decided improvement of the old intestinal symptoms.

Fig 1

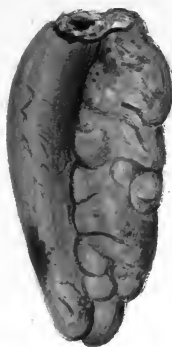
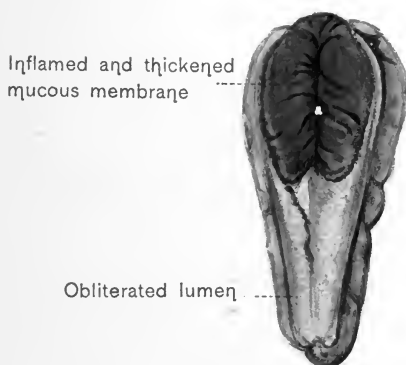


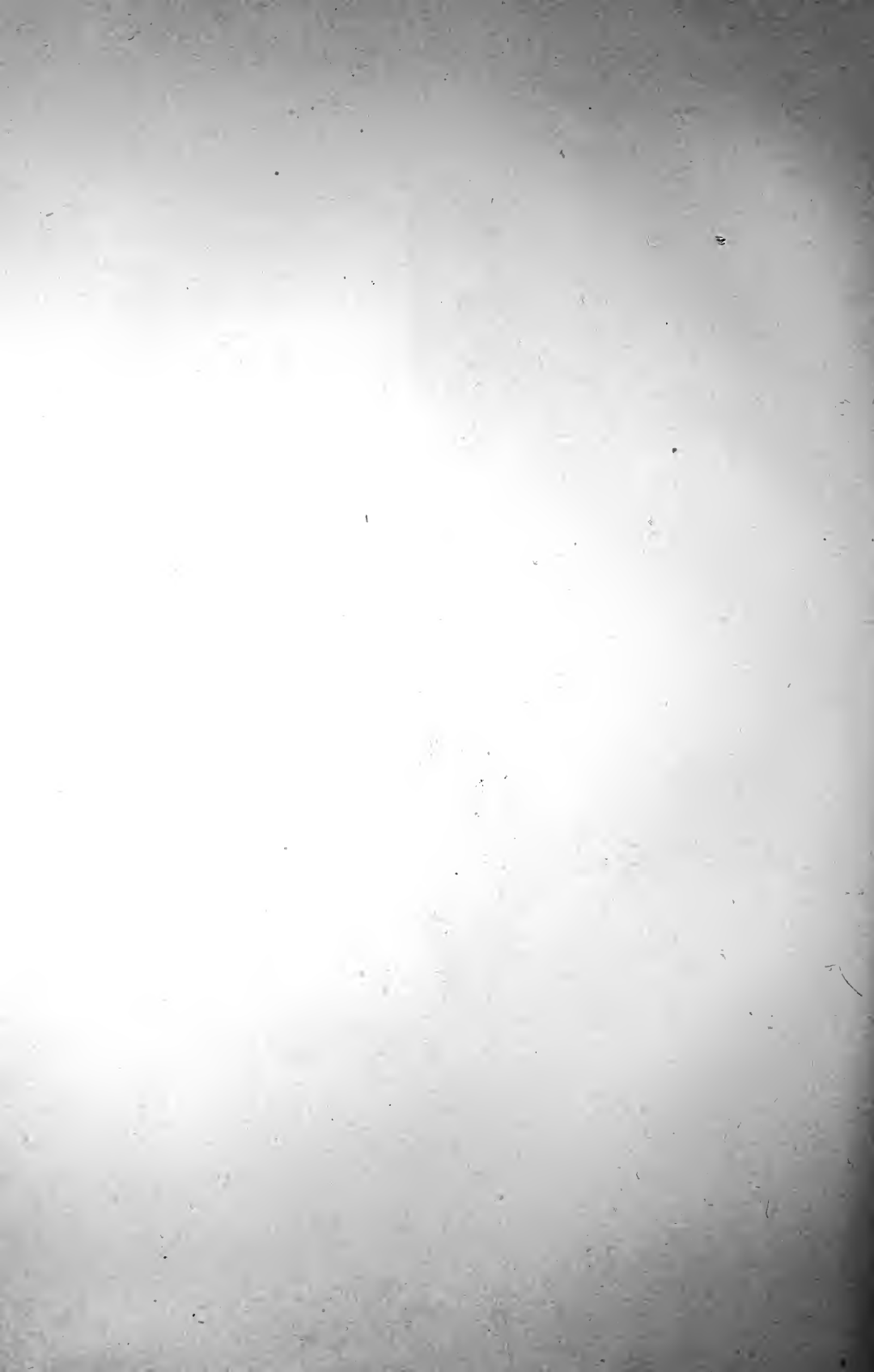
Fig. 2



Chronic interstitial appendicitis

FIG. 1. External aspect of the appendix illustrating thickening of the wall of the organ and congestion of the subperitoneal blood-vessels.

FIG. 2. Internal aspect of the appendix illustrating congestion, induration, and superficial ulceration of the mucous membrane, and complete obliteration of the distal third of the lumen.



fined to the distal half of the organ, but the entire organ is relatively often involved. Rarely, a central portion may be implicated, the tip and proximal portions being free. Under such circumstances, however, the tip is much more likely to be entirely obliterated.

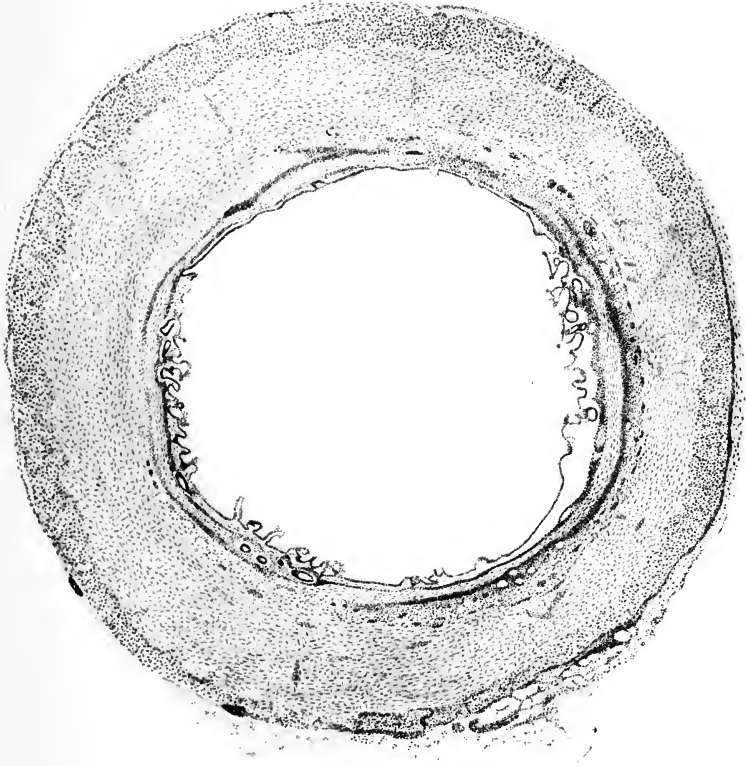
These cystic dilatations vary much in size. At times they are not much larger than a walnut, but instances of excessive size have been reported. Virchow stated that they might reach the size of a large fist. One removed by Deaver from a woman, aged twenty-five years, who had had two attacks of appendicitis, was the size of a small orange, and was adherent both to the neighbouring coils of small intestine and to the right broad ligament. The lumen of the appendix was entirely occluded one-quarter of an inch from its caecal end.

In shape they may be ovoid, cylindroid, round, or irregular. The character of the contained fluid also varies. It may be clear or slightly turbid, tenacious, gelatinous, or sometimes more limpid and watery. Leube long ago drew attention to the fact that at first the contained fluid consists of tenacious mucus, and that it later assumes the characteristics of a watery serum. This ensues because the wall of the appendix, as it becomes distended, usually also becomes thinned, its inner surface growing smooth and the distribution of its vessels being more superficial than normal. This results, on the one hand, in facilitating the escape of the watery portion of the blood, and, on the other, in reducing to a minimum the formation of mucus.

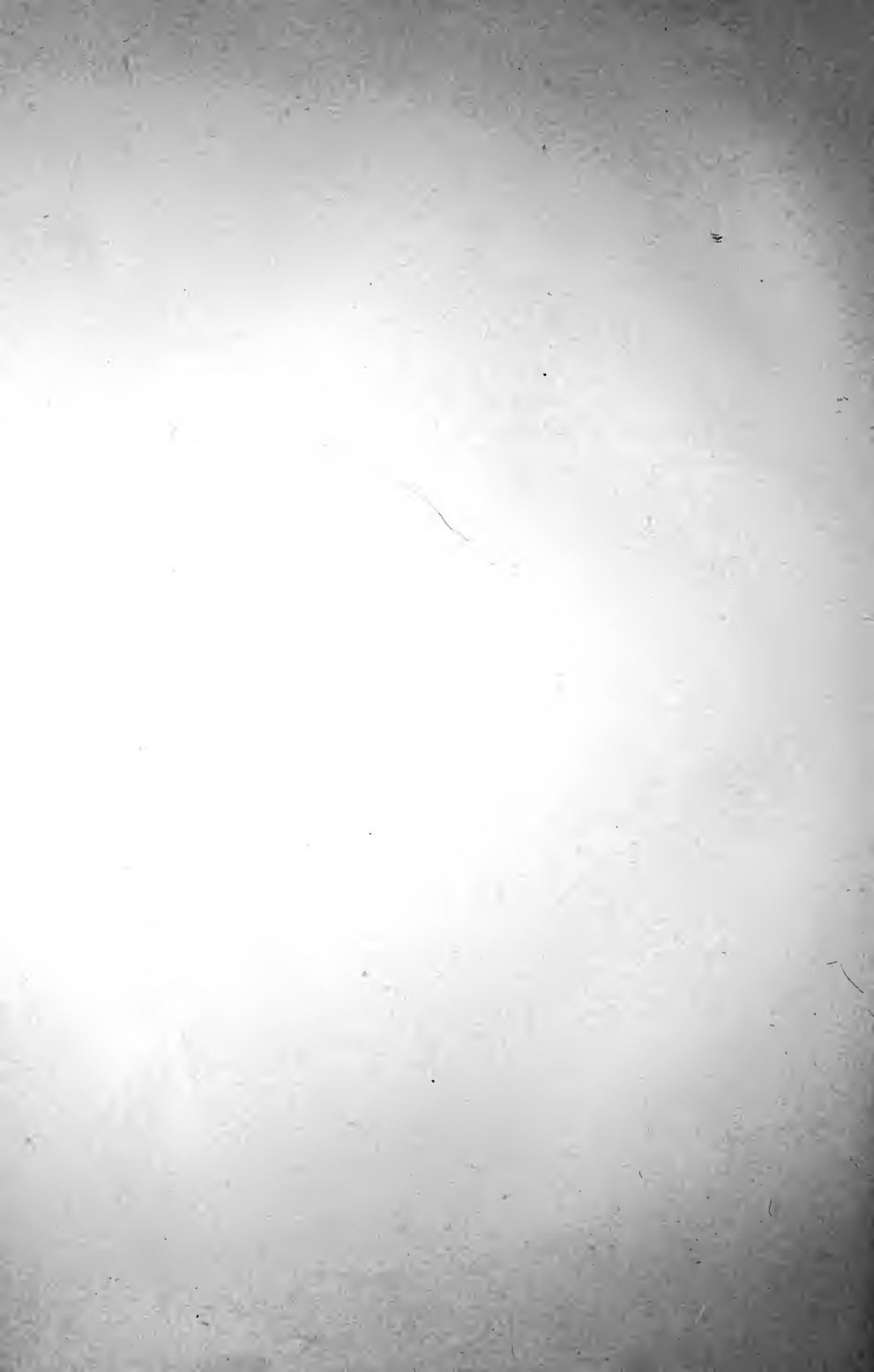
Some very unusual conditions have been reported. Thus, Coats, Weir, and Kelynack have observed cases in which the contents were gelatinous in character. In Kelynack's case "the appendix was greatly distended, and presented two very distinct diverticular processes, which were directed beneath the folds of the mesentery of the appendix. The diverticula were connected with the dilated cavity of the appendix through

PLATE XXIII.

CHRONIC INTERSTITIAL APPENDICITIS—CYSTIC DILATATION OF THE APPENDIX.—A transverse section through the appendix at the seat of marked distention. The section shows the mucous membrane markedly thinned, flattened, and atrophic. In many places it has been reduced to a single layer of epithelial cells. To the right it has become detached in the preparation of the section. There is also marked atrophy of the lymphoid follicles and considerable hyperplasia of the muscular coats. Hæmatoxylin-eosin preparation. $\times 70$.



CHRONIC INTERSTITIAL APPENDICITIS—CYSTIC DILATATION OF THE APPENDIX.



well-defined circular openings." Hawkins states that there is a specimen in St. Thomas's Hospital Museum that shows five or six diverticula on the surface of the cyst. Hawkins, Bland Sutton, and Page report cases in which the contents consisted of purulent matter; but these were probably ordinary empyemas of the appendix. Fenwick reports a case in which the appendix was distended by a "milky fluid." Guttman reports a case in which the dilatation was 14 cm. in length and 21 cm. in its greatest circumference. In the case illustrated in Plate XXIII the contents were quite clear and were somewhat tenacious.

Not all cases, however, are due to obliteration of a portion of the lumen of the appendix; sufficient obstruction may be produced by a very acute angulation. An instructive case of this sort has been reported by Treves and Swallow. A tumor two inches in length and one inch in diameter was made up of the appendix acutely bent upon itself and distended with mucus. The angulation was maintained by old peritoneal adhesions. When this was relieved, the contents escaped of their own accord.

The development of this condition of cystic dilatation of the appendix depends upon several factors. The obstruction of the lumen must be complete, or almost so; the obstruction or obliteration must have obtained at a time when the affected portion of the organ contained no pathogenic micro-organisms; the mucous membrane of the affected portion must be intact, or at least capable of functioning; and the secretion by the mucous membrane must be more rapid than the absorption from the portion of the appendix involved. If the obstruction be not complete, the secretion is likely to be forced through even a narrow opening with sufficient rapidity to prevent a large accumulation, and, on the other hand, infection is likely to occur through the patulous lumen, converting a cystic dilatation into an empyema. If there are already virulent bacteria in the affected portion of the appendix, an empyema, of course,

rather than a cystic dilatation, will develop in the first place (Plate xv). If the mucous membrane is incapable of functioning, there can be no accumulation of fluid, and the same is also true if absorption be more rapid than secretion.

The condition is readily recognized as cystic dilatation of the appendix. The mucous membrane is usually smooth, and is generally in a high state of atrophy as a consequence of mechanical pressure. There is also marked atrophy of the lymphoid follicles. If the distention be but moderate, it is not uncommon to find the wall much thickened, as a result of compensatory hypertrophy of the muscular coats, and also of some connective-tissue hyperplasia (Plate xxiii). Both these conditions, as evidences of chronic inflammation, as is mentioned elsewhere, may have developed prior to the hydrops. If with the occurrence of the distention the wall does not increase still more in thickness, it is likely to become much attenuated under the influence of the progressive accumulation of the fluid.

Microscopy.—The microscopical appearance of the extirpated appendix in cases of chronic appendicitis varies considerably in different instances. In some cases in which the clinical manifestations have extended over a period of some years the microscopical evidences of disease are very slight. In these cases, however, the indications of disease are self-evident from the macroscopical appearances, the distortions of the organ, and the chronic peritoneal adhesions. Even in these cases, however, careful microscopical examination will usually detect some of the catarrhal alterations already detailed in connection with chronic catarrhal appendicitis and some hyperplasia of the submucous or muscular coats or of both. In addition, more or less round-cell infiltration will commonly be noticeable. In other cases the hyperplasia of the submucous and muscular coats is excessive, and there is considerable round-cell infiltration, which is usually scattered in small amounts throughout the various coats. If the lesions of the mucous membrane, already

referred to, are not present, there is commonly more or less atrophy of this structure, and in some instances it is replaced by cicatricial connective tissue—the lumen, under such circumstances, being very narrow. In most cases of chronic appendicitis a hyaline degeneration of the submucous and muscular coats is a rather conspicuous feature. This varies in extent in different cases, at times being minimal, at others quite diffuse. If the appendix be examined while the process of cicatrization of an ulceration is in progress, remnants of the mucous membrane may still be detected. This, however, is not usual. On the contrary, what remains of the mucous membrane and submucosa is the seat of extensive round-cell infiltration, which is present also, to a greater or less extent, in the muscular coats. As a consequence of this round-cell infiltration, and of some hyperplasia of the submucous and muscular coats, the wall of the appendix is thickened and noncollapsible, and peristalsis is inhibited. Conditions are favourable, therefore, for the approximation of the opposed granulating surfaces—the free edges of the lumen—and for the formation of adhesions. In many cases delicate strands of embryonic connective tissue may be seen bridging the narrow slit—remains of the lumen—and uniting the opposed surfaces. In the early stages of this process, however, these strands are so delicate that they are frequently torn in the manipulations necessary in preparing the sections, and hence may be overlooked. Newly formed blood-vessels are frequent, and about these there spring up new granulations, which tend to cicatrization and to the formation of fibrous connective tissue. Obliteration of the lumen at some point may now be complete. Cicatrization continues, and the diameter of the appendix becomes, in consequence, gradually lessened. The blood-vessel walls are often thickened, and at times there is interstitial hyperplasia of the nerves, especially of those of the meso-appendix. There may also be some proliferation of the endothelium of the blood-vessels.

OBLITERATING APPENDICITIS.

By oblitative or obliterating appendicitis is understood a variety of interstitial inflammation of the appendix attended by or leading to obliteration of its lumen. Of the 299 cases of chronic interstitial appendicitis examined, 6 were recognized as of this subvariety.

Macroscopy.—Upon naked eye examination such appendices, as a rule, do not differ materially from those described under the heading Chronic Interstitial Appendicitis. In some instances, however, the region of the obliteration of the lumen is made evident by a marked thinning of the appendix, which may be reduced to one-half or less of its original size. Exceptionally, it may be reduced to a mere filament; and if but a portion be so affected, this presents a marked contrast to the remaining portion, which may be normal in thickness, or even somewhat increased, as a consequence of hyperplasia of the muscular coats. Upon endeavouring to incise the organ—that is, to open its lumen lengthwise—the obstruction or obliteration of the lumen is encountered. This may be situated anywhere along the course of the appendix, and, depending upon the stage of the process, there may be friable bands of adhesions or an impervious band of dense cicatricial connective tissue. Indeed, the whole appendix may be converted into such an impervious band of connective tissue by obliteration of the entire lumen. Under such circumstances, of course, subsequent attacks of appendicitis are rendered impossible: that is, a so-called natural cure has resulted. But such an event is of great rarity. Usually, the obliteration is limited to a portion of the organ, which may be the tip, the distal third, a half, or more. At times, as already indicated, the obliteration may affect a portion of the appendix at a distance from the tip, and the latter, if its mucous membrane be preserved and functional, may subsequently become the seat of cystic

dilatation. Appendices the seat of obliteration of the lumen are commonly embedded in a dense mass of fibrous adhesions, which, by contracting, tend to hasten the process of obliteration. Even if complete obliteration occurs, these adhesions, which remain, sometimes give rise to disastrous intestinal and other complications.

Senn, who has directed particular attention to the obliterating variety of appendicitis, speaks of varying degrees of contraction of the lumen of the appendix that he has encountered, and that differ in extent from slight stenosis to complete obliteration; and these cases he includes in his category of obliterative or obliterating appendicitis. It seems to me, however, that this is an incorrect interpretation of the pathological conditions, and that it is much wiser to limit the designation obliterative appendicitis to those cases in which an actual obliteration of the lumen occurs, and to exclude those cases developing merely a constriction—a stenosis of the lumen. These are essentially different pathologically. In the latter the lumen is preserved, though it tends to become progressively smaller, and is always less than normal; it may be lined in part by epithelium, or in great part by cicatricial connective tissue, but there is still some opening through the stricture, just as there is through a stricture of the urethra, which is hardly spoken of as an obliterative urethritis. In the case of true obliterative appendicitis, however, the opposed surfaces of the lumen have become firmly united to each other, and the obliterating band is absolutely impervious. Were the designation obliterative appendicitis employed in all cases in which the constriction of the lumen becomes marked, many of the cases that I have included in the category of simple chronic interstitial appendicitis would necessarily be classed as obliterative—a classification impossible of justification.

Microscopy.—The microscopical appearances of the appendices in cases of obliterative appendicitis do not differ from

those described in connection with chronic interstitial appendicitis; they are merely more extensive. In extreme cases microscopical examination may reveal nothing but dense cicatricial connective tissue and a few muscle fibres, especially in the impervious bands mentioned.

There are several particular forms of chronic disease of the appendix that may be attended by ulceration and that demand special consideration. Of these, the most important are tuberculosis and actinomycosis.

Tuberculosis of the appendix (Plate xxiv) may be primary or secondary, miliary or caseous. Primary tuberculosis of the appendix must be accounted among the greatest of rarities, and it may be doubted whether any well-authenticated case of primary tuberculosis of the appendix has yet been recorded. Even in the event of detecting tuberculosis of the appendix alone, particularly at operation, it is hardly possible to assert with certainty that tuberculosis does not exist elsewhere in the body; that the condition is primary in the appendix. Of the occurrence of tuberculosis of the appendix in association with, or secondary to, tuberculous lesions elsewhere in the body a great number of instances have been observed. There are, however, no trustworthy statistics of sufficient magnitude upon which to base an opinion as to the frequency of their occurrence. Fenwick and Dodwell, who reported the records of the necropsies performed upon 2000 subjects dead of tuberculosis in the Brompton Hospital for Consumption, found that the intestine was the seat of ulceration in 500 (56.6 per cent.) out of 883 cases. In 85 per cent. of these cases the ileo-cæcal region was involved; in 9.6 per cent. it was the only portion of the intestine that showed evidence of disease. From this region the frequency of implication diminished in both directions. Thus, the jejunum was involved in 28 per cent. of the cases; the duodenum, in 3.4 per cent.; the ascending colon in 51.4 per cent.;

the transverse colon, in 30.6 per cent.; the descending colon, in 21 per cent.; the sigmoid flexure, in 13.5 per cent.; and the rectum, in 14.1 per cent. It was quite exceptional to find the appendix uninvolved when there was disease of the ileo-cæcal region; in 17 of the cases the appendix was the only portion of the intestinal tract that presented ulceration. Whether or not this ulceration was tuberculous was not definitely determined.

Upon macroscopical examination tuberculosis of the appendix is likely to elude observation in many cases. The lesions may not differ materially from those of simple catarrhal inflammation or ulceration of the appendix. On the other hand, the entire mucous membrane may have become converted into a discoloured caseous mass, with more or less extensive ulceration. At times the nature of the affection may be recognized by the detection of minute grayish tubercles in the floor of the ulcer, or similar tubercles may reveal themselves beneath the peritoneal coat of the organ. If there be extensive tuberculous disease elsewhere in the body, of course, the tuberculous character of the lesions of the appendix is more likely to be recognized. If the disease be of the miliary variety, it should not escape detection; it is usually associated with similar disease of other intra-abdominal organs or tissues, particularly the peritoneum. Tuberculosis of the appendix does not manifest any very marked tendency to perforation, though such eventuality may occur. In almost all cases there is associated a more or less circumscribed tuberculosis of the peritoneum. The lesions are eminently chronic, and tend to the formation of fistulas.

Upon microscopical examination the well-known lesions of tuberculosis are detected. There are more or less extensive formation of epithelioid cells, giant cells, and round-cell infiltration, with a varying amount of caseation and partial or complete degeneration of the cellular exudate. The lesions are prone to involve the lymphoid follicles and to spread along the

PLATE XXIV.

TUBERCULOUS APPENDICITIS.—The patient, aged fourteen years, was admitted to the German Hospital on February 15, 1896, and the following history was elicited: During the past ten months he had had six typical attacks of appendicitis, but on each occasion operation had been declined. On the day prior to admission he complained of pain in the right side, which had grown rapidly worse until the entire abdomen had become involved. When examined, his temperature was 104.4° F., his pulse-rate was 116, and his abdomen was enormously distended, tympanitic, and tender, particularly in the region of the appendix. The tenderness, however, was less marked than the amount of distention would lead one to expect. Rigidity was present only as part of the general distention, and was distributed equally. On the day after admission his temperature fell to 101° F., but rose again in the evening to 104° F. An area of dullness was found over the left lung posteriorly, but no tubercle bacilli were detected in his sputum. There was no record of tuberculosis in his family.

A diagnosis was made of tuberculous appendicitis with subsequent involvement of the general peritoneum. Operation was advised and was agreed to.

Upon section of the peritoneum a small quantity of dark, odourless fluid escaped. The cæcum and appendix were adherent by means of fibrinous exudate. The appendix, meso-appendix, and cæcum revealed numerous miliary tubercles, which were also distributed throughout the general peritoneum. The cavity was irrigated, glass drainage was introduced, and the wound was closed. The patient died two months later.

Tubercular appendix



The white spots represent miliary tubercles.



submucous coat, possibly involving other tissues; but histologically they do not differ from similar lesions in other portions of the body. With appropriate staining procedures tubercle bacilli may be detected.

The appendix illustrated in Plate xxiv is an instructive case of tuberculosis of the appendix in which the lesions of the appendix probably antedated those of the general peritoneum.

Actinomycosis of the appendix is a rare condition due to the pathogenetic activity of *Streptothrix actinomyces*, or ray fungus. *Actinomyces* in man is itself a rather rare condition, and up to 1899 Ruhrah was able to collect from the literature but 70 cases reported in this country. Of these, the appendix was affected in 5. Hinglais, who has studied the appendico-cæcal form, found it in 60 out of 100 cases of the abdominal form. Grill, in reporting four personal observations of the abdominal form of the disease, was able to find 107 other cases in the literature. In 40 of the latter the portal of entry of the actinomyces was definitely made out, and was as follows: The appendico-cæcal region in 19; the colon in 8; the rectum in 7; and other portions of the intestinal tract (jejunum, duodenum, etc.) in 6. In 26 of the cases the process was perityphlitic and para-typhlitic, but no portal of entry could be definitely located; in 7, the process was peri-rectal; and in 36, the portal of entry was entirely indeterminate. Of Grill's 4 cases, one was probably an instance of gastric infection; the other three were peri-cæcal or peri-appendicular. From the statistics of Sonnenburg and Grill it appears that up to the present time there have been reported 26 cases in which actinomycosis of the appendix was definitely made out. These are as follows: Barth (4), Boström, Braun (2), von Bergmann (2), Illich, Israël (2), Langhans (2), Lanz (2), Lührs, Körte, Ponfick, Ransom, Regnier, Roux, Samter, Schreyer, Uzkow, and Vassilliew. To these may be added the cases reported by Ullman, Kern, Guder, Ekehorn, and Gangolphe and Duplant;

the three cases reported by Czerny and Haeddeus; and the five cases collected by Ruhräh—those of Lange (2), Latimer and Welch, Murphy, and Lee—making a total of 39 cases. In one of Lanz's cases the actinomyces was detected in the stools of the patient.

Actinomycosis of the appendix may be the result of direct infection—through the intestinal tract; of indirect infection, or extension from the thoracic cavity—through the diaphragm, behind the peritoneum, or through the abdominal muscles; or it may be the consequence of metastasis. According to Hinglais, the affection may be divided into four stages; (1) The period of visceral symptoms, which may last from a few days to several months; (2) the period of tumor, which varies much in duration, and during which frequent remissions may occur; (3) the period of fistula, during which the disease may extend to other tissues, such as the lumbar region, the psoas muscle, the hip-joint, the space of Retzius, etc., and during which extensive abscess formation, with fistula, which is likely to be multiple, may develop; (4) the period of reparation, during which the affection may heal spontaneously or as a consequence of surgical procedures. On the other hand, the disease may persist indefinitely and may finally terminate fatally.

It is agreed by Boström, Johne, Ransom, Czerny and Haeddeus, etc., that it is most likely that the affection in these cases is primary in the appendix; that the fungus is carried to the appendix by some grain or fragment of corn or barley; and that this lodges in the appendix, wherein the actinomyces proliferates. Czerny and Haeddeus, from a careful study of their cases, conclude that there first occurs an infection of the appendicular mucous membrane, which becomes necrotic and gives rise to the formation of an ulcer. This permits of ready access of the actinomyces to the submucosa, wherein it further proliferates, and, meeting with slight resistance, extends in various directions. In one of their cases the mucous mem-

brane did not appear ulcerated, and this fact is explained by supposing that, after the formation of the ulceration and the infection of the submucosa, reparation of the mucosa occurred, and that the necrotic mucous membrane was replaced by cicatricial connective tissues. These suppositions are confirmed by the absence of Lieberkühn's glands in the mucous membrane. Infection having occurred, suppuration, with the formation of fistulas, may supervene, or there may result the development of thick, indurative connective tissue. This differs from ordinary cicatricial connective tissue in that it contains small foci of pus, which may be absorbed if the fungus be absent. If the fungus be present, on the other hand, there may ensue further extension of the disease. In the peri-appendicular pus the characteristic grayish nodules may be detected. Upon microscopical examination these are found to be composed in whole or in part of *Streptothrix actinomyces*.

It has been pointed out by Barth, Partsch, and other observers that in those cases in which there occurs symbiosis, with the ordinary pyogenic cocci, the actinomycotic nature of the affection is likely to be nonapparent. It is only later, when, as a consequence of extension or metastasis, the disease develops in another portion of the body, that the true nature of the original infection is recognized. Probably because of this, and because some unsuspected cases have been cured at the primary seat of the disease, actinomycosis of the appendix seems more rare than it really is.

Other important pathological conditions of the vermiform appendix are tumor formations.

Tumors of the appendix may be primary or secondary, benign or malignant, but they are very uncommon. In some search of the literature I have been enabled to find but a single reference to benign tumors, and but few to malignant tumors of this organ. Lafforgue, in 1893, was able to find references

to but seventeen tumors of the appendix. Among these were one lipoma, one myoma, two lymphadenomas, two hydatid cysts, nine carcinomas, and two malignant tumors the nature of which was poorly defined. The two instances of hydatid cyst, or echinococcus, of the appendix are referred to on page 205.

Personally, I have encountered two cases of fibromyoma of the appendix. One was from a patient the subject also of fibromyomas of the uterus, and both organs were removed at the same operation.* The appendix presented two fibroid growths, each of which was spheroid in shape and about five millimetres in diameter. One was situated at the mid-point of the appendix, opposite the attachment of the mesentery; the other toward the tip of the organ, within the mesenteric attachment. They projected somewhat from the surface of the appendix, and each was well circumscribed, surrounded by a rather dense capsule, and was firm to the touch. On section they were whitish and glistening, and revealed a fibrillar structure. One was much harder than the other—being of almost stony hardness—and cut with a grating sensation. The wall of the appendix elsewhere was much thickened; the lumen much constricted. The mucous membrane appeared smooth and atrophic. On microscopical examination the lesions of moderate interstitial appendicitis (as already detailed), with considerable thickening of the walls of the blood-vessels were detected. The tumors consisted of bundles of dense fibrous connective tissue that coursed in various directions and intertwined among themselves, and interspersed between which there was a small amount of unstriped muscle fibres. The connective tissue contained relatively few nuclei and an abundance of intercellular substance. The blood supply was moderately good, but the walls of the

* This case has been reported by Dr. Deaver in the *Transactions of the Academy of Surgery of Philadelphia*, vol. 1, 1899, p. 23.

blood-vessels were thickened. The growth opposite the attachment of the mesentery contained a considerable amount of calcareous infiltration. The second specimen was much like the first. There was, however, but a single nodule, which contained no calcareous infiltration. In other respects the resemblance was marked.

Although reports have been made of instances of carcinoma, sarcoma, and endothelioma of the appendix, malignant tumors of this organ must be accounted rare. An idea of the relative frequency of these new growths may be gleaned from a number of statistics that are now available. Maydl has reported the statistics of the Pathological Institute of the Vienna General Hospital for the twelve years from 1870 to 1881, during which time 20,480 necropsies were performed. Among these there were 1460 cases of carcinoma, of which 100 affected the intestinal tract—its various portions as follows: Duodenum 2, jejunum 0, ileum 4, vermiform appendix 1, cæcum 9, ascending colon 6, colon in general 17, sigmoid flexure 13, and rectum 48. To these Nothnagel has added the statistics of the same Institute for the twelve years from 1882 to 1893, during which time 20,358 necropsies were performed. Among these there were 2125 cases of carcinoma, of which 243 affected the intestinal tract—its various portions as follows: Duodenum 5, jejunum 0, ileum 6, vermiform appendix 1, cæcum 14, colon in general 63, sigmoid flexure 40, and rectum 114. Thus, during twenty-four years, among 41,838 necropsies—3585 cases of carcinoma in general, 343 cases of intestinal carcinoma—the vermiform appendix was found the seat of the new growth in but 2 cases. Leichtenstern's statistics, based upon clinical and necropsy material, comprise 770 cases of intestinal carcinoma, as follows: 616 cases of carcinoma of the rectum, 42 of the sigmoid flexure, 11 of the descending colon, 30 of the transverse colon and the splenic and hepatic flexures, 6 of the ascending colon, 20 of the cæcum, 3 of the appendix, 9 of the ileo-

cæcal valve, 13 of the lower portion of the ileum, 3 of the upper portion of the ileum, and 17 of the jejunum and duodenum. Bryant has collected a series of 110 cases of carcinoma of the intestine, in which the regions affected were as follows: The small intestine in 6 cases, the cæcum and the ileo-cæcal valve in 7, the transverse colon and the hepatic and splenic flexures in 19, the sigmoid flexure and the rectum in 78. Müller, among 5621 necropsies performed in the Pathological Institute of Bern from 1886 to 1891, found 521 cases of carcinoma of the various bodily organs. Of these the rectum was the seat of the new growth in 19 cases, the large intestine in 13, the small intestine in 9 (the duodenum in 6 and other portions of the small intestine in 3). Ewald's statistics, a compilation of those of Maydl, Leichtenstern, Bryant, Müller, and others, are as follows: 874 cases of carcinoma of the rectum, 148 of the large intestine, 64 of the cæcum and appendix, 26 of the ileum, 17 of the jejunum, and 19 of the duodenum. If to these we add the statistics of Nothnagel, we ascertain that of 1391 cases of carcinoma of the intestine, the rectum was the seat of the new growth in 988 cases, the large intestine in 251, the cæcum and the appendix in 79, the ileum in 32, the jejunum in 17, and the duodenum in 24. Of the 79 cases in which the cæcum and appendix were involved, it is impossible to ascertain from the reported statistics the number in which the appendix alone was implicated or the number in which it was primarily the seat of the neoplasm. The number, however, is certainly small. There seems to be clear evidence that the tumor formation was limited to the appendix in but 5 cases—one of Maydl's, one of Nothnagel's, and three of the compilation of Leichtenstern. To these may be added a sixth case, reported by Zemann, who found one instance of carcinoma of the appendix among 165 cases of carcinoma of the intestine in general. In addition to these, at the time I wrote this chapter for the second edition of this treatise, I was able to find references to but 12 other cases

—those of Merling, Rokitansky (4), Prus, Beger, Draper, Stimson, Mossé and Daunic, Wright, and Cullen. I had overlooked the report of two cases by Letulle and Weinberg. Monks also had reported a case of carcinoma of the appendix and cæcum; but the primary seat of the growth is not stated. As already noted, Lafforgue, in 1893, was able to collect from the literature the reports of but 9 cases. One of these, Bierhoff's, is a case of secondary involvement of the appendix, and in another, Kolaczek's, the cæcum also was involved. Since 1900, however, much interest has been taken in carcinoma of the appendix, and at least 25 additional cases have been reported—by Hurdon, Rolleston, Letulle and Weinberg (2 additional cases), Goffe, Whipham, Kauffmann, McBurney (2), Regling, Harte and Willson (2), Jessup, Elting (3), Moschcowitz (3), Norris, Weir, Lejars, Cullingworth and Corner, Neri, and deRuyter.* While these statistics suggest the rarity of carcinoma of the appendix, I am inclined to believe that it is not so rare as it appears. I may have overlooked the reports of some cases, other cases have not been reported, and in some cases in which both the cæcum and the appendix were involved the new growth was doubtless primary in the appendix. Of especial interest, however, is the fact that of a total of less than 40 undoubted cases of primary carcinoma of the appendix, more than 60 per cent. have been observed during the last seven years—doubtless the result of more thorough, especially microscopical, investigation. In addition to the previously mentioned cases, Glazebrook has reported a case of endothelial sarcoma, Davis and Patterson each a case of round cell sarcoma of the appendix, and Kanthack and Lockwood a case of psammoma of the appendix and ovary.

Personally, in an examination of 706 of the appendices removed by operation by Dr. Deaver at the German Hospital,

* Additional cases are said to have been reported by Martin (2), Panchet, and Giscard, but the reports were not available in the original.

I have encountered 3 cases of carcinoma (2 primary, and 1 apparently secondary) and 1 case of endothelioma, of the appendix. No new growths were found in any of the appendices removed at necropsy.

CASE I.—*Carcinoma of the Appendix.*

The clinical history of the case, unfortunately, can not be found. The following are the notes of the macroscopical examination of the appendix (No. 21, 1898), which was removed by operation, February 19, 1898: The appendix weighs 8 gm.; its length is 11 cm.; its exterior diameter at its proximal end, 8 mm. This diameter is maintained for about 3 cm. of its length, when it increases to 1.2 cm., and continues of this diameter throughout the remainder of its length. The organ is irregularly distorted, and the wall of its proximal two-thirds is of greenish hue and is softened and necrotic. The wall of the distal third is thickened and congested. The lumen of the organ measures 4 mm. at the proximal end, and gradually decreases to measure 1 mm. toward the tip. The mucous membrane is much congested and ulcerated toward the proximal extremity. Toward the tip the inflammatory phenomena are less marked. The lumen contains a small amount of mucopurulent material.

Cultures revealed *Bacterium coli commune* in pure culture.

On microscopical examination the lesions of a high-grade ulcerative appendicitis (as detailed elsewhere) are observed. The meso-appendix is also the seat of marked inflammatory alterations. In addition, just distal to the necrotic portion of the appendix there is an area of tumor formation, which is about 6 mm. in diameter. It involves the mucosa and the submucosa—the muscular coats being unimplicated except for atrophy the consequence of the pressure by the neoplasm against the unyielding serous coat of the organ. There is some slight indication of persisting mucous membrane, which consists of the ordinary reticulum of the mucosa, the seat of extensive round-cell infiltration, and a few glands of Lieberkühn, which are hyperplastic and cystic. There is no surface epithelium lining the lumen of the appendix. The tumor formation consists of a connective-tissue stroma, which forms alveoli, within which the tumor cells are detected. These cells are arranged in nests, which vary much in size and general configuration. For the most part they are large and ovoid. Some of them are really very large and roundish; others are elongated and narrow. They consist almost exclusively of solid masses of cells. The individual cells are polyhedral in shape,—the result of mutual compression,—and they are distinctly epithelial

in appearance. They have relatively large nuclei, which are clear and vesicular and stain well. The stroma, which is relatively inconspicuous as compared with the masses of tumor cells, consists of narrow bands of fibrous connective tissue, with a moderate number of elongated cells with rod-shaped nuclei. It is probably the altered submucosa. There is also a small amount of round-cell infiltration. The blood supply is not especially conspicuous.

CASE II.—*Endothelioma of the Appendix.*

The patient, E. S., a married woman, aged twenty-four years, was admitted to the German Hospital, March 24, 1898. Her father and mother had died of pulmonary tuberculosis, and one brother and one sister in infancy of causes not ascertainable. The patient had had measles, scarlet fever, and typhoid fever, the last-named at the age of nineteen years. Menstruation had been established during her ninth year, and had been regular since her tenth year. The flow was usually free, lasted about three days, and was accompanied by backache, headache, and nausea. There was also some leukorrhœa. About a year prior to admission to the hospital she had had a severe attack of abdominal pain, which came on suddenly and was accompanied by vomiting. The pain is thought to have been diffuse, but nothing additional is remembered of the attack. Since then there have been three other attacks—the last one three weeks prior to the date of admission. It began with general abdominal pain and vomiting. The pain soon became localized in the right iliac fossa, in which region constant pain and tenderness persisted. The appetite was poor and the bowels were constipated. During the latter part of February, 1898, she had been operated upon in the German Hospital for *fistula in ano*.

Examination of the heart and lungs revealed normal conditions. On palpation of the abdomen, the appendix was easily outlined, and was found to point northward. Vaginal examination yielded negative results.

At operation, performed March 26, 1898, the appendix was found free, and was excised from the cæcum. Silk sutures were employed to close the opening in the cæcum and silkworm-gut to close the abdominal wound, which was covered with an aseptic silver-foil dressing. The sutures were removed April 3d, and the patient made an uneventful recovery.

The following are the notes of the macroscopical examination of the excised appendix (No. 47, 1898): The organ is 9 cm. in length, and its diameter varies from 7 mm. at its proximal end to 5 mm. at its tip. Externally, it is of a bluish-red colour. Its wall appears of normal thickness. The lumen measures 2 mm. in diameter throughout its length. The mucous membrane is thickened and congested. No meso-appendix accompanies the organ.

On microscopical examination there are detected the lesions of chronic catarrhal and interstitial appendicitis (as narrated elsewhere). They are, however, of minor grade. There is some thickening of the walls of the blood-vessels. In addition, toward the base of the appendix there is a small area in which there is an infiltration of the wall of the organ with cells that vary much in general arrangement. In places, infiltrating between fasciculi of fibrous connective tissue or between bundles of muscle fibres, there are narrow columns of cells. These are frequently not more than one or two cells in thickness and may be ten or twenty cells in length. They are often pointed at their extremities, though in some sections they appear rounded, and they present a seemingly intimate connection with the surrounding connective-tissue stroma. Other collections of similar cells are much thicker and shorter, and are roundish, ovoid, or irregular in outline. Some collections, relatively, are of massive size and irregular contour. In other regions there is a distinct plexiform arrangement—an anastomosing network of these cells. The individual columns of these latter cells are usually very narrow except at their points of crossing or anastomosing. Not only do the narrow columns of cells exhibit an apparently intimate association with the surrounding connective-tissue stroma, but such association is general throughout the growth; that is, the sharp demarcation between the nests of tumor cells and the stroma that obtains in a carcinoma, the clear spaces that surround the nests of epithelial cells in the latter, are generally absent. In some portions of the growth there is a clear space about a collection of tumor cells, but this is usually within the nests of cells; that is, some cells—a single layer generally—preserve an attachment with the surrounding stroma despite the detachment or retraction of other cells of the same group. The individual cells are polyhedral or irregular in shape; others, particularly those toward the pointed extremities of narrow columns of cells, are quite flattened. Their nuclei are of moderate size, and stain well and diffusely. The stroma supporting the tumor cells consists in part of fibrous connective tissue, in part of unstriped muscle fibres—the normal tissues of the appendix. The fibrous connective tissue presents in places relatively few cells and a large amount of intercellular substance, in part homogeneous and evidently the seat of hyaline degeneration. Even within the large collections of tumor cells a small amount of stroma can be recognized. This consists of fine trabeculæ, which serve to divide these large collections into smaller ones.

CASE III.—*Carcinoma of the Appendix.*

The patient, a man, J. M., aged nineteen years, was admitted to the German Hospital on March 11, 1899. His father, mother, four brothers, and

five sisters were living and well. One brother and one sister had died in infancy of causes not ascertainable. He had always been well until eight days prior to admission, when he was suddenly seized with cramp-like abdominal pain. Upon the third day he vomited a small quantity of frothy mucus, and on this day also the pain became localized in the right iliac fossa. His bowels had been moved several times as a result of the administration of laxatives. On admission, the pain persisted, but was relieved by flexing the right thigh. There were some abdominal distention and tenderness in the right iliac fossa, marked rigidity of the right rectus muscle, an area of dullness, and, on palpation, a mass about three inches in diameter in the right iliac fossa. Appetite was poor, but there was no headache. His temperature on admission was 102° F.; the following day it rose to 103.2° F.

At operation, performed March 12, 1899, the head of the colon and the appendix were found surrounded by a small encapsulated collection of pus. This was evacuated and the appendix was removed. Gauze and rubber tubing were employed for drainage. The patient made a good recovery.

The following are the notes of the macroscopical examination of the excised appendix (No. 280, 1899): The organ is 5 cm. in length and about 1 cm. in thickness throughout its extent. It is much congested and inflamed, and is covered with a discoloured fibrino-purulent exudate. This, when removed, shows the organ much distorted.

Cultures revealed *Bacterium coli commune* in pure culture.

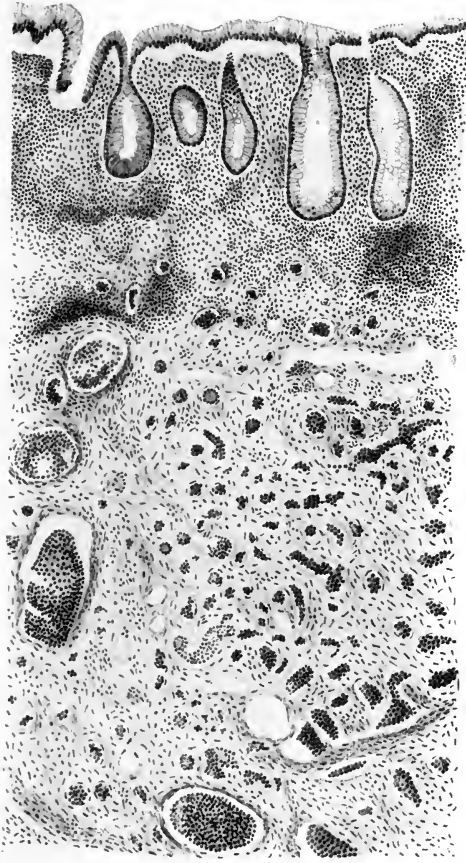
Upon microscopical examination the lesions of ulcerative appendicitis (as narrated elsewhere) are detected. In addition, toward the base of the appendix there is a small new growth (Plate xxv), which in cross-section occupies hardly three-fourths of the microscopical field of a AA Zeiss objective and a No. 2 eyepiece. It is situated entirely within the submucosa—the superjacent mucous membrane being intact except for compression of its lowermost portion. The new growth consists of cells, which, infiltrating the submucosa, are arranged in solid masses or nests of varying size and conformation. They are mostly very small; a few, however, are relatively large. Some are roundish in outline, others are very irregular. The individual cells are epithelial in appearance; they are of moderate size, and their nuclei are vesicular and stain well. The supporting stroma consists of the altered submucosa, which shows but a very slight amount of inflammatory reaction. In certain sections there is a slight amount of infiltration of the muscular coats with small numbers of the tumor cells.

CASE IV.—*Carcinoma of the Appendix. (Secondary?)*

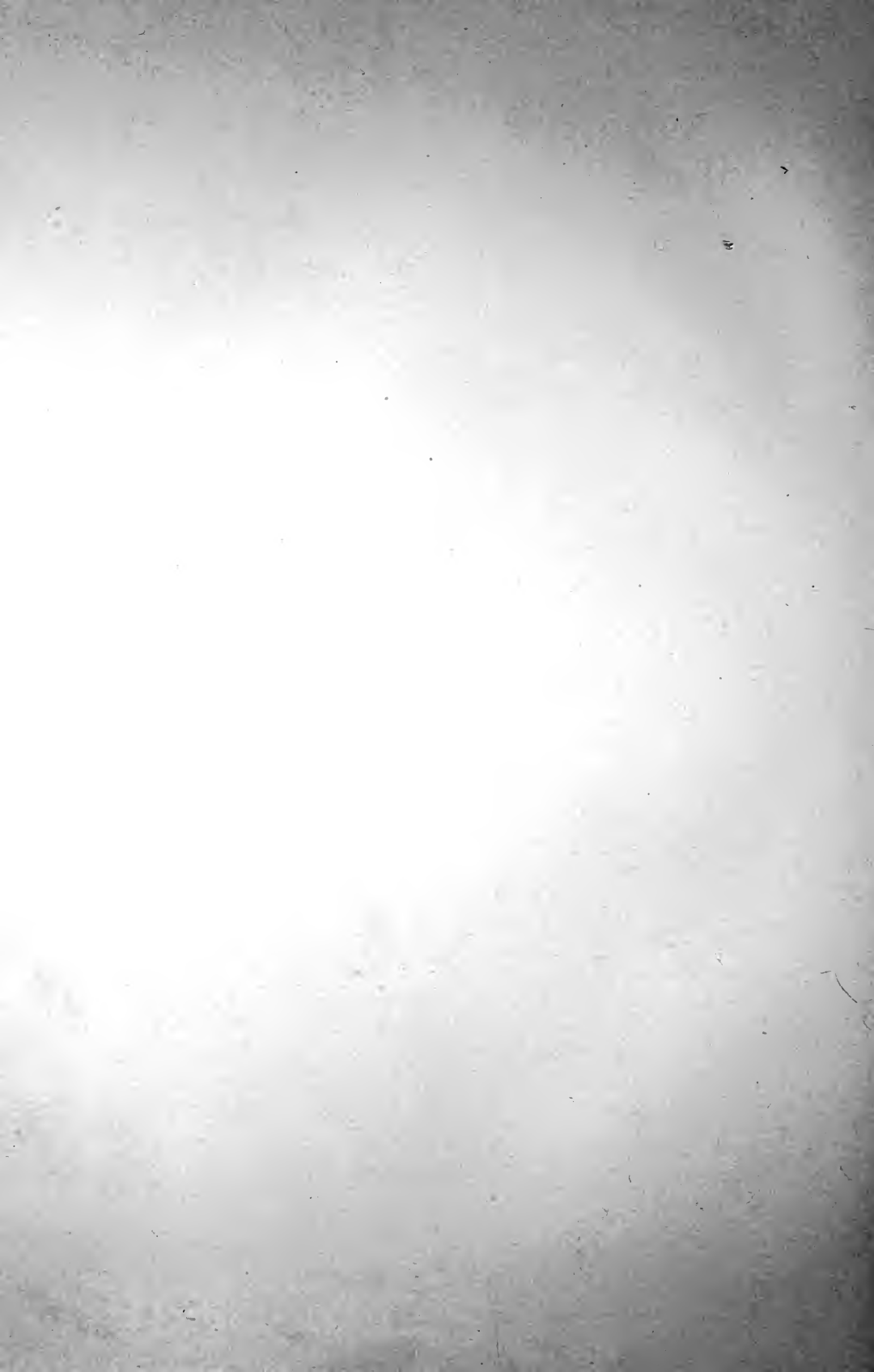
The patient, a man, T. R., aged sixty-three years, was admitted to the

PLATE XXV.

PRIMARY CARCINOMA OF THE APPENDIX.—The section shows a portion of a small carcinoma limited to the submucosa. It consists of epithelial cells arranged in irregular nests that infiltrate the submucosa without definite arrangement. The nests vary much in size and configuration. Hæmatoxylin-eosin preparation. $\times 250$.



PRIMARY CARCINOMA OF THE APPENDIX



German Hospital, on August 11, 1899. His father and mother had died of causes unknown to him. Nothing was known of his brothers and sisters. With the exception of the ordinary diseases of childhood, and "colds" during the winter, he had enjoyed good health until recently, when he commenced to complain of attacks of abdominal pain, which were more severe in the right iliac region, and were accompanied by constipation. When the attack was severe, there was also nausea and vomiting. Lately the attacks had become more frequent than formerly, but they were always relieved by free purgation. When admitted to the hospital, the symptoms already narrated were complained of, and examination revealed tenderness over the region of the appendix. His temperature was normal; his pulse-rate, 116 a minute.

At operation, performed August 17th, the appendix was found intimately adherent to the surrounding structures. The adhesions were loosened and the appendix was excised from the cæcum and the opening in the latter sutured. The appendix and intestines were studded with numerous miliary whitish or grayish-white nodules that suggested miliary tubercles. There was also enlargement of the retro-peritoneal glands. The day following the operation the patient's temperature was 101° F., and the succeeding day it reached 102.4° F. The patient did well, however, and the temperature gradually subsided, to reach 99° F. on the evening of the sixth day. The following day the stitches were removed. The wound seemed healthy and there had evidently been union throughout; the abdomen was flat. The pulse, however, had remained rapid, and the patient had developed a cough. On the evening of the day on which the stitches were removed it was noticed that the dressings were soiled with blood. On removing these, the wound was found gaping widely and the intestines were presenting. There seemed to have resulted no union whatever, either of the peritoneum or of the structures of the abdominal wall. The patient was etherized and the incision was resutured. He was, however, much shocked; his pulse was weak and 170 a minute, and he died seven hours after the operation. No necropsy was permitted.

The following are the notes of the macroscopical examination of the excised appendix (No. 381, 1899): The organ is 2 cm. in length and varies in external diameter from 1 cm. to 2 cm., having a constriction about the centre. It is firm to the touch and appears moderately congested. Scattered over the surface there are a number of small, miliary, grayish-white nodules, which suggest tubercles.

Microscopical examinations of sections from three regions of the organ reveal the normal appearances in none. In those from the centre and the proximal end there is a lumen in the centre of this section, but nowhere any indication of mucous membrane or lymphoid follicles. The sections from

near the tip reveal no lumen. With difficulty, here and there some submucosa can be recognized, and also some more or less distorted and altered muscularis. Throughout the entire wall of the appendix, but especially in what may be taken for the submucosa, there are nests of cells that vary much in size and configuration. In the submucosa the arrangement is most irregular, and they course in various directions. In the muscular coats they run especially between and in the direction of the bundles of muscle fibres. For the most part these nests are elongated and narrow. Many, however, are very irregular in shape, and some are very large. Many of them appear as hollow cylinders, being composed of a single layer of cells surrounding a clear lumen. In some areas there is a double or a triple layer of cells; in others, there are solid nests of cells. The individual cells are distinctly epithelial in appearance; they are low cylindrical or cuboid in shape—in the solid nests they are polyhedral. They have relatively large, clear, vesicular nuclei that stain well. In the stroma—which consists, as already intimated, of the altered submucosa and the muscularis—there is a moderate amount of round-cell infiltration. The meso-appendix is also the seat of carcinomatous infiltration.

Especial interest attaches to these four cases because in all the clinical symptoms were those of appendicitis, for the relief of which the operations were undertaken. In three—Cases I, II, and III—in addition to the new growth, inflammatory alterations were found. In these three cases also the tumor formation was doubtless primary in the appendix; in Case IV the involvement of the appendix was possibly secondary to a carcinoma elsewhere in the body. The entire absence of mucous membrane in the appendix, however, and the appearances of the carcinomatous cell formations, suggest that the new growth may have arisen in the appendix and may have subsequently implicated other structures. It is also worthy of note that in Cases I, II, and III the tumors were of microscopical size, and were not detected by the ordinary macroscopical examination. The youth of two of the patients, who were aged respectively twenty-four years and nineteen years, is also of interest. As a matter of fact over 60 per cent. of the cases reported, in which the age of the patient is given, occurred in persons less than thirty years of age.

THE PERITONITIS AND ITS CONSEQUENCES.

Although the dissociation of the lesions of the appendix from those of its serous covering (peri-appendicitis) and the peritoneum in general is at most artificial, there are several reasons, not alone of convenience, that render profitable the discussion of each separately. In the first place, similar lesions of the appendix, in different cases, may give rise to most diverse peritoneal lesions; that is, there is no constant relationship between the lesions of the appendix and those of the peritoneum. There can be no question that in certain cases of appendicitis the peritoneum presents no deviations whatever from the normal. These cases, however, are of comparative rarity, and are almost exclusively instances of catarrhal or mild inflammation. But not all cases of catarrhal appendicitis are unaccompanied by inflammation of the peritoneum. Again, there are still rarer cases of fulminating appendicitis with rapid gangrene, in which the diseased organ may be excised by the surgeon, or the patient may die before there has been time for the developement of peritonitis. Further, instances of chronic interstitial appendicitis with ulceration, unattended by evidences of implication of the peritoneum, have been recorded by several observers, among them Schede and Sonnenburg. But these are unusual cases. Excepting the previously mentioned instances, all cases of appendicitis are complicated by peritonitis, and it is for this reason that the designation appendicular peritonitis is most appropriate. It is because of the peritonitis to which it gives rise that appendicitis acquires the importance that attaches to it.

The reasons for the implication of the peritoneum in appendicitis are not difficult to find. The peritoneal covering of the appendix is, in reality, a portion of the organ itself, and it is readily conceivable that an inflammation that affects one or more coats of a tube such as the appendix should, under favourable circumstances, affect all. That certain cases of catarrhal

appendicitis are unattended by peritonitis is equally plausible. In these cases the operations of the noxious agents provocative of the catarrhal inflammation are confined to the mucous membrane, either because of their attenuation or of the resistance offered by the other tissues to their further progress. On the other hand, the factors for the ready dissemination of the inflammatory irritants are found in the virulence of the bacteria and their toxins and in the anatomical construction of the appendix. The liberal lymphatic supply to which Polya and Navratil have recently directed attention, and to a less extent the blood supply, must be held answerable for the conveyance of the irritants from one coat to the others.

The detection of bacteria in association with all varieties of peritonitis naturally led to the inference that there was some causal relationship between the former and the development of the latter. The demonstration experimentally that peritonitis follows the introduction into the peritoneal cavity of certain bacteria confirmed this view. The matter, however, is not so simple as at first sight appears.

In marked contrast to the opinions entertained some years ago, it has now been repeatedly demonstrated, both experimentally and otherwise, that the peritoneum is possessed of considerable powers of resistance to the action of all deleterious influences. These powers of resistance are comprised essentially in the following: (1) The bactericidal action of the peritoneal serum; (2) the great resorptive power of the peritoneum; (3) the marked tendency exhibited by the peritoneum to unite, to form adhesions, and cause circumscription—encapsulation of infectious foci. The first, the bactericidal action of the serum of the peritoneum, is probably of little importance, though it seems that it should not be entirely ignored. The second, the great resorptive power of the peritoneum, is of considerable importance. Bacteria that gain access to the peritoneal cavity may be destroyed *in situ* by the bactericidal activity

of the peritoneal serum, which, as stated, is not conspicuous, or they may be robbed in great part of their pathogenetic powers by their rapid resorption by the peritoneum. This, it seems, is of considerable moment, and there is good reason for belief, that, such is the rapidity with which bacteria are often absorbed by the peritoneum, they are removed from the peritoneal cavity before they have had time to exert sufficient deleterious activity to engender inflammatory reaction. Having been absorbed, they are finally destroyed by phagocytes in the lymph channels, blood-vessels, etc. Frequently, however, neither of these factors suffices, and, in an effort to resist general infection, the peritoneum exerts itself to the utmost by uniting, forming adhesions, and leading to encapsulation of infectious foci. The exact nature of this process is still imperfectly understood; but the fact is well established that, as bacteria in cultures may die as the result of the action of the toxine they themselves produce, so in such encapsulated foci the contained bacteria, after the lapse of a certain time, gradually lose their virulence and finally succumb; and that the cellular exudate undergoes various retrograde metamorphoses, becomes fatty, forms a granular débris, and is, partly at least, removed by absorption. It is not only the encapsulation and limitation of the infectious foci *per se*, but also the concomitant peritoneal lesions, that serve to protect against general infection. The obstruction of the lymphatic stomata and the regionary lymphatic radicles by the coagulated fibrin which also covers the serosa subserves the same useful purpose.

Appreciating the nature and character of the powers of resistance offered by the peritoneum, the comprehension of the mode of production of peritonitis is much facilitated. The introduction of nonpathogenic micro-organisms into a healthy peritoneum is without morbid consequences. The introduction of pyogenic micro-organisms into a healthy peritoneal cavity is not followed by peritonitis, provided the bacteria be

not excessive either in number or in virulence. Peritonitis, however, does result from the access of pyogenic bacteria to the peritoneum when the bacteria are excessive in number or virulence or both; that is, when there are excessive demands upon the resorptive power of the peritoneum, be it that there is a sudden accession to the peritoneum of a large quantity of bacteria, or an intermittent or continuous supply of bacteria in small numbers; when the resorptive power of the peritoneum is below the normal; when the peritoneal cavity contains a quantity of fluid, particularly an albuminous fluid susceptible of decomposition—even a simple ascites is of significance—when the peritoneum is subjected to mechanical injury at the site of the introduction of the bacteria, such as occurs in case of operative wounds and rupture of intra-abdominal organs, as the appendix, etc.; and when the patient is debilitated.

The disastrous consequences of peritonitis are due in part, particularly in the purulent varieties, to the local suppuration, to the loss of the bodily fluids, but in great part to intoxication of the general organism. The paramount importance of this latter is evident from the fact that the most severe and rapidly fatal forms of peritonitis are unaccompanied by the formation of any appreciable exudate; hence they are not attended by loss of the bodily fluids. The clinical manifestations of the severe forms of this affection—such as disturbed cerebration, partial coma or delirium, pale and “leaky” skin, cyanosis of the lips and finger-tips, dry tongue, rapid and fleeting pulse, rapid and shallow breathing, etc.—are the manifestations of intoxication rather than of infection. The different varieties of peritonitis, however, present marked differences in the degree of accompanying intoxication. Thus, in many of the cases of circumscribed peritonitis the intoxication is but slight. In some of the suppurative forms with gangrene of the appendix it may, however, be quite marked. Of the diffuse forms of peritonitis, those attended by the formation of pus, though

extremely virulent and producing marked toxæmia, are less virulent and give rise to a less degree of toxæmia than do the hæmorrhagic forms and those marked by the absence of exudate. The latter, which may be designated toxic peritonitis, is accompanied by so extreme a degree of toxæmia that the patient generally succumbs very quickly. The shock attendant upon the rupture of the diseased appendix is of itself not of so much significance in the sudden development of alarming symptoms as is the rapid absorption of a large quantity of preformed toxins that are suddenly evacuated into the general peritoneal cavity. It is under such circumstances that the great resorptive power of the peritoneum, of such significance in guarding against infection, becomes the very agent whereby the system is suddenly overpowered by a large quantity of these preformed toxins. The absorption also of a quantity of ptomaines that are sometimes liberated with the toxins contributes to the production of alarming symptoms. At times, of course, the fatal issue is determined by pyæmia rather than by intoxication.

Pathologically, the lesions of the peritoneum, like those of the appendix, may be acute or chronic as regards their course; circumscribed or diffuse as regards their extent; and serous, sero-fibrinous, fibrinous, purulent, or hæmorrhagic as regards their character. Just as in the different varieties of appendicitis, there may also be all gradations, from the mildest peritoneal implication to the most virulent—from those with slight circumscribed serous exudate to the most severe, malignant, generalized, purulent, hæmorrhagic, or toxic peritonitis. Nevertheless, there are attending the various forms of appendicitis several varieties of peritonitis which differ as to their mode of production, extent of implication of the peritoneum, and character of the exudate, and which, in consequence, permit of a practical classification of the peritoneal lesions of appendicitis. These will be described as follows:

Appendicitis.

- I. Acute Appendicular Peritonitis.
 1. Circumscribed serous, sero-fibrinous, and fibrinous peritonitis.
 2. Circumscribed purulent peritonitis, or peri-appendicular abscess.
 3. Diffuse or generalized peritonitis.
- II. Chronic Appendicular Peritonitis.

ACUTE APPENDICULAR PERITONITIS.

CIRCUMSCRIBED SEROUS, SERO-FIBRINOUS, AND FIBRINOUS PERITONITIS.

By serous or sero-fibrinous peritonitis is understood an inflammation of the peritoneum attended by the formation of a serous or sero-fibrinous exudate. Of all the varieties of peritonitis complicating appendicitis, the serous is probably the most infrequently met with, and, in consequence, but little attention has been directed to it. Its apparent uncommon occurrence is due not so much to its actual nonexistence as to the fact that at the time of observation, either at operation or necropsy, it has given way to one of the severer forms of peritonitis. As a result, however, of the practice that has obtained in recent years of operating early in cases of appendicitis, sufficient opportunity has been afforded to note the not uncommon occurrence of such serous or sero-fibrinous peritonitis.

It is but natural to infer that if the peritoneum be implicated in a mild attack of appendicitis, the lesions of this structure, particularly in the early stages, will also be mild. For this reason it can not be doubted that some at least of the severer forms of peritonitis, particularly the fibrinous (nonsuppurative) form, and even also some of the purulent variety, are initiated as a serous or sero-fibrinous inflammation. The peritonitis, however, in many of these cases, either because of the virulence of the irritant or its long-continued action, does not remain of

this character, but speedily progresses to the fibrinous or purulent variety.

Serous or sero-fibrinous peritonitis is encountered in association with the milder forms of appendicitis only—acute catarrhal and mild interstitial appendicitis and the chronic forms of the disease with mild, acute exacerbations. Under such circumstances the peritoneum covering the appendix is in a state of inflammatory hyperæmia. It is injected, many of the vessels being quite distended and visible to the unaided eye, while other minute ones, by their congestion, lend a diffuse redness to the tissue. In addition, the peritoneum has lost its normal lustre, is slightly opaque, and is somewhat rough, velvety, or viscid to the touch. This latter characteristic is dependent upon the presence of a serous or sero-fibrinous exudate that, at times, is so slight as to be scarcely appreciable. Occasionally rupture of minute blood-vessels occurs and leads to hæmorrhagic foci. These alterations, as a rule, do not extend beyond the limits of the peritoneal covering of the appendix. Exceptionally, they may also implicate the meso-appendix, and more rarely the cæcum, adjoining coils of intestine, and the parietal peritoneum. In certain isolated instances there may be in the neighbourhood of the appendix a small collection of serous fluid.

Sonnenburg in particular believes in the occurrence of such serous peritonitis, and states that even large collections of serous exudate may be encountered. He records one case in which, at operation, he found a large exudate, consisting of turbid fluid free from bacteria, surrounded by a fibrous capsule, in the neighbourhood of a chronically inflamed appendix. The occurrence of such circumscribed serous exudates is also spoken of by Roux, Lennander, Kümmel, Frankfurter, Renvers, and others. Sahli, commenting upon these cases, states that the possibility of their being either tuberculous or instances of polyarthritic (rheumatic) serous peritonitis can not be excluded. Nor can it be denied that some at least of them may have been originally

sero-purulent, and in the course of time have become more serous and sterile as a consequence of the demise of the contained bacteria.

Fibrinous peritonitis is but an aggravation or further stage of the serous or sero-fibrinous variety of inflammation. It is found in association with acute catarrhal and interstitial appendicitis of moderate intensity, and with cases of chronic appendicitis in which there have been recurrences, the most recent one of some intensity. It is quite likely that in some cases in which an early operation discloses merely fibrinous peritonitis, a later or deferred operation would reveal progression to fibrino-purulent peritonitis, with or without perforation of the appendix.

In cases of fibrinous peritonitis the peritoneum in the region of the appendix is covered with a layer of fibrinous deposit of a grayish or grayish-yellow colour and viscid to the touch. This is intimately adherent to the underlying peritoneum, and varies considerably in amount in different cases. At times it is excessively thin and watery, from the admixture of much serum and relatively little fibrin, and differs but little from the ordinary sero-fibrinous exudate. Again, there may be little serum and great amounts of fibrinous deposits. In the same case, also, the amount of fibrinous exudate may vary in different regions. Through the medium of this fibrinous or plastic exudate the appendix and the neighbouring coils of intestine are more or less firmly united to each other and to the omentum and parietal peritoneum. After the separation of adherent coils of intestine the exudate may be stripped off in successive layers, revealing the peritoneum markedly congested, roughened, and lustreless. At times the exudate is so excessive that to locate the appendix requires more or less extensive dissection. Sometimes the appendix still eludes detection, and is found only after diligent search embedded in a dense amount of coagulated lymph that may surround it to an extent of from one to three centimetres.

Upon microscopical examination of the peritoneum in cases of serous, sero-fibrinous, or fibrinous peritonitis, dilatation and overfilling of the blood-vessels, proliferation of the endothelial cells lining the peritoneum, serous infiltration of the fibrous layer of the latter, and more or less round-cell infiltration are detected. On the outer layer of the peritoneum there is a deposit of fibrin, which, of course, varies in amount in different cases. It commonly presents itself as a fine network that forms a support for the proliferating endothelial cells and wandering leukocytes. Occasionally, also, newly formed capillaries are detected. The cells of the network undergo various degrees of retrograde metamorphosis, and at times rupture of the newly formed capillaries ensues and gives rise to hæmorrhagic foci. The serous fluid usually contains a few flocculi of coagulated lymph, and, even when quite clear, reveals microscopically a number of lymph corpuscles and desquamated endothelial cells.

In case this fibrinous peritonitis does not progress to suppuration, evidences of organization become manifest. The fibrinous network acts as a support for newly formed connective-tissue cells and capillaries. This granulation tissue, through the well-known processes of regeneration, is transformed into fibrous connective tissue that speedily undergoes cicatrization. Thus chronic peritoneal adhesions and bands, of which mention will be made subsequently, result.

CIRCUMSCRIBED PURULENT PERITONITIS, OR PERI-APPENDICULAR ABSCESS.

The most common peritoneal complication of acute appendicitis, and clinically the most important, because of its disastrous consequences, is circumscribed purulent peritonitis—the formerly so-called peri-typhlitic abscess. Just as a severe interstitial or ulcerative appendicitis may follow a catarrhal or a mild interstitial inflammation, so circumscribed purulent peri-

tonitis may be an aggravation of a milder variety of peritoneal inflammation, and may follow in the sequence of a serous, a sero-fibrinous, or a fibrinous peritonitis. Thus, it is found in association with interstitial appendicitis without perforation, with ulcerative appendicitis without perforation, and it is always a concomitant of ulcerative appendicitis with perforation, unless the peritoneal involvement be diffuse. The peritonitis of gangrenous appendicitis is also of the purulent variety. Again, the acute infection or exacerbation of the inflammatory phenomena of a chronically inflamed appendix may be the starting-point of a circumscribed peri-appendicular abscess.

The serous and fibrinous exudates already described in connection with serous, sero-fibrinous, and fibrinous peritonitis are to be interpreted as the results of the reaction of the peritoneum to the action of an irritant—as an effort on the part of the peritoneum to protect itself from general infection. This exudate thus subserves a useful purpose. More than this, in the event of perforation of the appendix—the perforation in the majority of cases occurring into, rather than outside of it—it has already formed a barrier that in most instances, for a time at least, prevents infection of the general peritoneal cavity. It is, however, not essential that perforation occur in order that an abscess result. An exudate originally fibrinous often becomes fibrino-purulent or purulent without perforation of the appendix developing.

In circumscribed purulent peritonitis, or peri-appendicular abscess, a greater or smaller portion of the peritoneal cavity lodges a focus of suppuration that develops at the site of the original source of infection and is walled off from the general peritoneal cavity by more or less firm fibrino-plastic exudate. This peri-appendicular abscess may develop slowly or exceedingly rapidly, and in different cases it varies much in size and in other characteristics. There may not be more than one or two cubic centimetres of pus, in which case the abscess may be

difficult to find; on the other hand, the abscess may be exceedingly large, and may contain upward of a litre of pus. Usually, however, in an ordinary case there are not more than thirty cubic centimetres of pus. The abscess may be single or multiple, and may be regular or irregular in outline. It is not rare to find several pockets of pus that communicate with a common cavity. Under other circumstances several isolated pockets may communicate with one another by narrow and tortuous channels.

The wall of the abscess cavity is made up of a grayish-yellow or yellowish-green discoloured fibrino-purulent exudate. This is of variable firmness and consistency, and serves to unite more or less securely the appendix, cæcum, neighbouring coils of intestine, omentum, mesentery, and parietal peritoneum. The pus is sometimes yellowish in colour and distinctly creamy in appearance. More commonly, however, it is thinner than cream, of a yellowish-green, brownish, or greenish-black colour. Sometimes it is bluish or greenish in colour, and under such circumstances may reveal *Bacillus pyocyaneus* in pure culture. It usually possesses a peculiar, penetrating, disagreeable, fæcal odour. At times it is distinctly putrid, and may contain gas, the latter the result of the activities of contained bacteria or of admixture of intestinal gases in cases of perforation. In addition to the pus, the abscess may contain more or less necrotic remnants of fibrinous exudate, one or more fæcal concretions, and some fæcal matter. In it also we may detect the more or less altered appendix. The appendix, in whole or in part, may appear suspended, as it were, in the abscess cavity, or it may have become entirely separated from its cæcal attachment by circular amputation, and may float entirely free in the pus. More commonly it will be found embedded in the exudate forming part of the limiting wall of the abscess.

The situation of the abscess varies greatly in different cases, and is naturally dependent to a considerable extent upon the

situation, the direction, the length, the mobility, and the possible fixation of the appendix. In exceptional cases the appendix and the cæcum are found in anomalous positions, which in the event of appendicitis exert considerable influence in determining the situation of possible peri-appendicular suppuration. In the majority of cases, however, it is possible to divide these abscesses, with respect to their situation, into certain groups, of which Sonnenburg distinguishes four that are of common occurrence: (1) Anteriorly; (2) posteriorly; (3) medianly; (4) in the pelvis. In the first, according to him, there at first occurs an adhesion of the coils of intestine that normally are almost always found in front of the cæcum. Beneath these the abscess originates. As it increases in size, the adherent coils of intestine are displaced and the pus reaches the parietal peritoneum. The latter thus forms the anterior boundary of the abscess, the cæcum the posterior and median boundary, and the iliac fossa the outer boundary. In addition, various coils of intestine may assist in the limitation of the abscess above. In these cases the appendix is usually found anteriorly in the iliac fossa or attached to the outer or lower surface of the cæcum. When situated posteriorly, the abscess is limited anteriorly by the posterior surface of the cæcum, and posteriorly by the posterior abdominal wall. In these cases the appendix is usually attached to the posterior surface of the cæcum and is directed upward. These abscesses are situated higher than those of the former group, and, spreading out in the region of the kidney, they may give rise to perirenal suppuration; or, reaching the lumbar region, they may cause protrusion of it. Abscesses situated medianly are bounded laterally or externally by the median aspect of the cæcum and ascending colon; posteriorly, by the meso-colon; mesially, anteriorly, and above, by various coils of intestine. Attaining a considerable size, these abscesses may reach to, and be limited by, the bladder. Abscesses situated in the pelvis commonly occupy the right

p. 287

half of it, though they frequently extend also to the left. They are often situated in the retro-vesical space—in women, in Douglas's *cul-de-sac*. The appendix is usually detected in the upper and outer wall of the abscess; frequently, however, it may be adherent to the bladder, uterus, tubes, ovary, rectum, etc. This classification had been adopted independently by Deaver, who, in addition to describing the foregoing four varieties of peri-appendicular abscess, is in the habit of speaking of a fifth variety—the diffuse abscess, or diffuse purulent peritonitis. As already intimated, these peri-appendicular abscesses may be encountered in most unusual situations. Of such may be mentioned: Near the gall-bladder, near the spleen, in the region of the umbilicus, beneath the right lobe of the liver, beneath the diaphragm, in the left iliac fossa, in a hernia—inguinal or femoral, of either the right or left side—etc.

Heretofore mention has been made only of the suppurative complications of appendicitis that occur within the peritoneal cavity—to circumscribed appendicular peritonitis. It must, nevertheless, be stated that, in the event of suppuration ensuing upon an attack of appendicitis, it is not necessary that the collection of pus be situated primarily within the peritoneal cavity. The abscess may be retro-peritoneal—the formerly so-called *para-typhlitic abscess*. This may be due to one of several causes: (1) It may occur if the appendix be situated retro-peritoneally, as happens, as has been mentioned already, in about 2 per cent. of the cases. In case infectious material penetrate the wall of the appendix, or if perforation of the organ occur, the retro-peritoneal connective tissues are those first attacked, and a retro-peritoneal abscess results. (2) Such may also develop, although the appendix be situated intra-peritoneally, if the perforation occur into the meso-appendix. Under such circumstances the liberated infectious material dissects its way between the two layers of the meso-appendix, and finally reaches the retro-peritoneal connective tissues, where the abscess orig-

inates. It is quite likely also, that, in the absence of perforation, some retro-peritoneal abscesses may be produced by virulent infectious material being carried by the lymphatics of the meso-appendix to the retro-peritoneal connective tissues. (3) Such retro-peritoneal suppuration may also occur in some cases in which rather firm adhesions bind the appendix to the posterior layer of the peritoneum. In these cases this posterior layer of the peritoneum may have become so altered by the inflammation that, in the event of perforation, it offers but little resistance to the advances of virulent bacteria and their toxins. Being less resistant than the firm adhesions, it gives way first, and there thus occurs a perforation of the appendix, directly through its peritoneal coat, some adhesions, and the posterior layer of the peritoneum, into the retro-peritoneal connective tissues. A retro-peritoneal abscess results, without any associated intra-peritoneal suppuration. (4) Retro-peritoneal abscesses may occur secondarily by perforation through the posterior layer of the peritoneum of an abscess that originated intra-peritoneally.

Such retro-peritoneal abscesses sometimes give rise to the most extensive phlegmonous infiltration. Following the course of the iliac vessels, they may present themselves beneath Poupart's ligament; they may involve the region of the kidney and engender a large perirenal abscess, with or without implication of the kidney; they may ascend behind the liver and spread out over its surface, producing an extensive sub-diaphragmatic abscess; they may perforate into the pleura and produce an empyema; they may penetrate the lung and give rise to a pulmonary abscess, that may or may not be expectorated externally; they may perforate again into the peritoneal cavity, etc.

Reverting again to peri-appendicular abscess situated primarily within the peritoneal cavity, it will be recalled that it was stated that it may attain a capacity of a litre. Such an

occurrence, however, is most exceptional. Usually, if the abscess be progressive, before it has attained such a size one of several events will have ensued. There will either have been produced a general peritonitis—of which mention will be made later—or, if the adhesions be sufficiently firm to protect the general peritoneal cavity from infection, the abscess will probably have ruptured in one of several directions. As the abscess increases in size it not only compresses the adjacent organs and tissues, but the latter themselves become the seat of more or less superficial or deep inflammation with purulent infiltration and necrosis. The various organs and tissues of the region of the appendix permit of a certain amount of compression without much resentment, but when the limit has been reached, the abscess of necessity ruptures in the direction of least resistance. As some of the organs of this region, because of their implication in the inflammation, are themselves the points of least resistance, it is into them that rupture often occurs. Certain organs, however, are much more likely to be the seat of such perforation than others. The relative frequency of perforations into different tissues and organs is indicated by Sonnenburg, who cites the reports of various observers. These include a total of 424 cases, the combined statistics of Bull, Langheld, Einhorn, Krafft, and Paulier. Collectively, the most frequent perforations were as follows.

| | |
|---------------------------------------|----|
| Through the abdominal wall, | 46 |
| Into the cæcum, | 40 |
| “ peritoneal cavity, | 8 |
| “ pleural cavity, | 6 |
| “ ascending colon, | 4 |
| “ rectum, | 4 |
| “ ileum, | 3 |
| “ bladder, | 3 |
| “ uterus, | 1 |

It was misconception of the real direction of the perforation in certain cases of peri-appendicular abscess that, in part at least, led to the erroneous view maintained some years ago,

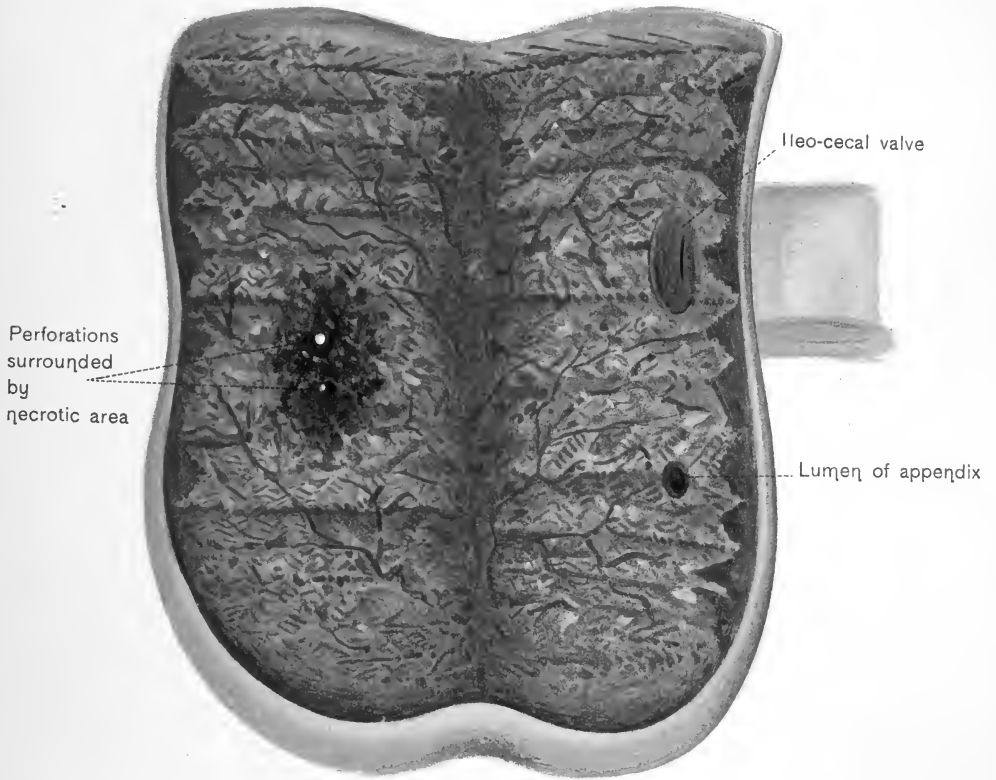
PLATE XXVI.

ACUTE APPENDICITIS WITH PERI-APPENDICULAR ABSCESS RUPTURED INTO THE CÆCUM.—H. W., twenty-five years, was admitted to the German Hospital on January 15, 1896. Ten days prior to admission, after eating, he was suddenly attacked with acute pain in the right iliac fossa, which was followed by tenderness and marked rigidity. There was neither nausea nor vomiting. He remained in bed two days. The symptoms abated, but pain, which was increased on motion, persisted in the right iliac region. At the time of admission to the hospital there were tenderness on pressure over McBurney's point and rigidity of the right lower abdominal wall, and on palpation a mass could be felt in the right iliac fossa. The tongue was coated and the temperature was normal.

At operation the appendix was found situated throughout almost its entire length in front of the cæcum. It was curled about the cæcum, however, and its tip was adherent to the posterior surface of that viscus. It was covered by dense adhesions, upon loosening which about one pint of thick, foetid pus escaped from behind the cæcum. The pus cavity was wiped with dry gauze (no irrigation); the appendix was freed and excised; gauze drainage was inserted and the wound was closed.

For sixteen hours after the operation the patient did well and suffered little. Suddenly he had a sharp accession of pain in the epigastric region, was nauseated, and finally began to vomit greenish matter in which some blood was discernible. There was slight abdominal distention. The wound was dressed, the gauze was removed, and the cavity was cleansed. Delirium set in, vomiting became continuous, and death ensued on the third day after the operation.

At the necropsy the incision was found closed and in good condition. In the upper posterior portion of the cæcum there was a large area of necrosis, in which were two small perforation ulcers, which were most extensive on the serous surface of the cæcum. There had occurred, from without inward, necrosis and perforation of the cæcum. The cicatrix at the site of the amputation of the appendix was scarcely discernible.



Internal aspect of a cecum illustrating a necrotic area and two perforations—acute appendicitis with peri-appendicular abscess ruptured into the cecum.



that appendicitis was typhlitis, peri-typhlitis, and para-typhlitis, and that the suppurative forms of the latter were the result of perforation of the cæcum. Suppurative disease about the cæcum did not, as was then held, result from disease and perforation of the cæcum. On the contrary, perforation of the cæcum, in many of these cases, was due to rupture into the cæcum of an already formed peri-appendicular abscess (Plate XXVI); in other cases it was due to a direct rupture of the appendix into the cæcum, with which it had formed adhesions (Plates VII and XXVII). There occur, however, cases of perforation of the cæcum due to some morbid condition of that viscus, such as large enteroliths, etc.

In addition to the previously detailed directions of rupture of peri-appendicular abscesses rare instances of perforation into other organs have been encountered. Thus, cases have been reported in which the abscess ruptured into the gall-bladder, into the duodenum, into the vagina, into the ureter (pelvis of the kidney), etc.; and Sonnenburg mentions a case in which, probably through infection of a patulous vaginal tunic of the testicle, there resulted a pyocele of the testicle.

But other secondary disastrous consequences ensue upon the persistence of the abscess. Thus, lymphangitis and lymphadenitis, thrombo-phlebitis and pylephlebitis may occur. The thrombo-phlebitis usually affects the mesentery and portal veins, but thrombosis of the iliac and femoral veins of either the right or the left side, or of both, may develop. The pylephlebitis is sometimes of the mild or noninfectious variety—the so-called adhesive pylephlebitis—in which the thrombus leads to partial or complete obliteration of the portal vein. Frequently, however, the process is infectious; the thrombus becomes purulent and leads first to abscess of the liver, and subsequently to general infection, or pyæmia. Again, erosion of a principal branch of the mesenteric vein has been encountered (Aufrecht), and implication of a branch of the inferior

PLATE XXVII.

CHRONIC APPENDICITIS WITH ACUTE EXACERBATION—ACUTE ULCERATIVE APPENDICITIS WITH PERFORATION DIRECTLY INTO THE CÆCUM.—The following case was that of the wife of a physician, who has kindly furnished me the subjoined history:

Mrs. H., early in April, 1895, had several attacks of abdominal pain accompanied by diarrhœa, but they were not considered of any importance. On April 28th another severe attack came on suddenly at 2 A. M. At 10 A. M. she had excruciating pain, which, though general throughout her abdomen, was particularly severe in the region of the navel and the right iliac fossa. The pain finally became localized in the right side, and was accompanied by extreme tenderness, nausea, vomiting, and diarrhœa. A hypodermic injection of morphine and repeated small doses of calomel were administered, and hot poultices were applied locally. The abdomen soon became distended, the pain and tenderness increased, and on palpation thickening and induration were detected. Appendicitis was diagnosed. A consultation was held with reference to the advisability of operation. This was not concurred in, as the consultant considered that the case was not one of appendicitis, but ordinary catarrh of the intestines. The poultices were continued and the morphine was stopped, and calomel was administered on account of constipation which had followed the original diarrhœa. For the first week there was little change in her symptoms. After the first week improvement commenced, but upon the slightest touch there was marked tenderness, and the induration remained. Four weeks from the time of the last attack her condition was fair, but, upon other advice, operation was decided upon.

At operation the parietal peritoneum was not adherent. There was a mass of omentum adherent to the cæcum, which was deeply congested and infiltrated, resembling in appearance a cock's comb. The adherent omentum was freed, ligated, and removed. The cæcum was exposed, and revealed behind it a small collection of foul pus. The appendix was adherent to the cæcum. It was detached, ligated, and removed, whereupon a perforation was seen in both the cæcum and the appendix, permitting of the discharge into the cæcum of the appendicular contents. The margins of the perforation in the cæcum were freshened and sutured. Gauze drainage was employed.

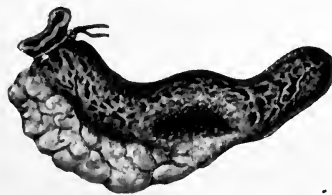
Recovery, though delayed by a stitch abscess, was eventually complete.



Appendix adherent to cæcum.



Appendix dissected off, showing perforation into cæcum.



Perforation upon detached surface of appendix.

CHRONIC APPENDICITIS WITH ACUTE EXACERBATION—PERFORATION DIRECTLY INTO THE CÆCUM.

vena cava, with consecutive pulmonary abscesses, is not unknown. Of other conditions secondary to the abscess may be mentioned: Erosion of the internal iliac artery or of one of its branches; iliopsoitis; perihepatitis; suppurative pleuritis; endocarditis; parotitis; meningitis; abscess of the kidney, spleen, etc.; disease of the female genitalia; and general septicæmia, pyæmia, etc.

It can not be denied, however, that, under exceptional circumstances, absorption of pus may occur. This is, nevertheless, a very rare event, and ensues only when the abscess is very small and the virulence of the contained bacteria very slight. Under such circumstances the abscess gradually becomes sterile, then inspissated, and there may result the formation of a thick mass of indurative connective tissue which rarely has been found the seat of calcareous infiltration. Under other circumstances the abscess may remain fluid and encysted—surrounded by a firm connective-tissue capsule.

Of recent years, as the nature of appendicitis is becoming more thoroughly appreciated, and the appropriate treatment more generally undertaken, the previously detailed disastrous complications are becoming progressively less. The more universal become the early recognition and the prompt surgical evacuation of appendicular and peri-appendicular suppuration or the removal of the diseased appendix before the supervention of suppuration, the less frequent are the secondary results of such collections of pus. It is for this reason that they whose practice it is to operate early in cases of appendicitis do not meet with these complications so frequently as do they who delay operation.

DIFFUSE OR GENERALIZED PERITONITIS.

In diffuse or generalized peritonitis the entire, or almost the entire, visceral and parietal peritoneum are involved in the

Appendicitis.

inflammatory processes. Such peritonitis may develop in a variety of ways, and its pathological anatomy differs considerably in different cases. It is found associated with severe cases of acute interstitial appendicitis without perforation, with ulcerative appendicitis with or without perforation, and with gangrene of the appendix. Several types of diffuse or generalized peritonitis may be distinguished, and a classification may be based not only upon the character of the pathological alterations, but also upon the manner of their production.

Thus, there is a form that may develop by gradual progression from a circumscribed purulent peritonitis—the *progressive fibrino-purulent peritonitis* of Mikulicz. This variety of general peritonitis is the slowest of all forms in its diffusion. From their original focus of infection, which may be a peri-appendicular abscess or a small perforation—the perforation occurring at a time when limiting adhesions have not yet formed—the entire peritoneum, step by step, as it were, becomes implicated. As this occurs, each new portion that is affected becomes walled off from the remaining unaffected peritoneum by more or less firm adhesions, in a manner similar to that which limits the original infectious focus or surrounds the appendix before it has perforated. These adhesions, which may unite portions of the intestine and omentum with any of the abdominal organs or with the parietal peritoneum, thus serve to protect the remaining peritoneum from sudden infection. These adhesions, in the majority of instances, are at first purely fibrinous in nature. However, they speedily become fibrino-purulent and purulent, and there are thus formed, in various portions of the peritoneum, pockets of pus that are more or less separated from one another. Some of them are entirely isolated, but many of them may communicate with one another by more or less tortuous channels. Gradual leakage of the infectious material occurs, additional portions of the peritoneum are involved, new adhesions (limiting barriers) are formed, new foci of suppuration develop, until

finally the entire peritoneum may become implicated. It is rather uncommon to find the entire peritoneum involved; there usually remain larger or smaller areas that seem to have resisted the onslaughts of the infection, and these are always separated from the affected peritoneum by the fibrinous wall. Careful search is sometimes necessary not only to detect these unaffected regions, but also to determine the situation of some of the pockets of pus.

In another series of cases there occurs a *diffuse* or *generalized purulent* or *suppurative peritonitis* without noteworthy fibrinous exudate, and consequently with but slight and friable adhesions between the coils of intestine, omentum, abdominal organs, and parietal peritoneum. Such peritonitis develops when perforation of the appendix occurs suddenly and soon after the onset of the disease—at a time when the peritoneum has not yet had time to form a plastic exudate; when a large and ill circumscribed empyema of the appendix suddenly bursts; when there occurs a sudden gangrene of an appendix that is not well surrounded by adhesions; and when, for any reason the adhesions limiting a peri-appendicular abscess suddenly give way and liberate a large quantity of pus. Thus, the peritoneal lesions vary somewhat, depending upon whether the ulcerative processes in the appendix, and consequently the perforation, develop slowly or rapidly. If the former, the peritoneum has had time to form a greater or less amount of plastic exudate that completely surrounds the appendix, and, in the event of perforation, a circumscribed peritonitis or abscess results, as has already been detailed. If the perforation develops suddenly, the appendicular contents are poured forth into the free peritoneal cavity. The intensity of the resulting inflammatory lesions depends upon the amount, the fluidity, the virulence, and the rapidity of the evacuation of the appendicular contents. These, having gained access to the general peritoneal cavity, are rapidly dispersed through extensive portions of the perito-

neum by the peristaltic action of the intestines, and a diffuse purulent peritonitis ensues.

In this variety of inflammation the peritoneum is the seat of an intense inflammatory hyperæmia; it is opaque and lustreless, and is covered with a small amount of a grayish-yellow or yellowish-green, veil-like, slimy, viscid exudate. These lesions, as a rule, are not distributed with uniformity throughout the peritoneum, but are commonly more marked near the seat of infection. It is not unusual, however, to find them affecting the peritoneum of the small and large intestines, the omentum, the mesentery, the solid abdominal organs, and the abdominal wall. The slight amount of exudate may serve loosely to unite neighbouring loops of intestine, but, as a rule, there are no firm adhesions unless they be old. The exudate, being attached loosely, often appears as a shredded covering of the intestine, and the unattached ends of the shreds can frequently be detected floating upon the surface of the pus contained within the peritoneal cavity. At times these shreds become entirely detached from the intestine and float free in the pus. The pus varies considerably in different cases. At times there is relatively little; again, the amount is excessive—a litre or more, and this within a short time of the onset of the attack. For a time, at least, it is freely movable, and, following the laws of gravity, seeks the dependent portions of the peritoneal cavity—recesses between adjoining coils of intestine, the pelvis, and the pre-renal regions. Later, if some adhesions are formed, there may occur more or less circumscribed collections of pus in various other regions. In character the pus is rarely thick and creamy; it is usually rather thin, limpid, of a greenish-yellow colour, at times of a brownish tint, and of a distinctly fæcal odour.

At times this variety of peritonitis assumes markedly putrid characteristics—*putrid peritonitis*. The peritoneum is swollen, congested, softened, and of a turbid grayish or grayish-red, opaque colour. The exudate is usually rather small in amount,

of a turbid grayish, grayish-red, or grayish-brown colour, and exceedingly malodorous. At times it may contain gas, even in the absence of perforation of the appendix. This is of most unusual occurrence; but despite the prevailing differences of opinion, it can not be denied that certain gas-forming bacteria may penetrate the diseased wall of the appendix and give rise to the formation of gas in the peritoneal cavity, even in the absence of perforation of the appendix. As a matter of fact, however, this variety of peritonitis is usually found in association with gangrene of the appendix with perforation. As a consequence, the production of gas is readily explicable, as is also the fact that at times portions of the gangrenous appendix, a fæcal concretion, or rarely, a foreign body can be detected free in the peritoneal pus.

Under other circumstances the peritonitis assumes a hæmorrhagic character—*hæmorrhagic peritonitis*. The peritoneum is excessively congested and the seat of more or less extensive hæmorrhagic suffusions. There is also some admixture of blood with the purulent or sero-purulent exudate, which gives it a reddish or brownish colour. Otherwise the lesions do not differ from those already detailed.

The last-named varieties of peritonitis are closely allied to that even more rapidly fatal form known as *septic peritonitis*, or *peritoneal sepsis*. In view of the fact, however, that the symptoms and pathological lesions of none of the varieties of peritonitis are unassociated with the activities of bacteria, the reservation of the term *septic*—a term variously interpreted at present—to designate a certain class of inflammations of the peritoneum is open to objection. As the clinical and pathological features of this variety of peritonitis are due to the rapid absorption of a large quantity of virulent toxins, it may be preferable to designate it *toxic peritonitis*. Clinically, the predominating characteristics of this variety are not only the evidences of disease of the peritoneum, but also, and particularly, the

indications of profound intoxication, which, as is well known, manifest themselves principally by disturbances of the nervous system and of the general economy. Pathologically, cases of this class differ from those of the other classes by the relative meagerness of the lesions. In the other varieties of peritonitis the peritoneum is able to offer some resistance to the spread of the infection, and this resistance is manifest by the evidences of inflammation and the attempts at restriction of the infectious focus to a portion of the peritoneum. In cases of toxic peritonitis, however, the peritoneum, and secondarily the general economy, are suddenly overwhelmed with such a quantity of virulent toxins that the patient may succumb before the peritoneum is able even partly to recover itself and to attempt an adequate resistance.

The lesions detected in these cases are often inconspicuous. Aside from injection of the peritoneum, either in whole or in part, there may be no deviations from the normal. In other cases the congestion may be more intense and widespread, and there may be minute hæmorrhages beneath the serosa; in addition, the peritoneum may be a little less glistening than normally, and there may be a slight amount of free fluid. The latter is usually small in amount, thin, limpid, and of a yellowish-green colour and somewhat malodorous. At times the peritoneum is quite dry. There may also be a diffuse, infectious, serous peritonitis, as described by Tietze. Under other circumstances portions of the intestine may be distended, whereas others may preserve their normal calibre. Here and there a few fibrinous flakes may be seen, but firm adhesions are never encountered. The spleen is enlarged and there is cloudy swelling of the liver, kidneys, heart muscle, etc.

CHRONIC APPENDICULAR PERITONITIS.

If an attack of sero-fibrinous or fibrinous peritonitis complicating appendicitis take a favourable course—that is, do not go on to suppuration—or if the appendix be not removed by operation, the exudate, as has already been intimated, undergoes the ordinary alterations characteristic of the formation of fibrous tissue. There thus result bands of adhesions that unite the appendix, portions of intestine, omentum, mesentery, and parietal peritoneum. The longer the affection of the appendix has continued, and the more numerous and severe have been the recurrences, the more certain are peritoneal adhesions to be found, and the more firm and extensive are they likely to be. After the removal of the diseased appendix by operation the remaining exudate always tends to organization and cicatrization.

The macroscopical appearances in cases of chronic peritonitis vary somewhat, depending upon whether the examination be made during a recurrence or during the interval between attacks. Generally, however, the appendicular peritoneum—usually, also that of the meso-appendix—is congested, thickened, opaque, and harder than normal. The appendix is more or less firmly united to the cæcum, colon, omentum, intestine, mesentery, parietal peritoneum, or some of the viscera by means of bands of adhesions that vary much in thickness and firmness. They may be slight, long, much attenuated, and readily broken, or they may be short, very thick, and exceedingly dense and fibrous. Not only is the appendix often united to the structures just enumerated, but the latter are themselves frequently firmly united with one another. A portion of the omentum, the appendix, and a loop of intestine may, with adhesions, form so dense a mass that only careful search reveals the situation of the appendix, and the most painstaking dissection is requisite to remove it. This may also be true of the cæcum and of other portions

of the intestine, which are often bound down, twisted, constricted, and dislocated by bands of adhesions of various characteristics.

The associations that the appendix forms with other organs by the medium of these bands naturally depend upon its situation, and this, in certain cases, is not independent of the great mobility of the organ. In its ordinary situation the appendix is, of course, most frequently united with the cæcum; then, in order of frequency, the peritoneum of the right iliac fossa, the mesentery, the small intestine (ileum), the omentum, and the colon. In women it is often adherent to the right uterine adnexa. When in unusual situations, or when excessively long and motile, the appendix may have formed adhesions with almost any of the intra-peritoneal organs—the duodenum, gall-bladder, liver, spleen, ureter, bladder, rectum, left uterine adnexa, etc.

These adhesions are of varying importance. If they be small, of slight extent, and yielding, they may be devoid of portentous significance. On the other hand, they are commonly distinctly detrimental to health. They contribute to renewed attacks of appendicitis by restricting the free motion and the peristaltic action of the appendix, and by causing compression, strictures, twists, angulations, etc., of the organ. In addition, they often engender the most disastrous intestinal conditions. By their mere adhesion to portions of the bowel they inhibit peristalsis, and by their contraction they may, by compressing or encircling the bowel, cause intestinal obstruction, angulation, or strangulation. They may also compress the ureter and give rise to hydronephrosis and pyonephrosis, and produce a variety of clinical manifestations by reason of their connection with the liver, spleen, bladder, ovary, etc. On the contrary, they are not altogether without value. Contributing, as they do, to recurrences of appendicitis, in the event of such developing and perforation ensuing they have formed a barrier that, for a time at least, effectually prevents infection of the general peritoneal cavity. Theoretically, at least—es-

pecially if they surround the appendix or bind it to the wall of the pelvis—as they contract they assist in the constriction and obliteration of the lumen of the organ. If the latter occurs, the likelihood of recurrence of the inflammation is excluded.

The frequency of these adhesions is indicated by the statistics of Leichtenstern, who found, among 1541 cases of intestinal obstruction, 34 resulting from disease of the appendix.

THE BACTERIOLOGY.

As the basis of a discussion of the pathogenetic rôle of bacteria in appendicitis the results of the bacteriological investigations of 286 appendices removed by operation may be detailed. The first inoculation in each case was made from the lumen of the appendix after aseptic incision of its wall, and the inoculation was always made from the seat of most manifest disease. At times inoculations were also made from the exudate on the peritoneal surface of the appendix, from pus of the abscess, from free pus in the peritoneal cavity, and from drainage fluid subsequent to the operation. The results of these later inoculations in no case differed from those of the primary inoculations from the lumen of the appendix. Inoculations in the first place were made into bouillon or into agar tubes, or both. Subsequently, in many of the cases, Petri-dish cultures were made, and later various other inoculations, for the purpose of fully establishing the identity of the bacteria under investigation. In some instances, also, cover-slip preparations were made directly from the pus or other contents of the lumen of the appendices, from the exudate on the peritoneal surface, or of the free pus. Of the 286 appendices examined bacteriologically, 128 were instances of acute appendicitis; 158 of chronic appendicitis. The results of the examinations may be tabulated as follows:

Appendicitis.

Acute appendicitis:

| | | |
|---|-----------|---------------------|
| Bacterium coli commune alone, | 93 cases | (72.656 per cent.). |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 17 " | (13.28 per cent.). |
| Bacterium coli commune and Streptococcus pyogenes, | 6 " | (4.69 per cent.). |
| Bacillus pyocyaneus alone, | 6 " | (4.69 per cent.). |
| Staphylococcus pyogenes albus alone, | 3 " | (2.344 per cent.). |
| Staphylococcus pyogenes aureus alone, | 1 case | (0.78 per cent.). |
| Bacterium coli commune and Staphylococcus pyogenes citreus, | 1 " | (0.78 per cent.). |
| No growth, | 1 " | (0.78 per cent.). |
| Total, | 128 cases | (100.00 per cent.). |

Specifically, the results of the bacteriological examinations with reference to the various forms of acute appendicitis were as follows:

Acute catarrhal appendicitis:

| | |
|--|----------|
| Bacterium coli commune alone, | 4 cases. |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 1 case. |
| Total, | 5 cases. |

Acute interstitial appendicitis:

| | |
|--|-----------|
| Bacterium coli commune alone, | 15 cases. |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 6 " |
| Bacillus pyocyaneus alone, | 2 " |
| Total, | 23 cases. |

Acute ulcerative appendicitis without perforation:

| | |
|--|-----------|
| Bacterium coli commune alone, | 39 cases. |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 3 " |
| Bacterium coli commune and Streptococcus pyogenes, | 3 " |
| Bacillus pyocyaneus alone, | 3 " |
| Staphylococcus pyogenes aureus alone, | 1 case. |
| Total, | 49 cases. |

Acute ulcerative appendicitis with perforation:

| | |
|---|-----------|
| Bacterium coli commune alone, | 24 cases. |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 5 " |
| Staphylococcus pyogenes albus alone, | 3 " |
| Bacterium coli commune and Streptococcus pyogenes, | 1 case. |
| Bacterium coli commune and Staphylococcus pyogenes citreus, | 1 " |
| | <hr/> |
| Total, | 34 cases. |

Gangrenous appendicitis:

| | |
|--|-----------|
| Bacterium coli commune alone, | 11 cases. |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 2 " |
| Bacterium coli commune and Streptococcus pyogenes, | 2 " |
| Bacillus pyocyaneus alone, | 1 case. |
| No growth, | 1 " |
| | <hr/> |
| Total, | 17 cases. |

The following were the results of the bacteriological examinations in the cases of chronic appendicitis:

| | |
|--|-------------------------------|
| Bacterium coli commune alone, | 142 cases (89.873 per cent.). |
| Bacterium coli commune and Staphylococcus pyogenes aureus, | 7 " (4.43 per cent.). |
| Bacillus pyocyaneus alone, | 2 " (1.266 per cent.). |
| Bacterium coli commune, Staphylococcus pyogenes aureus, and Staphylococcus pyogenes albus, | 1 case (0.633 per cent.). |
| Staphylococcus pyogenes aureus alone, | 1 " (0.633 per cent.). |
| Bacterium coli commune and Bacillus prodigiosus, | 1 " (0.633 per cent.). |
| No growth, | 4 cases (2.532 per cent.). |
| | <hr/> |
| Total, | 158 cases (100.00 per cent.). |

From the foregoing, therefore, it is evident that Bacterium coli commune was found alone in 72.65 per cent. of the acute cases and in 89.873 per cent. of the chronic cases; that it was found either alone or in combination with other bacteria in 117 (91.4 per cent.) of the acute cases and in 151 (96.2 per cent.) of the chronic cases. Although these facts are extremely sug-

gestive, the relation of *Bacterium coli commune* to the development of appendicitis and consecutive peritonitis is not the simple one that it at first sight appears.

It is not many years since *Bacterium coli commune* was looked upon merely as an innocuous inhabitant of the intestine—as an organism devoid of pathogenetic properties. Its detection in pure culture, however, in many cases of peritonitis, as well as in morbid conditions of other intra-abdominal organs, directed attention to the possibility of it possessing pathogenetic attributes. Finally, the determination that *Bacterium coli commune* isolated from the intestine in case of disease of that structure is more virulent than that secured from the normal intestine, and the experimental production of peritonitis by the introduction of cultures of this organism into the peritoneal cavity of lower animals, definitely proved its pathogenetic properties.

Investigations of recent years have conclusively demonstrated not only that *Bacterium coli commune* is variable in pathogenetic properties—that is, in virulence—but also that it exhibits other biological and morphological differences, such as of size, shape, motility, etc. It suffices to mention that its variation in size is well known; that some cultures are much more actively motile than others; that Adami has recently described a diplococcus form; and that the organisms described as *Bacillus pyogenes foetidus* (Passet), *Bacillus lactis aërogenes* (Escherich), *Bacillus neapolitanus* (Emmerich), *Bacillus enteritidis* (Gärtner), the pyogenic urinary bacillus of Clado and Albarran, etc., are most likely but varieties of a class of bacteria most appropriately designated the “colon group.” These exhibit quantitative differences in their biological characteristics, but it is questionable if they do so to a degree sufficient to warrant their separation into distinct species.

When *Bacterium coli commune* was found in the peritoneal cavity, and in the exudate upon the serous coat of the intes-

tine, in the absence of perforation of that structure—as, for instance, in so-called idiopathic peritonitis, strangulated hernia, volvulus, etc.—the relations of this organism to the intestinal wall and *vice versa* demanded study. That which particularly required elucidation was the question whether this micro-organism possesses the power to penetrate the wall of the intestine. As a consequence of investigation it has been determined that this bacterium does possess the power to penetrate the wall of the intestine, although the normal intestine, particularly its mucous membrane, opposes effectually a barrier to the bacterium of ordinary virulence. If, however, the bowel be reduced in resistance—as occurs in congestions, inflammations, etc.—the bacterium penetrates the wall with more or less facility. It is most certain, also, that the toxine elaborated by virulent *Bacteria coli communia* retained within a restricted portion of the bowel may so alter the mucous membrane as to permit of invasion of the wall. This, without a doubt, occurs in such an anatomical tube as the appendix.

We have thus come to view *Bacterium coli commune* as a group of bacteria rather than as a single species. The individual species have been described under a variety of names, and exhibit quantitative differences in their biological properties. These bacteria are normal in all portions of the intestinal tract where they appear a few hours after birth. They are probably directly or indirectly concerned in the processes of digestion. Ordinarily, they are but slightly virulent, or they may be innocuous. Under a variety of circumstances, however, they become greatly increased in virulence, and their toxine may acquire very high potentiality. This augmentation of virulence occurs in a number of diseased states, such as obstruction, strangulation, volvulus, congestion, œdema, and inflammation of the bowel; in various diarrhœic conditions, such as that which follows the administration of purgatives, typhoid fever, cholera, etc.; and in marked and long-continued consti-

pation. This heightened virulence may be due to the association with *Bacterium coli commune* of other bacteria, but under some circumstances it seems to be due to alterations of the bowel alone.

That *Bacterium coli commune* is not the only micro-organism concerned in the pathogenesis of appendicitis is sufficiently evident from the foregoing statistics and from the investigations of other observers. Tavel and Lanz first directed attention to the frequent implication of several forms of bacteria in the production of appendicitis, and these authors were soon followed by Barbacci, and since then by others, among whom may be mentioned Welch and others in this country. It has been contended by these observers that appendicitis is the consequence of a mixed infection; that it rarely results from a mono-infection. The fact that *Bacterium coli commune* alone is usually isolated from cultures of the pus from cases of appendicitis is explained by stating that *Bacterium coli commune* proliferates much more luxuriantly than do the other bacteria present, and thus outgrows them,

In but 33 of the 286 cases examined was such mixed infection demonstrated by the methods of investigation pursued. These comprised 24 acute cases (18.75 per cent.) and 9 chronic cases (5.7 per cent.). It should be mentioned here that in those instances in which cover-slip preparations of the contents of the appendix and of the peri-appendicular exudate and pus were examined the results of the examination did not differ from the results obtained by culture methods. Cocci, in particular, were conspicuous by their absence. In this respect my own investigations are somewhat at variance with those of other observers. While free to admit that the systematic examination of such cover-slip preparations in all cases of appendicitis might lead to the detection of the associated presence of two or more varieties of bacteria in a larger number of cases than my statistics indicate, I am nevertheless confident that *Bacterium*

coli commune takes by far the greatest part in the bacterial origin of appendicitis.

I have repeatedly observed that if the cover-slip preparations be made from the contents of the appendix at a point somewhat removed from the seat of most manifest disease, a great variety of bacteria will often be disclosed. In the same case, however, preparations from the seat of more advanced disease, or from the peritoneal exudate or pus, will disclose only a bacillus morphologically identical with *Bacterium coli commune*. In a few cases cocci also were detected, but not in a greater proportion of cases than is indicated by the statistics as previously cited. I am inclined to consider the contaminating organisms in the first-mentioned instances as more or less innocuous, nonpathogenic, intestinal bacteria.

I have also taken opportunity to examine sections from a number of acutely inflamed appendices for the presence of bacteria in the various coats of the wall of the organ. The organisms that it was possible to identify were almost exclusively such as were morphologically similar to *Bacterium coli commune*. In exceptional cases some cocci were also seen. The micro-organisms were commonly within the lymph spaces, and were often some distance in advance of the cellular alterations. Of course, I am not unmindful of the fact that such evidence with reference to the identity of bacilli must be accepted with great reservation. It is extremely suggestive, however, that cocci were so regularly conspicuous by their absence, and that *Bacterium coli commune* was equally conspicuous by its presence—not only in cover-slip preparations made from the intra-appendicular pus, extra-appendicular exudate, and pus, but also in the respective cultures and in the wall of the appendix.

Of the extreme virulence of *Bacterium coli commune* under certain conditions sufficient experimental and clinical evidence has been accumulated. When to this we add the fact that the

conditions in the appendix are most favourable for the sudden and rapid increase in the virulence of a bacterium that may be innocuous, or almost so, in other portions of the intestinal tract, it seems to me that the predominating importance of this organism in the ætiology of appendicitis can not be gainsaid. It can not be denied that *Bacterium coli commune*, under suitable conditions, proliferates most luxuriantly in culture media. Nor, on the other hand, can it be denied that the appendix is a most appropriate test-tube, and that the contents of the appendix are most suitable media, in which to cultivate a virulent growth of *Bacterium coli commune*. I believe, therefore, that as this organism outgrows other bacteria in artificial media, so also does it, under suitable conditions, assume a predominance in the appendix. This organ, like the intestine, under normal circumstances contains a variety of bacteria; but under conditions favourable for the development of appendicitis, particularly when the lumen of the appendix becomes occluded, *Bacterium coli commune* rapidly becomes the predominating and most virulent organism.

These statements naturally do not eliminate from consideration other bacteria as ætiological factors in inflammatory affections of the appendix. A number of other micro-organisms have been found sufficiently often by different observers, as well as by myself, and their virulence has been repeatedly tested, to indicate their importance in the production of appendicitis. Interest is attached to the presence of *Bacillus pyocyaneus* in six of my cases of acute appendicitis and in two of the cases of chronic appendicitis. The pathogenetic importance of the streptococcus, when present, can not be overestimated, and the same is also true of the staphylococci. Of other bacteria encountered in appendicitis the following may be mentioned: Varieties of proteus, *Bacillus subtilis*, *Bacillus capsulatus*, *Coccus conglomeratus*, *Bacillus fusiformis*, bacilli resembling those of diphtheria, glanders, tetanus, actinomycosis, etc., and the pneu-

mococcus, etc. The last-named organism was isolated by Barbacci from 60 per cent. of his cases, but I have not encountered it.

Undoubtedly, in certain cases bacteria other than *Bacterium coli commune* do contribute to cause appendicitis; in some cases they are doubtless the sole ætiological factor. This is indicated by the fact that in certain of my own cases, as well as in those of other observers, this bacterium was absent, whereas other micro-organisms were present. It has been stated that undue prominence is assumed by *Bacterium coli commune* because of the property it possesses of invading tissues already the seat of morbid alterations inaugurated by other organisms. The latter, following invasion by *Bacterium coli commune*, are believed to assume a subsidiary rôle, and to become overshadowed by reason of the active proliferation of the invaders. Personally, I am inclined to accord predominance to that organism which, it is believed, so readily overcomes such well-known and virulent bacteria as the streptococci, etc., rather than believe that other organisms inaugurate the morbid condition in the appendix and then succumb to the activities of *Bacterium coli commune*. I believe that conditions are analogous in the appendix and in the test-tube; and that, further, as most of my examinations of acute cases were made very early in the attack, if bacteria other than *Bacterium coli commune* were so frequently concerned in the ætiology of appendicitis, as is held by some, they would have been detected by the methods of investigation pursued.

As will appear later, the most important factor in the augmentation of the virulence of *Bacterium coli commune* in the appendix is defective drainage. When the drainage of the appendix becomes impeded or ceases entirely, *Bacterium coli commune* rapidly multiplies and increases in virulence, producing a toxine of very high potentiality. This, either alone or associated with the products of decomposition of the appendicular contents, suffices to inaugurate catarrhal alterations in the appendix. As a consequence of this, and also of the mechanical pressure exerted

by the accumulating secretion, the mucous membrane becomes reduced in vitality, and invasion of the wall of the organ is a matter easy of accomplishment. The bacteria may successively invade each coat of the appendix until they reach the serous coat. Here they may give rise to a peritonitis, which may become suppurative, and may be either circumscribed or diffuse. It is thus that peri-appendicular suppuration arises in the absence of perforation of the appendix. As the bacteria penetrate deeper into the wall of the appendix, they commonly liquefy the tissues by peptonizing them, and, as a matter of fact, most cases of appendicitis with appendicular peritonitis present more or less ulceration of the appendix. In some cases the toxine elaborated is excessively virulent (and some of these are doubtless streptococcic), and there is widespread disease of the appendix, possibly gangrene, with virulent peritonitis, and still no perforation of the appendix. There thus can be no question that bacteria alone are amply capable of exciting appendicitis; that such appendicitis may be attended by ulceration in the absence of appendicular calculi; and that suppurative peritonitis may be associated with appendicitis without perforation of the appendix.

The differences in the severity of the clinical manifestations of cases of appendicitis are explicable upon the assumption of variations in the virulence of the toxins elaborated by the bacteria provocative of the inflammatory attack. In some cases it is likely that two or more varieties of bacteria acting in symbiosis produce a much more virulent composite toxine than would either alone. The leukocytes and nuclein are defenses provided by nature, but they are often ineffectual. The absorption of the toxins engenders the various general manifestations of the disease, of which the most important are albuminuria with casts; urobilinuria; indicanuria; a peculiar icteric tint of the skin; disturbances of cerebration, of cardiac action, etc. It is a peculiarity of the toxine of some cases which develop insidiously that it gives rise to symptoms which, for a time at least, much resemble those of typhoid fever.

THE PATHOGENESIS.*

In considering the pathogenesis of appendicitis it must be borne in mind that inflammation of the vermiform appendix is in many respects so unique a disease; it differs so materially from inflammatory affections of other portions of the gastro-intestinal tract; it is often so sudden in its onset, so alarming in its aspects, and so disastrous in its consequences, that it behooves us to look for some cause or causes resident in or about the appendix itself to account for the much greater frequency of inflammation of this portion as compared with other portions of the gastro-intestinal tract, and for the preponderating rôle such inflammation plays in the ætiology of peritonitis. As a matter of fact, there pertain to the appendix certain important anatomical and physiological peculiarities that must of necessity exert considerable influence in the production of diseased conditions of that organ—that act as **predisposing causes**. The most important of these are: (1) The shape of the meso-appendix; (2) the excessive length as compared with the width of the appendix; (3) Gerlach's valve; (4) the histological structure of the organ; (5) the blood supply; (6) the nerve supply; (7) the evidences of involution of the organ.

The **meso-appendix** is of importance for several reasons. It not only acts as a predisposing factor in the causation of inflammation of the appendix, but it also has important bearings with reference to the possible results of such inflammation. The relations of the appendix to the peritoneum and *vice versa* are various. As a rule, the appendix is completely enveloped by a fold of peritoneum, and lies free within the peritoneal cavity—it is an intra-peritoneal organ. Exceptionally, however, its posterior surface is unprovided with a peritoneal covering. Under

* Consult: Kelly, A. O. J., "The Pathogenesis of Appendicitis," Philadelphia Medical Journal, iv, pp. 928, 983, and 1032, 1899.

such circumstances the organ is in direct association with the retro-peritoneal connective tissue, and this relation is of importance as influencing the course of possible peri-appendicular supuration. Commonly, however, as already stated, it lies free in the peritoneal cavity and is almost invariably provided with a meso-appendix. The latter is usually triangular in shape, though it varies considerably in size, in thickness, and in the extent to which it is attached to the appendix. In the majority of instances the meso-appendix extends the entire length of the appendix. Exceptionally, however, the tip of the organ may be free; and more rarely, the meso-appendix may be attached to but the proximal two-thirds or one-third of the organ. It is, however, because of its size that the meso-appendix bears an important ætiological relationship to appendicitis. If it have a breadth commensurate with its length, or if it be very short or entirely absent, as far as the meso-appendix is concerned, the appendix will be quite straight. If, however, it be relatively narrow as compared with its length, the appendix will be correspondingly curved or distorted. Under such circumstances, depending upon the degree of the curve, flexure, or distortion, the free drainage of the appendix, so essential to its well-being, is compromised. As will be detailed later, when the free and thorough drainage of the organ is interfered with, one of the most important ætiological factors of appendicitis becomes operative.

The **excessive length of the appendix** as compared with its width, and more particularly with the calibre of its lumen, is another important ætiological factor in appendicitis, and this also because of the interference thereby engendered with thorough drainage. Appendices vary considerably in length, some being very short, others very long. The longest that I have encountered was 14 cm. The average length is from 8 cm. to 9 cm. On the other hand, the diameter of appendices that appear not to have been diseased varies between 3 mm. and 5 mm., and there are often marked differences at different levels

of the same organ. The relation, then, of the diameter of the lumen to the length of the appendix is about as 1 to 16 or 25—an evident disproportion, to which must be ascribed considerable pathogenetic significance. It appears that if the appendix once becomes the seat of disease, this disproportion is much accentuated. Thus, in over 75 per cent. of appendices the seat of chronic inflammation that were examined the lumen had been reduced in diameter to 2 mm. or less throughout. In a number of the remaining 25 per cent., the lumen was but 2 mm. at certain levels, but exceeded this at others. Of those in which the diameter of the lumen was 2 mm. or less throughout, it was in many places 1 mm. or less. The pathogenetic significance of this disproportion between the calibre of the lumens and the length of appendices apparently healthy becomes much augmented if for any reason the lumen be diminished, as by chronic inflammation or otherwise.

The exact significance to be attached to **Gerlach's valve** is indeterminate, and this largely because that structure itself is very indeterminate. It is usually evident, when the cæcum is viewed from within, as a small prominence of the mucous membrane surrounding, either completely or in part, the orifice of the appendix. Upon close inspection it is seen to be made up of a reduplication of the mucous membrane, and microscopical examination reveals, in addition, some lymphoid tissue. It is better developed in youth than in old age. It is said to be most marked in infants during the first year of life; in adults and the aged it often eludes detection by the unaided eye. Microscopical examination, however, usually reveals some indication of it. Krafft states that Nanninga has observed immediately below this valve a second smaller one. At all events the valve is admittedly a rather inconstant structure. Nevertheless, it can readily be surmised that when present it serves to retard the entrance into the appendix of intestinal contents, and to hinder, possibly to a less degree, the escape into the cæcum of appendic-

ular contents. It is this latter function that is the more important in this connection. If for any reason the region of the cæcum about the appendicular orifice, or Gerlach's valve, become swollen, the escape of appendicular contents is more effectually prevented, defective drainage ensues, and appendicitis results.

The **histological structure of the appendix** has important bearings upon the pathogenesis of inflammation of the organ. It is quite correct to state that in general the appendix conforms in histological architecture to the structure of the large intestine, but it is, nevertheless, very unwise to lose sight of the many particulars in which it presents deviations from that type. That which is especially the most important is the presence in the mucous membrane of the appendix of a considerable amount of lymphoid tissue. These lymphoid cells at times infiltrate without definite arrangement the mucosa; at times they are collected into definite groups that are spoken of as lymphoid follicles. It is because of this richness in lymphoid tissue that the appendix has been aptly compared to the tonsil. It has been spoken of as the "abdominal tonsil," and comparison has been made between cases of "simple tonsillitis" and "simple appendicitis" (which Sahli even speaks of as "angina of the appendix")—both of which are considered by some amenable to medicinal treatment—and between suppuration of the tonsil and suppuration or sloughing of the appendix.

The amount of lymphoid tissue in the appendix seems to bear some relation to the age of the individual, and this may not be without significance in the ætiology of inflammation of that organ. My investigations, which have been so largely with diseased appendices, hardly warrant me in formulating a positive opinion on this subject; they have, however, led me to believe, with Ribbert and Kelynack, that lymphoid elements are more abundant in the appendix during childhood than during later life. It is well known that affections of adenoid tissue are more

likely to occur in the young than in the aged, and in some cases of appendicitis this fact is probably of ætiological importance—appendicitis being preëminently a disease of adolescence and early adult life. Ribbert states that the typical arrangement of the lymphoid elements into follicles is preserved until about the thirtieth year, when the follicles commence to undergo some atrophy and become more widely separated. Exceptionally, this physiological atrophic process may be installed as early as the twentieth year. Ribbert and Kelynack, nevertheless, state that lymphoid tissue may be found in the appendices of the aged, and my own investigations certainly confirm this view. Ribbert mentions, also, that in the rabbit, more so than in man, the appendix is characterized histologically by the presence of such an amount of lymphoid tissue as to make it resemble a single large Peyer's patch. Hawkins, on the other hand, is reservedly inclined to believe that the amount of lymphoid tissue in the appendix does not bear any direct relationship to the age of the individual, but states that only the examination of a large number of normal appendices would warrant any definite statements on this subject. It is reasonable, also, to assume that those the subjects of the "lymphoid diathesis" are rather prone to appendicitis, as to affections of adenoid tissue in general, and in this connection the operations of heredity may not be without significance.

Another histological peculiarity of the appendix of considerable significance is the relatively extensive epithelial surface that it presents—extensive as compared with the size of the appendix. Under circumstances of even slight irritation or erosion it thus affords a large surface for the absorption of the noxious products of bacteria. This is further increased by the numerous crypts of Lieberkühn wherein the bacteria become lodged and continuously produce their toxins.

The **blood supply of the appendix** and the pathogenetic relationship that the blood-vessels and the arterial supply bear

to inflammation of that organ have been considerably studied. It is unnecessary here to go into a detailed description of the blood supply of the appendix, but some slight reference to the blood-vessels themselves may be opportune. If I mistake not, it was Fowler and Van Cott who first directed particular attention to the important ætiological rôle of the circulatory apparatus of the appendix in inflammation of that organ. These authors believe that the appendix is peculiarly exposed to vascular and nervous, and hence to nutritional, disturbances, and base their opinion upon an examination of thirteen appendices made by Van Cott. The examination of these is said to have revealed in the vessels of the meso-appendix some form or other of obstruction to the blood current, either paravascularitis, perivascularitis, or endovascularitis; and these, it is believed, must have preceded the intense round-cell infiltration, the coagulation necrosis, the purulent foci, that they detected in the walls of the appendices. Van Cott also states that in several cases he found a distinct chronic interstitial neuritis with extensive atrophy of the nerve fibres resulting from hyperplasia of the endoneurium and perineurium. He argues from these that the real cause of the *locus minoris resistentiæ* admitting of bacterial invasion is not to be sought in a trauma of the mucosa, but in a trophic disturbance of the appendix, the result of chronic vascular lesion or of chronic nerve lesion, or both; and that the ulcerative processes in the appendix, while they may be increased by bacterial invasion, may nevertheless owe their origin to these trophic conditions.

These opinions have been subjected to critical investigation and have commonly not been confirmed. In particular, Breuer, at the instigation of Nothnagel, carefully examined thirty appendices, some of which had been removed at necropsy and some at operation, among the latter there being instances of acute and chronic appendicitis. By means of carefully performed injection of the arteries, he first of all determined that the vascular supply of the appendix is not a terminal one, such

as obtains in the brain, spleen, kidney, etc., but that a not inconsiderable collateral blood supply comes from the adjoining cæcal vascular area. Furthermore, it was determined that these anastomosing arterial branches course partly beneath the mucosa, partly in the muscularis, and partly directly beneath the serosa. But as the pertinent result of his investigations, Breuer was unable to detect vascular alterations of the constancy and extent described by Van Cott. In cases of chronic inflammation of the appendix the larger arteries of the meso-appendix were regularly intact, even when surrounded by hyperplastic connective tissue. Not only this, but the smaller vessels—the arteries and veins—of various regions of the wall of the appendix revealed but rarely pathological alterations. For instance, in areas in which the entire mucous membrane was converted into cicatricial connective tissue there were evident but slight thickening of the vessels, endothelial proliferation, etc.,—changes that, it is asserted, are detectable in every cicatricial tissue and in instances of normal involution of the appendix. In cases of acute suppurative appendicitis the alterations of the vessels were more common, but they were limited to the acutely inflamed region and its immediate vicinity. As the result of my own investigations, I believe there can be no question that Van Cott is correct in asserting that these vascular alterations are present in some presumably normal and in some diseased appendices, but I also believe that he erroneously interprets their significance and overestimates their importance.

In a considerable number of presumably normal appendices removed at necropsy and subjected to histological investigation the thickness of the vessel wall of the appendix, as well as of the meso-appendix, impressed me forcibly. In many of these the deviations from the normal were almost exclusively confined to the muscular coat. In not a few instances, however, there was a distinct proliferation of the intima. The vessel walls of the remaining appendices appeared entirely normal. Patho-

logical alterations, particularly endothelial proliferation, were more common in the diseased appendices examined. In some of the appendices that had been the seat of recurring attacks of inflammation the thickening of the vessel walls was very apparent. In some of the acute cases the endothelial proliferation was equally conspicuous. In other appendices—those which for a shorter or longer time had been the seat of chronic inflammation, and which had more recently suffered an acute exacerbation—alterations of both the media and intima were evident. (Plate XVIII.) In many of the acute cases, however, the vessel walls presented no noteworthy deviations from the normal. Some interstitial connective-tissue overgrowth was also occasionally detected in and about the nerves of the meso-appendix, but by no means so regularly and constantly as indicated by Van Cott. As the result, therefore, of my own investigations considerable pathogenetic significance is ascribed to the condition of the arteries, but more to the blood supply. I believe that cases in which nerve lesions may with justice be held accountable for the development of appendicitis are quite exceptional. However, excluding instances of thrombosis and embolism of the chief appendicular vessels or their branches, and obstruction of the blood supply by means of torsions, angulations, or contracting bands of connective tissue compressing the vessels, I do not believe that ulceration of the wall of the appendix can with reason be ascribed to arterial alterations. I believe, though, that the precarious blood supply of the appendix may with justice be held at least partly accountable for the disastrous consequences to the appendix of causes therein provocative of inflammation, but which in other portions of the intestinal tract remain inoperative. I believe, also, that in case the blood supply of the appendix becomes very defective by reason of torsions, flexures, etc., conditions obtain in the appendix that render the common exciting causes of ulceration very prone to produce their deleterious effects. And, finally, I believe that many of the instances of proliferation

of the endothelium of the vessels of diseased appendices are to be interpreted as the consequence, not the cause, of the inflammation.

The **indications of involution of the appendix** demand careful consideration, and the proper interpretation of suggestive alterations is frequently a matter for judicious discrimination. Particular investigation of this question has been made by Ribbert, Zuckerkandl, and Piersol. Ribbert examined 400 appendices obtained at necropsy and determined that 99 (25 per cent.) presented evidences of retrogressive atrophic alterations without indications of previous inflammation. These alterations were, therefore, interpreted as evidences of involution. Zuckerkandl investigated 232 appendices, and detected in 55 evidences of obliteration of the lumen—therefore in 23.7 per cent. Of 100 appendices of persons over twenty years of age examined by Ribbert, 32 presented these evidences of retrogression. The obliteration of the lumen was commonly but partial; it was complete in but 3.5 per cent. In one-half of the cases the distal quarter was closed; in one-half of the remaining cases the obliteration affected between one-fourth and three-fourths of the entire length of the appendix. In 14 per cent. of Zuckerkandl's cases the obliteration of the lumen extended throughout the length of the organ; in the remaining 9 per cent. the obliteration was but partial.

There can be no question that these evidences of retrogression are common. In the presumably normal appendices removed at necropsy that I examined they were found in almost one-fourth of the cases. They were usually confined to the tip of the organ, and to a small portion of it. Exceptionally, they implicated about one-fourth, or a little more, of the entire length of the organ. In these cases the remainder of the organ presented no recognizable histological deviations from the normal. These indications of involution were also evident in appendices manifestly the seat of inflammatory disease, and, as in the other

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cases, they were commonly limited to the distal end of the organ. In no case did they implicate as much as one-half of the appendix. In all these cases, however, the inflammatory character of the associated alterations was beyond question.

The exact nature of these involutory changes is still more or less a matter of conjecture. Ribbert states that in appendices undergoing these alterations three zones can usually be recognized: (1) A central zone more or less rich in cells; (2) a zone which shows gradual transition from the first, and which is poor in cells and made up largely of connective tissue; and (3) the muscular coat. The first or inner zone corresponds to the former mucous membrane; the second or middle, to the former submucosa. The inner zone at times reveals a small, narrow slit, indicative of the former lumen. Careful examination of this, however, will often reveal a few strands of delicate connective tissue traversing it from side to side. These are readily torn and are likely to escape detection. Ribbert believes that the symmetry of the process, its progression from the distal to the proximal end of the appendix, and the absence of irregularities, of cicatricial tissue, and of other indications of previous inflammatory conditions justify the assumption that the process is involutory in nature. It may be mentioned that this fact is indicated, in addition, by the absence of degenerative alterations in the mucous membrane—the change being rather one of gradual atrophy. I believe, with Zuckerkandl, that the submucosa plays a most important rôle in these alterations, and that the changes in the other coats follow those of the submucosa. Piersol concurs in this opinion, stating that “changes within the submucosa inaugurate the process leading to the retrogression of the appendix and precede the alterations affecting the mucosa.” Defective nutritive supply is doubtless the basis of the process. As regards the rôle that these involutory changes play in the causation of appendicitis, it suffices for the present to state that they are to be considered as indica-

tive of a *locus minoris resistentiæ*, which permits of the more ready operation in the appendix than in other portions of the intestinal tract of the exciting causes of appendicitis.

The foregoing, then, are the factors that predispose the appendix to attacks of inflammation. They acquire their pathogenetic significance because they interfere with the proper and thorough drainage of the organ; because they reduce the capability of the organ to resist the influences of various morbid agencies; because of the facility with which nutritional disturbances may be engendered; and because of the relatively large surface presented for the absorption of the toxic products of bacteria that find their exit from the appendicular lumen retarded or prevented. Bearing in mind these facts, when we institute a study of the pathogenesis of appendicitis, it is immediately patent that no one factor alone can be held accountable for the development of all cases of the affection. On the contrary, the previously mentioned anatomical and physiological peculiarities of the appendix render the organ less resistant to the well-known morbid agencies provocative of inflammation in other portions of the body. In individual instances one or the other of these peculiarities predominates over, and thus assumes a pathogenetic significance disproportionate to, the others.

The **exciting causes of appendicitis** do not differ from those that induce inflammation in other portions of the body. As is well known, the most common causes of inflammation are mechanical and chemical irritation and bacteria. In a given case of inflammation it is often difficult to distinguish sharply between these ætiological factors, particularly between the action of chemical irritation and bacteria; in many instances there is certainly no distinction. In this respect, what is true elsewhere in the body, is true also as regards the appendix.

The bacteriology of appendicitis has already been discussed. Of the production of appendicitis by chemical irritants, apart

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from bacteria, we know very little. The development of appendicitis has been attributed by some, and probably with reason, to the presence of lead in the appendix. It has been conjectured that the lead either of itself acts as the necessary irritant or that it in some way so influences the appendix as to favour infection. Reports have also been made of cases of appendicitis occurring in association with the so-called gouty diathesis, or during the course, or following an attack, of rheumatism, influenza, etc. It is extremely likely that the origin of these cases is closely connected with the operations of bacteria. Our information in this realm, however, is very meagre. That mechanical irritants, such as traumas, act as exciting causes of appendicitis is evident from the development of appendicitis following injuries, such as blows in the region of the appendix, sudden straining efforts, etc. These traumas act as do traumas generally, reduce the vitality of the appendix, and permit of the more ready operation of the exciting cause of appendicitis—bacteria. Byron Robinson considers that the chief exciting cause of appendicitis is the action of the right psoas muscle, and Edebohls believes that a movable right kidney is of prime importance. He states that chronic appendicitis is present in from 80 per cent. to 90 per cent. of women with symptom-producing movable right kidney, and that chronic appendicitis is one of the chief, if not the chief symptom of movable kidney.

It is well remembered that early in the development of our knowledge concerning appendicitis the origin of the disease was commonly attributed to the presence in the appendix of various foreign bodies, such as cherry-stones, grape-seeds, seeds of various other fruits, pins, needles, hair, bits of bone, gall-stones, and the like. Of recent years, as a result of more careful investigation, it has become evident that many of the formations previously considered seeds of various fruits were in reality but faecal concretions or appendicular calculi, the misconception as to their real nature being due to the resemblance that they bore in size

and shape to the different objects for which they were mistaken. Undoubtedly, foreign bodies do gain access to the appendix, and in the event of that organ subsequently becoming the seat of inflammation, it is but natural to ascribe an ætiological rôle to such foreign body. The frequency of the occurrence of foreign bodies in the appendix is indicated by Mitchell, who, among 1400 cases collected from various sources, found foreign bodies in about 7 per cent. The statistics of various observers differ somewhat. Thus, Fitz, in 152 cases of perforative appendicitis, found fæcal concretions in 47 per cent. and foreign bodies in 12 per cent. Renvers reports some collective statistics, comprising 459 cases, in which fæcal concretions were found in 179 (39 per cent.) and foreign bodies in 16 (3.5 per cent.). Matterstock, in 169 cases of appendicitis, found fæcal concretions in 53 per cent. and foreign bodies in 12 per cent. Ferguson found foreign bodies, including enteroliths, orange-pips, cherry-stones, etc., in 15 (7.5 per cent.) of 200 cases, and Murphy, in 141 operative cases, found foreign bodies in 5 (3.5 per cent.), and fæcal stones in 43 (30 per cent.). Hawkins did not find any foreign bodies in 67 fatal cases. Mitchell states that in 250 cases of appendicitis in Johns Hopkins Hospital there occurred but one foreign body—a segment of a tape-worm. Mitchell mentions the following as among the foreign bodies that have been found in the appendix: Shot (122 shot in one case), pins, worms, gall-stones, a tooth, pieces of bone, grape-seed, date-seed, cherry-stone, apple pips, oat husk, corn husk, bristle of a tooth-brush, wisp of a broom, fin of a fish, etc. Curiously, a pin is at once one of the most frequent and most dangerous foreign bodies found in the appendix.

Mitchell, who has collected from the literature a total of 36 cases in which pins have been encountered in the appendix, states:

“One would naturally suppose that such a foreign body in the appendix would lead to rapid perforation; but, while this is generally the case, it is not

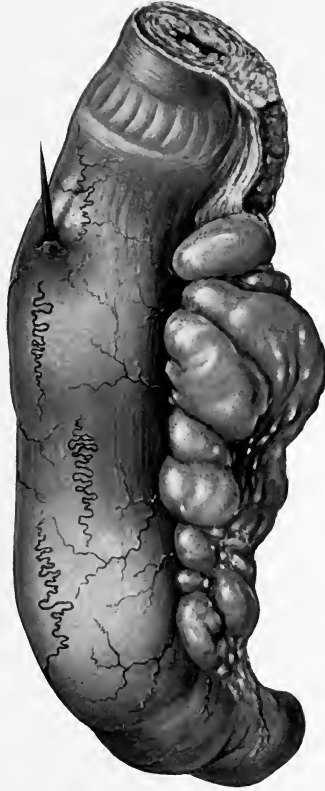
PLATE XXVIII.

ACUTE APPENDICITIS WITH A PIN IN THE APPENDIX.—Mrs. A. G., aged thirty-six years, was admitted to the German Hospital during May, 1897, and the following history was elicited: Ten days prior to admission she was suddenly seized with sharp pains in the right side and vomiting. The abdominal wall became rigid and markedly tender upon pressure in the region of the appendix. Constipation was present. The vomiting continued for two days, but the pain, tenderness, and rigidity, though they decreased in intensity, continued for one week.

On admission her temperature was 101° F.; her pulse-rate, 112. There was neither nausea nor vomiting. Her abdomen was slightly distended, and in the right iliac fossa, close to the iliac spine, there was a mass that was *not* painful on pressure. Moderate tenderness could, however, be elicited on deep palpation. Appendicitis was diagnosed, but, on account of the absence of pain and tenderness in the mass over the appendix, which seemed an anomalous condition, operation was deferred for one day. The patient's temperature, however, steadily rose to 103° F., and immediate surgical interference was considered necessary.

At operation the abdominal muscles were found thickened, and the parietal peritoneum was adherent to a mass which consisted of the omentum and the appendix bound together by some partly organized exudate. The appendix was freed, ligated, and removed, and was found to contain a black pin.

The case is interesting because, despite the presence of a mass, pain and tenderness were not marked. It also indicates that, in the absence of great local tenderness, a diagnosis of pus in or about the appendix is not warrantable.



ACUTE APPENDICITIS—THE APPENDIX PERFORATED BY A PIN.

always so. All types of appendicitis may result. Some give rise to only mild symptoms, and may lead to chronic appendicitis (7 cases) with recurrent attacks, or with long-continued pain, or only a feeling of uneasiness in the right iliac region, which may last for months or years, and perhaps finally end in an abscess (Cases 14 and 15). Most often, however, there is rapid perforation and abscess formation, following the first appearance of the symptoms. The pin may enter the appendix by its head or point. It is generally straight, lying in the lumen of the appendix with its long axis parallel to that of the appendix, and perforating with its point. In one or two instances, however, it lay directly across the lumen and perforated with its head one wall, and with its point, the opposite. Dr. McBurney removed an appendix which contained two pins lying side by side and perforating the opposite walls of the appendix in this manner. On two occasions pins have been found in appendices contained in hernial sacs. The pin may be free from deposit, rusty, or corroded. Usually, however, it is the nucleus of a fæcal concretion which covers the head and most of the shaft, leaving the point free. . . . While many curious and unexpected things are occasionally found, the appendix would nevertheless seem to act especially as a trap for pointed bodies and for small heavy objects, like shot or bullets. . . . Those foreign bodies of light weight, like grape-seeds and cherry-stones, so popularly assigned as a cause of appendicitis, . . . are in reality exceptional, and their frequency is much overestimated on account of the close resemblance of fæcal concretions and the lack of careful examination of the bodies described."

My own investigations certainly indicate the infrequency of foreign bodies as a cause of appendicitis. With the exception of the pin in the appendix illustrated in Plate XXVIII, I do not recollect having encountered a single foreign body in any of the appendices examined. It is interesting to recall that various enterozoa have been found in the appendix. Thus, *Oxyuris vermicularis*, *Trichocephalus dispar*, and *Ascaris lumbricoides* have been encountered. In addition, Scholler has reported a case of echinococcus of the appendix in association with echinococcus of the liver, and Birch-Hirshfeld an instance of echinococcus of the appendix alone.

While, in the light of recent experimental and other scientific research, the views formerly maintained with regard to the rôle of various foreign bodies in the production of appendi-

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citis has largely been abandoned, the relation of what we now know to be appendicular calculi to the development of appendicitis still demands careful consideration. That calculi may be borne in the intestinal tract and in the appendix without inducing any important pathological process is well established as a result of the investigations of a considerable number of observers, and is being constantly confirmed by all who have occasion to see much necropsy work. On the other hand, that calculi are associated with a considerable number of cases of appendicitis is equally well established. The statistics of various observers with regard to the frequency of appendicular calculi in appendicitis have already been cited. Of 460 of the cases examined by myself they were found in 74 (16 per cent.)—35 of a total of 208 acute cases, and 39 of a total of 252 chronic cases. The 35 instances in which they were found in cases of acute appendicitis were distributed among the different varieties of this affection as follows:

| | | |
|----|--|----------------------|
| Of | 7 cases of acute catarrhal appendicitis, . . . | None. |
| " | 32 cases of acute interstitial appendicitis, . . . | 2 (6.2 per cent.). |
| " | 56 cases of acute ulcerative appendicitis, without perforation, | 9 (16.0 per cent.). |
| " | 64 cases of acute ulcerative appendicitis with perforation, | 19 (29.8 per cent.). |
| " | 49 cases of acute gangrenous appendicitis, . . . | 5 (10.2 per cent.). |
| | <hr/> | <hr/> |
| Of | 208 cases of acute appendicitis, calculi in, . . . | 35 (16.6 per cent.). |

From these statistics it is evident that calculi are present in a considerable number of cases of acute appendicitis, and it is further plain that the more severe the inflammatory lesions, the greater the proportion of cases in which they are found. Thus, they are more common in cases of ulcerative appendicitis, especially with perforation, and in gangrenous appendicitis, than in any of the other acute varieties. There can, however, be no question that they are even more often associated with some varieties of acute appendicitis than the foregoing figures

indicate. It not infrequently happens in cases of ulcerative appendicitis with perforation, and in gangrenous appendicitis, that at the time of operation or necropsy the calculus has already escaped from the lumen of the appendix and is not detected during the operative manipulations, or, being detected, is not preserved.

The relation of these calculi to appendicitis, however, is not the simple one of cause and effect, as was originally assumed. A consideration of the anatomy of the cæcum and appendix is sufficient to indicate the impossibility of formed calculi, even of small size, gaining access to the appendix—at all events, after the first year of life. (During the last-named period the appendicular orifice is often quite patulous). This view has been confirmed, if such confirmation were necessary, by some experimental investigations. Calculi, therefore, are formed within the appendix.

The condition of the cavities of normal appendices removed at necropsy varies in different instances. It has been found entirely empty; but in most cases it is partly or completely filled with fluid or semifluid fæcal matter. It is natural to infer that such fæcal matter frequently gains access to, and is as frequently expelled from, the lumen of the appendix by the muscular contractions of the organ, which are aided by the shape, position, length, calibre of the lumen of the organ, etc. If such fæcal matter remain long in the appendix, it becomes inspissated, in consequence of the rapid absorption, by the numerous lymphatics, of its watery constituents. The longer it remains, the more inspissated it becomes. It is probably the efforts of the appendix to expel such inspissated fæcal matter and calculi that give rise to attacks of appendicular colic, the occurrence of which can not well be doubted. Nor can it be doubted that such colicky pain occurs in the absence of calculi and fæcal matter from the appendix. The irregular peristalsis of an inflamed and ulcerated appendix is of itself sufficient to

give rise to acute pain, which increases in wave-like exacerbations—the manifestations being similar to the tenesmus of a posterior urethritis or a proctitis. If the egress of fæcal matter from the appendix be hindered by inappropriate position or fixation of the organ, internal constrictions, external bands of cicatricial connective tissue, swelling of the mucous membrane or of Gerlach's valve, flexures, angulations, weakness of the muscular coats, impassiveness of the organ, or other causes, the contents become correspondingly more inspissated. From what was originally a mass of fæcal matter of greater or less size, a small, hardened, fæcal particle results. Around this as a nucleus inspissated mucus, desquamated epithelial cells, pus-corpuses, débris, etc., are deposited, in successive concentric layers. These, collectively, result in the formation of a so-called fæcal concretion. Inasmuch, however, as only the central nucleus of this concretion consists of fæcal matter, the remainder of it being made up of the products of inflammation, etc., the preferable designation is appendicular calculus.

Chemical investigation of these calculi shows that they are composed of phosphate, carbonate, and sulphate of calcium; phosphate of magnesium; at times cholesterin, fat, débris, etc. Interesting investigations have recently been made by Ribbert, who, in addition to confirming the older view, according to which the centre of the calculus alone is made up of fæcal matter, showed, by means of Weigert's fibrin stain, that the mucus of the outer layers of the calculus is in continuous association with that filling up the mucous glands lining the appendix. It is quite likely that fæcal matter of itself, if retained in the appendix for some time, is capable of setting up some catarrhal inflammation, and this, probably, as a consequence not only of attrition of the lining membrane, but also of increase in the virulence of the retained bacteria. This is indicated by the many instances of catarrh of the appendix found at necropsy in the absence of calculi. This catarrh of the appendix is one of the

most fertile sources of appendicular calculi. Not only do the swelling and œdema thus produced retard the exit of fœcal matter from the appendix and favour its inspissation by affording opportunity for the absorption of its watery constituents, but the products of the catarrhal inflammation themselves furnish the necessary ingredients—the salts—to be deposited in layers about the nucleus of fœcal matter.

Calculi in the appendix vary in number, size, shape, and colour. They may be single or multiple. Usually, there is but one; there are often two; there are rarely more than four. According to Volz, they vary in size from that of a lentil to that of a hazelnut. The largest calculi that I have encountered were from a case of gangrenous appendicitis of five days' duration, the patient being reported never to have had any previous attacks. The appendix removed at operation contained three concretions. The largest was 2 cm. in length and 1.2 cm. in diameter; the second, 2 cm. in length and 1 cm. in diameter; and the smallest, 0.8 cm. in length and 0.4 cm. in diameter. The calculi are usually elongated; though some are relatively much thicker than others. They are commonly rounded at the extremities. Sometimes, however, they are distinctly conoid or pointed, as were the two largest of those the dimensions of which have just been cited. Externally, they may be smooth or rough. In colour they are grayish-white, yellowish, or brownish. On section, they present a distinctly lamellated concentric structure, and are harder toward the centre than toward the periphery.

Sonnenburg, writing of the formation of such calculi, or, rather, of the deposition of successive layers about the central nucleus, asserts his belief that there must have existed a dilatation of the appendix at the site where such calculi have formed. He believes that the deposition of successive layers is impossible in case the wall of the appendix surrounds the calculus firmly as an unyielding band, and that, therefore, a certain space is essential in order that mucus and other ingredients may

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gain access to the fæcal particle. The roundish form of the calculi is also thought to indicate that they have been subject to more or less movement. Were there not a certain free space, calculi of excessive size would certainly lead to rupture before they do. Be these suppositions as they may, calculi certainly form part of a vicious circle in appendicitis. Originally, they are hardly the cause of appendicitis; rather are they the result of inflammation of the appendix. But having resulted from an attack of appendicitis, they are an important factor in continuing the inflammation, in furnishing the necessary irritant to incite renewed attacks of acute exacerbation, and in contributing to some of the most disastrous consequences of appendicitis—perforation and consequent purulent peritonitis. Granting that the attainment of a certain size presupposes more or less of a free lumen, when that size has been reached, the constant pressure and attrition of the calculus naturally results in further inflammation, erosion, ulceration, and perforation. As already intimated, catarrhal inflammation, with hypersecretion of mucus, desquamation of epithelial cells, and purulent exudate, afford ample opportunity for the increase in size of the calculi; the inflammation renders the wall of the appendix less resistant to the operations of bacteria and to the mechanical effects of the calculi; and the implication of the muscular coats lessens or prevents peristalsis and diminishes the likelihood of the extrusion of the calculus.

Considering, now, the relative rôles played by bacteria and appendicular calculi in the causation of appendicitis, it seems to me that it may be unhesitatingly asserted that appendicitis is, without exception, an infectious process; that the inflammations of the appendix are the results of the activities of bacteria; and that the rôle of calculi is quite subsidiary to that of bacteria. Such being the case, the queries naturally suggest themselves: Why is it that bacteria normally present in the intestinal tract are provocative of such serious pathological lesions

in the appendix? and why is it that calculi innocuous, or almost so, in the intestine are associated with inflammatory affections of the appendix? The reasons for these are to be found in the anatomical and physiological peculiarities of the appendix, of which mention has already been made. These, on the one hand, decrease the capability of the organ to resist the influences of various morbid agencies, and, on the other, afford opportunities for the rapid increase in virulence of bacteria contained within the appendix. Because of the previously detailed anatomical and physiological peculiarities, morbid agencies that are readily overcome by the normal physiological activities of the intestinal tract are capable, when present in the appendix, of inducing the most deleterious consequences. And, in addition, when these morbid agencies—principally bacteria—become heightened in virulence, they effect their disastrous results much more readily. It must also be borne in mind that disease is due not alone to the virulence of the determining cause—be it bacteria, trauma, or other cause,—but is dependent to a considerable degree upon the predisposition of the individual, upon the vitality, the power of resistance, not only of the part affected, but also of the general economy.

To Recapitulate: The factors that operate to render the appendix less resistant than other portions of the intestinal tract to the onslaughts of bacteria and other determining causes of appendicitis are several. Of prime importance is the precarious blood supply and the consequent anæmia of many of the appendices. The blood supply is defective not so much because of the manifest alterations frequently demonstrable in the walls of the blood-vessels of presumably normal appendices, but also because of the liability of the occurrence of partial or complete obstruction of the blood channels as a result of angulations, torsions, external constricting bands of adhesions, etc., and of infective endovasculitis secondary to primary inflammation of

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the appendix. Disturbances of circulation, and hence of nutrition, are also produced by active, and sometimes ineffectual, peristalsis of the appendix induced by an effort to rid itself of foreign bodies, calculi, or even inspissated fæcal matter. The action of such circulatory and nutritional disturbances is further evident in the intense congestion often noted distal to an appendicular calculus about which the wall of the appendix may be firmly contracted, and by the fact that, under these circumstances, when perforation occurs, the part affected is not directly over the site of the calculus, but rather distal to this—the region of the previous intense congestion. Of importance in a limited number of cases are also, doubtless, alterations in the nerves supplying the appendix; but, as already stated, it is believed that these are not of such great importance as has been suggested by Fowler and Van Cott. Finally, in this connection, not without significance are the evidences of retrogression of the appendix, indicating, as they do, defective powers of resistance. The factors that in the appendix give rise to increase in the virulence of the bacteria normally present in the intestine are primarily such as interfere with thorough drainage of the organ. Defective drainage may supervene when, for any reason, the appendix is so situated that it can not be readily emptied; when its lumen is constricted, either externally by bands of cicatricial connective tissue (peritoneal adhesions), tumor formations, etc., or by cicatrices of its wall, or by obstructions within its lumen (as, for instance, by calculi or foreign bodies); or when the muscular coat of the organ is no longer capable of active peristalsis as is likely to be the case when the appendix is itself diseased or bound down by adhesions. Congestive disturbances of the appendix or of the cæcum may cause such swelling of the mucous membrane as to lead to approximation of the opposed surfaces in the appendix, or to occlusion of the outlet of the organ, and thus effectually prevent drainage. Of considerable significance with reference to this question of drainage are cer-

tain of the anatomical and physiological peculiarities of the organ previously described. Of these, may be mentioned the size and shape of the meso-appendix, the excessive length as compared with the calibre of the lumen of the appendix, and Gerlach's valve. As further conducive to imperfect drainage are the already mentioned torsions, angulations, peritoneal adhesions, cicatrices of the wall of the appendix, etc., which interfere not alone with the blood supply, but also with thorough drainage. Appendicular calculi are capable of at least a two-fold action, and that within a vicious circle. Originally resulting from, rather than causing an attack of, appendicitis, they may not only occlude the lumen of the organ and prevent drainage, but they may also induce passive congestion in that portion of the appendix distal to their situation, and by attrition—the result of constant or intermittent peristalsis—cause erosions of the mucous membrane, and thus reduce the power of the organ to resist the attacks of bacteria and their toxins. When small, these calculi are often doubtless innocuous; but when they have attained a considerable size, and are no longer capable of being extruded, they may engender the most disastrous consequences. The erosion and necrosis of the mucous membrane, resulting from constant attrition, progress, affecting all the coats, until perforation may be produced. As the erosion or ulceration increases there is afforded a favourable focus for the ready invasion of bacteria and the free absorption of their toxins. Thus, while calculi are of subsidiary importance in exciting the original attack of appendicitis, it is believed that in many cases they are of very great importance in determining perforation of the appendix and the situation of the perforation. These are evident from the preponderating number of cases in which calculi are found in ulcerative appendicitis with perforation, and in the direct association of the calculus with the site of the perforation. In addition, appendicular calculi are of considerable significance in the production of

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chronic recurring appendicitis, in provoking the acute exacerbations in a chronically inflamed appendix.

The preponderating importance of defective drainage in the pathogenesis of appendicitis is sufficiently evident from an examination of a large number of diseased appendices, but it finds additional confirmation from the clinical and pathological observation of analogous intestinal conditions and from some experimental investigation. Increase in the virulence of bacteria, particularly of the common colon bacillus, has been found not only in the appendix when its lumen has been obstructed, but also, as already mentioned, in cases of intestinal obstruction and strangulation, in various congestive and diarrhœic conditions, and even in some cases of marked and long-continued constipation. The experimental investigations of Roux, Roger and Josué, Dieulafoy, Frazier, and others are especially noteworthy as indicating the increase in the virulence of the common colon bacillus in the appendix when its lumen is occluded. A hollow glandular organ remains intact only as long as the production and evacuation of its secretion goes on normally. As soon as there occurs a disturbance, either overproduction or diminished evacuation, disease results. If the excretory duct of the gall-bladder be occluded, there ensues, under varying circumstances, either a hydrops, an empyema, or a cholecystitis or a cholangitis. The same is also true of the mammary gland, of the sebaceous glands of the skin, and of the appendix. When the lumen of the latter becomes obstructed, there occur retention, stagnation, and decomposition of its contents. This stagnation contributes also to the vicious circle, in that it not only exerts a deleterious influence on the wall of the appendix by reason of the mechanical pressure to which it gives rise, but it also serves as a most suitable culture medium for the growth of bacteria. When to the products of decomposition there are added the toxines produced by the retained bacteria increasing in virulence, the cause of appendicitis is self-evident.

As additional factors of importance are the relatively large extent of mucous membrane presented by the appendix and the large amount of lymphoid tissue, not only in the neighbourhood of Gerlach's valve, but also scattered throughout the wall of the appendix. The latter is of especial significance in view of the proneness of adenoid tissue throughout the body to inflammation whenever subject to even slight irritation by bacteria and their toxins. The mucous membrane, particularly if it be eroded or ulcerated, presents a very large surface for the ready invasion of bacteria and for the absorption of their toxins. This latter is of especial importance in the production of gangrene of the appendix—the result often of infective thrombosis or embolism following erosion or ulceration of the wall of the appendix.

It must also be remembered that the appendix is prone to participate in severe intestinal lesions, particularly those of typhoid fever and dysentery; and while the latter may subside without the production of appendicitis, there frequently persist sequels, in the form of cicatrices, etc., that are not without significance in the causation subsequently of inflammation of the appendix. Further, Klecki and other investigators have shown that *Bacterium coli commune* differs in virulence in various portions of the intestinal tract. It is most virulent in the ileum, less so in the jejunum, and least virulent in the duodenum and colon. It is conceivable that the attacks of indigestion accompanied by diarrhoea that in many instances precede the outbreak of appendicitis may result in the conveyance to the appendix of virulent bacteria, and that these overcome the resistance of the appendix more readily than do the less virulent bacteria normally present in the appendiculo-cæcal region. On the other hand, increase in the virulence of *Bacterium coli commune* has been found in the cases of marked constipation which, as is well known, sometimes precede the development of appendicitis.

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From the foregoing, therefore, it is evident that no one factor alone can be held answerable for the production of all cases of appendicitis. Although the affection is without exception the consequence of micro-organismal infection, it is of rather complex pathogenesis, and no one morbid agent is provocative of all attacks. It is because of the anatomical and physiological peculiarities of the appendix that factors innocuous in the intestine, or morbid agents capable of being successfully combated by the physiological activities of the intestine, become, in the appendix, of heightened virulence and, meeting lessened resistance, engender the most disastrous consequences. Finally, it is interesting to mention that Goluboff regards appendicitis as an infectious disease *sui generis*, as are follicular tonsillitis, dysentery, etc., and that he expresses the opinion that, in addition to the occurrence of sporadic cases, the affection may develop epidemically—that it is then an epidemic infectious disease. But this view can hardly be maintained with reason.

SYMPTOMATOLOGY.

In considering the symptomatology of acute appendicitis it must be borne in mind that it is not always possible to determine the pathological alterations in the appendix from the clinical manifestations of the disease. It is futile to ascribe to any symptom or symptom-complex pathognomonic significance with regard either to the progress or to the stage of the affection. It is true that there is a symptom-complex which, when present, warrants us in assuming the existence of mild appendicitis, or in assuming that the inflammation is confined to the appendix; that there is another symptom-complex that suggests appendicitis with circumscribed peri-appendicular suppuration; and that there is still another symptom-complex indicative of appendicitis with diffuse peritonitis. Such, however, are the manifold differences in the clinical manifestations of similar anatomical lesions of the appendix that the establishment of symptom-complexes that shall indicate definite pathological lesions of the appendix is impossible. There can be no question that reliance upon such symptom-complexes as have been formulated frequently leads to egregious diagnostic blunders. While it is true that, in general, the clinical manifestations become more marked with increase in the severity of the appendicular and peritoneal lesions—that is, when perforation, pus formation, or gangrene supervene—it is also a fact that remission of all symptoms, except local tenderness, may occur, and yet the disease may be progressing to a fatal termination. It is likewise a fact that the symptoms suggestive of perforation of the appendix and peri-appendicular suppuration in one patient may arise in another patient in conse-

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quence of the development of peri-appendicular suppuration without perforation of the organ. It thus seems rational not to attempt to separate clinically cases of appendicitis in groups—such as mild or nonperforative, perforative, gangrenous, etc.—but to describe acute appendicitis as a clinical entity whose manifestations seem more dependent upon the virulence of the infection and the resistance of the individual than upon the character of the lesions of the appendix and the surrounding peritoneum. Similar reasoning obtains with regard to chronic appendicitis, although in the latter the questions requiring solution are less complicated. In the vast majority of cases of chronic appendicitis the entire organ is affected, and such can be assumed with justice in the presence of the appropriate clinical symptoms. The supposition that merely catarrhal alterations exist may seem warranted in some cases, but examination of the excised appendix will usually reveal pathological lesions of all the coats. It need scarcely be mentioned that obliterative appendicitis can not be recognized clinically.

The symptomatology of two forms of appendicitis—the acute and the chronic—will be described. The acute form embraces those varieties of inflammation of the appendix usually described clinically as simple catarrhal, ulcerative, perforative, fulminating or gangrenous, and which, upon examination of the excised appendix, reveal acute catarrhal or interstitial inflammatory alterations, ulceration with or without perforation, or partial or complete gangrene. These terms represent in great part only differences in the degree and extent of the local inflammatory phenomena—differences between which it is impossible in all instances clinically to draw a distinction. The chronic form of appendicitis includes those varieties described clinically as sub-acute, chronic, relapsing, and recurrent, and which, upon examination of the extirpated appendix, reveal chronic catarrhal and interstitial inflammatory alterations, with or without ulceration, progressing in rare instances to obliteration of the lumen of the organ—obliterative appendicitis.

ACUTE APPENDICITIS.

There are three symptoms of acute appendicitis so constant and, when associated, so characteristic of the affection that I have designated them the "three cardinal symptoms." These are pain, tenderness, and rigidity of the right lower quadrant of the abdominal wall.

Pain is the initial symptom and is the expression of the reaction of the nervous mechanism to injury. It usually develops suddenly *in one previously well*, continues a variable length of time, recurs at irregular intervals, and is distinctly cramp-like in character. It has frequently been observed that the ingestion of food, especially when indigestible or improperly cooked, has been immediately followed by the onset of the attack. It must be assumed, in the absence of more accurate knowledge, that the increased peristalsis hastens the process of inflammation in an appendix already infected. At the onset of the attack the pain is paroxysmal or colicky in character, in which respect it simulates an attack of acute indigestion or, in aggravated cases, one of biliary, pancreatic or nephritic colic.

The paroxysmal character of the initial pain cannot be too strenuously insisted upon. These successive waves of pain are due to the accumulation of gas in the ileum and the disturbance of the inflamed appendix when the gas or fæcal matter pass into the cæcum. The term appendicular colic is frequently applied to the pain, but this designation has been objected to, because it is asserted that the pain is inflammatory and not functional in nature. It is generally assumed that in health the appendix empties itself of accumulated secretion and fæcal matter by its normal peristalsis, but it is not necessary to consider the pain as due to the effort on the part of the inflamed appendix to rid itself of calculi or retained material. When we recall the fact that fæcal concretions, often of stony hardness, are commonly found in appendices that are quite normal and that they are entirely

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absent from some appendices, despite the occurrence of the most severe paroxysmal pain, such a conclusion is seen to be unwarranted. But in view of the fact that defective drainage is one of the most important factors in the production of appendicitis, the consequences of the accumulation and stagnation of the secretion of the appendix are self evident; and it may be admitted that the effort of the appendix to rid itself of such accumulated secretion, *to which is opposed some barrier*, is sufficient to engender colicky pain. In this respect the pain is quite as functional as is that which attends the efforts of the gall-bladder or kidney to free themselves of calculi. It must always be borne in mind, however, that the condition is essentially inflammatory. Peristalsis of an inflamed appendix is of itself sufficient to give rise to paroxysmal pain, and the more extensive the ulceration and consequent exposure of nerve filaments, the more severe is likely to be the pain. The latter is reflected along the numerous branches of the superior mesenteric plexus of the sympathetic nervous system, some of which supply the appendix with both afferent and efferent nerve fibres.

The pain continues of a colicky character for a greater or less period of time, when the paroxysms gradually lessen in number and severity. The pain persists however, being continuous and of moderate intensity, though acute exacerbations of colic or intense pain may occur from time to time. These are provoked by various causes, chief of which is undoubtedly the passage of flatus through the acutely inflamed ileo-cæcal opening. Palpation of the affected area, motion of the right thigh, which causes contraction and relaxation of the psoas muscle, bending of the body to the left, deep inspirations, coughing, sneezing, local applications, etc., may also either excite or intensify the pain. Later on in the course of the attack the pain may moderate considerably, and this, often interpreted as a good omen, is frequently but an indication of perforation, gangrene of the appendix, or impending dissolution. In some exceptional cases the

pain is nonparoxysmal, constant and dull from the very onset of the attack. This is especially likely to be the case in recurring attacks, when the pain is often described as of a peculiar boring character.

The location of the initial pain, in the majority of instances, is the umbilical or peri-umbilical region; next in order of frequency, the epigastrium; and least commonly, the right iliac fossa. The typical pain of an attack of acute appendicitis is that which develops suddenly in one previously well, is cramp-like in character, referred to the umbilical or epigastric regions, and which later becomes localized to the right iliac fossa. The pain of appendicitis may, however, be referred to any region of the abdomen, depending upon the position of the appendix. It is a lack of knowledge of this fact that has led to many errors of diagnosis in acute abdominal affections. I have observed, moreover, in many attacks of slight appendicitis in young people, and particularly in children, that there may be no pain in the iliac fossa; in fact, there may not even be tenderness. It is this class of cases in which relapses are so frequent.

The location of what may be termed the *secondary pain* in an attack of acute appendicitis varies in different cases, and depends almost entirely upon the position and direction of the appendix and upon the extent of peri-appendicular involvement, to which latter condition it owes its origin. After the development of a circumscribed peritonitis it is usually referred to the right iliac fossa, because the appendix commonly occupies this region of the body. If the appendix be long and overhang the brim into the true pelvis, the pain will be referred to the left side of the abdomen, or along the course of the spermatic cord toward the testicle, or to the region of the ovary, or to the left side of the pelvis. If the appendix be post-cæcal with a diseased tip pointing north, the pain may be referred to the loin or back; at times, if it point north, lying either in front of or behind the cæcum, the pain may be referred to the region of the kidney or

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liver. When the appendix rests upon the psoas muscle and is in relation with the anterior crural nerve, the pain may be referred to the thigh along the course of this nerve, and even to the knee. The pain in other cases may be referred to the area of distribution of the right genito-crural nerve, the testicle, or vulva, or the upper, anterior and inner part of the thigh. With the pain referred to the right testicle, there may occur retraction of this organ, in which respect there is a resemblance to nephritic colic. In still other cases the pain may be referred along the inguinal branch of the ilio-inguinal nerve to the inguinal canal, etc. If the tip of the organ occupy the left iliac fossa, or if the entire appendix be situated in this region, as occurs in cases of extreme mobility of the cæcum or in those rare instances of transposition of the viscera, the greatest amount of pain will be referred to this region.

Tenderness upon pressure is one of the most valuable signs of acute appendicitis and is always present. This tenderness is both superficial and deep. The former variety, also described as cutaneous hyperæsthesia, is due to reflex stimulation of sensory nerves connected with the same region of the spinal cord as are the nerves supplying the appendix. This symptom of appendicitis has been specially studied by Sherren, who found that usually the area of cutaneous hyperæsthesia existed in the form of a triangle in the right iliac region, extending nearly to the median line in front, almost touching Poupart's ligament below, and having its apex above the anterior superior iliac spine in the anterior axillary line; but that this area might vary from a round circular spot situated at McBurney's point to a band-like area stretching from the spine posteriorly to the median line in front, between the loin and the iliac crest. Cutaneous hyperæsthesia is best detected by very gentle stroking or pinching motions, commencing in an unaffected part of the abdomen, and gradually approaching the sensitive area, which is thus quite accurately defined. This superficial tenderness is very constant, but not absolutely so early in the attack; it disappears gradually as

improvement progresses; and its sudden disappearance without amelioration of other symptoms may be looked upon as indicative of gangrene or perforation of the appendix. As noted by Rolleston this cutaneous hyperæsthesia may also be produced by other abdominal affections, it having been observed by him in a case where operation disclosed a normal appendix, but the presence of an inflamed and softening gland near the cæcum.

A much more reliable symptom is the deep tenderness, caused by the inflamed appendix itself. This area of tenderness in the beginning of an acute attack is small, and is limited to the site and position of the appendix. This is usually at McBurney's point, which is located between an inch and a half and two inches from the anterior superior spine of the right ilium on a line drawn from that bony protuberance to the umbilicus, and which marks the position of the base of the appendix.* It is natural to expect that the tenderness should be over the seat of the most marked disease of the appendix. As a consequence, the most tender point varies more or less with the position of the appendix, and at times, if the appendix be post-cæcal with marked rigidity of the abdominal walls, tenderness is difficult to elicit and its detection may require deep palpation.

The tenderness, when the appendix projects into the pelvis, may not be detected except by rectal or vaginal examination, the value of which in many instances cannot be overestimated. In women, the possibility of the tenderness being the consequence of inflammation of the right tube and ovary must be borne in mind, and a differential diagnosis should be attempted.

While, as intimated, the point of greatest tenderness is usually over the inflamed appendix, there are occasional exceptions to this rule. Thus, in a young adult I found the point of greatest tenderness to the left of the left rectus muscle, a little above the level of the anterior superior spine of the ilium. By rectal exami-

* Or the tenderness may be most marked at Clado's point, where the interspinous line crosses the right linea semilunaris.

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nation a small and very sensitive mass was detected in the rectovesical fossa. Operation demonstrated that the appendix occupied the latter situation. On the other hand, I recall a case in which the point of greatest tenderness was immediately above the middle of Poupart's ligament. This, as demonstrated by operation, corresponded in position with an acute curve in the appendix. In these cases the appendix originated from the postero-external aspect of the base of the cæcum. Thence it descended in front of the cæcum as far as its apex, where it abruptly curved upward.

After the remission which often follows the sudden severe primary pain there is sometimes only tenderness and rigidity of the abdominal muscles to indicate that the disease is still active. But after the advent of suppuration the tenderness in the right iliac fossa usually becomes exquisite, and the tender area increases in size with the extension of the abscess.

General diffused peritonitis and cases of rapidly-spreading peritonitis are often marked by the most intense pain and tenderness in every part of the abdomen.

Rigidity of the abdominal muscles, next to pain and tenderness, is the most reliable sign of appendicitis. In the more severe type of cases and when the initial general, epigastric or umbilical pain is marked there will be rigidity of the entire abdomen, but this rigidity appears to be under the control of the patient to a great extent. As the pain becomes localized to the right iliac fossa the abdominal muscles on the right side present a constant, often board-like, resistance to the palpating hand. The rigidity varies in degree in different cases, but is generally well marked, and is most intense over the site of the inflamed appendix. In some instances the rigidity is so pronounced that it precludes palpation of either the appendix or a possible peri-appendicular abscess, and, in addition, gives to the percussion note a high pitch. When the pain has been referred to the left side, if suppuration supervenes, and the pus collection occupies

the pelvis, marked bilateral rigidity of the recti muscles and of the lower portion of the abdominal wall develops. When peritonitis becomes diffuse, rigidity of the entire abdominal wall occurs.

Although the three cardinal symptoms are the most important indications of acute appendicitis, there are other clinical manifestations that present themselves with more or less regularity, and that are of value in the diagnosis. Of these, there should be noted: Disturbances of the gastro-intestinal tract, elevation of the temperature, disturbances of the cardiac and respiratory rhythm, changes in the number and quality of the leukocytes, abnormalities of the urine, etc.

Nausea and vomiting are observed more or less constantly, and the latter often occurs coincidentally with the onset of the initial pain, and may occur only once. While vomiting is a constant result of severe abdominal pain, its continuation is due, as Ochsner points out, to the interference with the physiological process of digestion by the congestion and consequent obstruction of the ileo-cæcal valve; the undigested food being forced back into the stomach by a persistent return peristalsis. With the localization of pain in the right iliac fossa vomiting usually subsides, but may persist for some time in the event of suppuration, and in unfavourable cases it may be continuous and uncontrollable. The vomited matter consists first of the gastric contents, then of bile or bile-stained fluid (the duodenal contents), and, finally, if septic peritonitis and consequent intestinal paresis have developed, of stercoraceous material. Hiccough is sometimes observed, especially if the appendix point north and peritonitis has developed; more particularly, however, if the diaphragmatic peritoneum is involved.

The condition of the bowels varies in different cases. In the majority of cases constipation is observed. Diarrhoea is sometimes present at the onset, and is usually associated with intense pain and an unfavourable prognostic outlook. In 606

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of my own cases, constipation was observed in 411, diarrhœa in 78, alternate constipation and diarrhœa in 11, and in 106 the bowels were normal. Obstinate constipation occurring early in the course of the disease is due to intestinal paresis the result of infection, to reflex paralysis of the bowel, or to the pernicious indiscriminate administration of opium, and more especially its alkaloid morphine. Acute appendicitis is an infectious disease with a sudden onset, and such infection is not dependent upon constipation or diarrhœa for its production. The majority of those attacked are young healthy adults with normal bowels. As soon, however, as appendicular infection takes place there results a disturbance of the normal movement of the intestine, and constipation usually results. The latter is thus a symptom, not a cause, of the disease. The occurrence of this constipation, in association with vomiting and acute abdominal pain, in one previously healthy has led to many errors in diagnosis—inflammation of the appendix being mistaken for acute strangulation of the bowel, or some other form of intestinal obstruction. The constipation may not develop at the onset of the attack, but its definite occurrence may be postponed until the third, fourth or fifth day, after which it may be most marked.

The **temperature** varies greatly in different cases of the same nature, and, in general, is a most unreliable factor in both diagnosis and prognosis. It certainly bears no direct relation to the gravity of the anatomical lesions. In what may be termed a typical attack of appendicitis there is usually moderate fever of short duration; that is, at the commencement of the attack there is generally fever that amounts to from 101° to 103° F., or more. The temperature usually rises rapidly, but sometimes rather slowly, and remains above 101° F. for one, two or three days, after which the morning temperature is often normal. Subsequently, renewed elevations of temperature of varying degree may occur. These are probably not unconnected with new foci of infection or of absorption of bacterial products. It must not

be presumed, however, that these latter always manifest themselves by elevations of temperature; they often occur without any rise of the temperature whatever. Indeed, the temperature often continues to approach the normal, or, having reached normal, remains so, despite the developement of severe complications. In some cases there occurs only a moderate elevation of the temperature, which does not persist more than a few days. A few cases have been reported in which there has been no fever from the commencement to the termination of the attack; but these are most exceptional. Coincident with the developement of a peri-appendicular abscess there is usually a rise in the temperature; in some such cases, however, the temperature remains stationary or falls and becomes subnormal. There may be early perforation or gangrene of the appendix and peri-appendicular abscess with but moderate rise of the temperature; on the other hand, there may be a decided rise of temperature with simple catarrhal appendicitis. A sudden fall of the temperature to the normal or to subnormal by no means warrants a favourable prognosis. Indeed, in a great number of cases such fall in reality indicates the lull preceding the storm of destruction—perforation of the appendix or rupture of a circumscribed abscess. With the developement of certain complications—such as general peritonitis, septic phlebitis, abscess of the liver, pyæmia, etc.—the temperature almost invariably rises, and often reaches a high point, 104° or 105° F. It may continue high, with remissions, and become decidedly hectic. There are, finally, some cases in which the temperature continues high from the commencement to the termination of the attack. Such cases may end in recovery, though they are much more likely to terminate fatally. The temperature is thus a most unreliable aid in both diagnosis and prognosis. It bears no relation whatever to the seriousness of the anatomical lesions, but is rather the expression of the reaction and the resistance of the individual to the virulence of the infection, and it fluctuates with the variations of these factors.

The **rate of the pulse** bears no relation to the gravity of the attack of appendicitis. It may be slow or it may be rapid, and in general what has been said concerning the temperature applies with equal force to the pulse-rate. The character of the pulse, however, is of considerable value with reference to the gravity of the attack and the prognosis. If the pulse be strong, of good volume, regular, and the rate proportionate to the temperature, the outlook is favourable. If, on the other hand, the pulse be rapid, disproportionate to the temperature, of poor volume, irregular, and weak, the outlook is most unfavourable. In general, the pulse is a much better index of the gravity of the attack than the temperature.

Variations in the **respiration** play a comparatively unimportant part in the symptomatology of most cases of appendicitis. Early in the attack there is usually voluntary limitation of the respiratory excursions, the patient favouring costal breathing. If abdominal distention is pronounced, respiration is correspondingly embarrassed, while if there is diffuse peritonitis, the respiratory movements are almost exclusively costal. Very rapid respiration is often a manifestation of toxæmia. In some such cases the breathing is excessively rapid; under such circumstances this often indicates some pulmonary complication, and usually presages a fatal termination. In advanced cases there is often noticeable a peculiar reflex condition of the pharynx that is described by the patient as a difficulty in swallowing.

Chills are of rather uncommon occurrence in appendicitis, yet if at the onset of the attack they occur in rapid succession, and are accompanied by high temperature, they indicate rapidly developing gangrene of the appendix. I have seen several cases in which the patient, previously well, was suddenly attacked with acute abdominal pain, severe chills and high fever, followed by profuse sweating—the attack in all respects resembling a malarial paroxysm with the exception of the pain. At the operation, undertaken within forty-eight hours, the appendix was found

gangrenous. The opinion commonly entertained that the development of peri-appendicular abscess is attended with chills is fallacious, and it is much to be regretted that this erroneous opinion is rather general, as the physician, awaiting such chills, is often deterred from regarding the proper treatment of a case of appendicitis as operative until a large fluctuating mass has formed. Chills occurring on the second or third day of the attack and associated with high fever, sweating, and a cold, clammy skin indicate the development of metastatic or embolic abscesses. In neurotic patients, however, a chill may be experienced and be of no moment.

The **general condition** of the patient varies in different instances. In the early hours of the attack there is a general facial expression of pain and considerable anxiety. Later, with the moderation of the pain, the patient remains quiet in bed and favours the right side. A characteristic posture is usually assumed in that the patient prefers the dorsal decubitus, inclines the body somewhat to the right, flexes the right thigh, keeps the left thigh extended, demands perfect quiet, and resents disturbance in the desire not to provoke or to intensify the pain. Aside from the general expression of pain and anxiety in the early hours of the attack, the facial expression is seldom indicative of serious disease. As the lesions become more widespread and peri-appendicular abscess and general peritonitis develop, the expression becomes more anxious, and a peculiar serious cast of countenance supervenes—*facies abdominalis*. In severe cases of sepsis cyanosis and profuse perspiration sometimes occur. When the disease is advanced, restlessness may develop. This, if marked, particularly in children, is indicative of severe infection, and of the probable presence of pus, and is a very unfavourable symptom. The tongue is usually furred; if diffuse peritonitis occur, the tongue may become dry, and sordes may collect upon the gums and teeth. In severe cases the tongue may become fissured. If there occur a sudden perforation of the appendix,

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or a rupture of an appendicular empyema or peri-appendicular abscess, the severe pain may suddenly remit, the temperature fall, the pulse-rate increase, a marked pallor, profuse perspiration, and a most anxious facial expression supervene. In some cases of severe sepsis, actual delirium occurs; in fact, the question of meningitis may arise.

The foregoing are the most noteworthy symptoms of acute appendicitis; the diagnosis of the condition, however, is much facilitated by a thorough physical examination of the patient. This should be done systematically, by inspection, palpation, percussion and auscultation.

The result of **inspection** of the abdomen in the majority of cases is completely negative. Sometimes *respiration* is seen to be entirely costal, and in a small proportion of cases there will be detected a greater or less *bulging* of the right iliac fossa. In the early stages of the attack this is uncommon; in the later stages it may be due to a peri-appendicular abscess or to tympanitic distention of adherent intestines; it is rarely due to a non-suppurative inflammatory exudate and serous infiltration of the abdominal wall.

A *general distention* of the abdomen is not infrequently observed, and may be due to one of several causes: To mechanical obstruction of the bowel, the consequence of the constricting action of bands of adhesions; to paralysis of the intestine, the result of septic infection, of the use of opium, etc.; to obstinate constipation with resultant accumulation of putrefactive gases, etc. In a few cases there develops, on the first day of the attack, a general distention and some diffuse tenderness of the abdomen usually subsiding rapidly. This occurs as a consequence of the extension of the inflammatory reaction to the mucosa of the ileo-cæcal valve, and of the general irritation of the peritoneum in the right iliac fossa. Richardson points out that it is possible, by means of auscultation, to distinguish between the distention

due to accumulated gas and that due to paralysis of the intestine the consequence of infection: the sounds of the peristaltic action of the bowel are clearly audible in the former condition, but are absent in the latter. Distention, though usually general, may sometimes, as above noted, be limited to the right side of the abdomen, as a result of that portion of the bowel contiguous to the inflamed area alone being affected. This local distention may, upon occasion, become marked, by reason of the still functioning intestine forcing a greater or less quantity of gas into the affected portion. As is to be expected, the distention is most marked when the peritonitis is diffuse. In some cases of diffuse peritonitis, however, though the intestines are more or less distended, the abdomen may be quite flat and its wall rigid and hard. Under such circumstances there often arise most unpleasant symptoms the consequence of pressure from below upward upon the thoracic organs. Marked distention of the abdomen, particularly of the epigastric region, associated with persistent and uncontrollable nausea and vomiting, presages a fatal termination.

By **palpation**, in the early stages of an acute attack, we are usually unable to detect more than *tenderness* in the right iliac region with *rigidity*—of which mention has already been made when discussing the three cardinal symptoms of the disease. In some cases, however, we can recognize by rather deep palpation a sense of resistance, which is sometimes distinctly circumscribed, and of elongated, cylindrical outline. This may with reason be ascribed to a thickened appendix, a fold of omentum, band-like contraction of the rectus muscle, or some possible peri-appendicular exudate of a nonsuppurative nature. In some cases such is the tenderness over the region of the appendix that even moderately deep palpation is impossible. In other cases the rigidity of the abdominal wall precludes satisfactory palpation.

On the other hand, in addition to tenderness and rigidity of the abdominal muscles, palpation may reveal a rather diffuse

resistence or a more or less distinctly circumscribed *swelling* or *tumor* in the right iliac region. The tumor, when palpable, is of smooth or roundish contour, and its edges are usually sloping. It varies in size in different cases. It is sometimes no larger than an egg; it is usually as large as a lemon or a small orange; it is rarely as large as a cocoanut. It generally courses parallel with Poupart's ligament and is removed a short distance from the crest of the ilium. When large, however, it may reach the ilium, and may extend upward beyond its crest and beyond the median line of the abdomen. The tumor in the vast majority of cases is immobile. It is generally firm, but may be quite soft; in some cases, particularly if it be large, it may present distinct fluctuation.

The conditions upon which this tumor or swelling depends vary somewhat in different instances. In cases unattended by peri-appendicular suppuration it is due to the thickening and œdema of the inflamed tissues—the appendix itself, possibly the cœcum and particularly the omentum; to peri-appendicular serous, sero-fibrinous, and fibrinous exudate; to inflammatory alterations not only of the viscera, but also of the parietal peritoneum of the iliac fossa and the abdominal wall; and in some cases to serous and cellular infiltration of the transversalis fascia and the abdominal muscles. In the majority of these cases the size of the swelling is usually dependent upon the amount of the peri-appendicular exudate, which at times is excessive. In endeavouring to formulate an opinion as to the cause of a swelling in an individual case it must be borne in mind that the plastic exudate surrounding an inflamed appendix may be 3 cm., 4 cm., or 5 cm. in thickness. As a consequence, it must not be assumed that all tumors, even if they be of moderate size, have within them a purulent focus. Some even very large swellings develop with such rapidity and become so quickly dissipated that it is impossible to hold with reason that they have been suppurative. Such exudates, however, are very prone to become purulent,

and it is true that all tumors of moderate and large size are, in part at least, composed of pus. It is, of course, in cases in which there is a considerable quantity of pus that fluctuation may be elicited. I have observed several cases in which a tumor mass has been simulated by excessive muscular rigidity of the lower part of the right rectus.

The consideration of this swelling naturally leads to a discussion of the question of *stercoral typhlitis*. That the condition formerly referred to as typhlitis is not typhlitis but appendicitis is stated elsewhere. That stercoral typhlitis—an inflammatory condition of the cæcum the consequence of the irritant action of fæces retained within it without extrinsic cause—does not occur is equally true, and must be evident to all who have had experience. In discussing this question Sahli aptly remarks that “anything under the sun may exceptionally occur once.” That stercoral typhlitis may occur cannot be denied; the assertion that it does occur is not based upon any sound evidence found at either operation or necropsy. By some a series of cases presenting pain, tenderness and a more or less soft tumor in the right iliac fossa, constipation, slight fever, etc., have been recognized as stercoral typhlitis—not that anyone has ever described the anatomical lesions of stercoral typhlitis, but solely upon clinical assumption. It is in such cases that early operation has demonstrated the presence of catarrhal and interstitial appendicitis with serous or fibrinous peritonitis. The cæcum in such cases rarely reveals evidence of disease, and such as does exceptionally occur is always less marked than is that of the appendix. In the event of coprostasis the cæcum is by no means the seat of predilection of such stagnating fæces. Fæces are commonly found in the colon, but they are rather unusually encountered in the cæcum, and such as are detected in the cæcum are always much softer than those elsewhere in the colon—as is to be expected from the close proximity of the cæcum to the ileum. In my operative experience, which is now considerable,

I have never encountered any fæcal stagnation in the cæcum. If fæcal stagnation were the cause of inflammation of the intestine, we would naturally expect the descending colon and the sigmoid flexure to be frequently the seat of such disease. Fæcal tumors that are palpable during life are never encountered in the region of the cæcum. Fæcal impaction, when it does occur in the cæcum, from causes such as stricture of the bowel, etc., does not give rise to the symptoms ascribed to stercoral typhlitis. The absence in extensive necropsy records of any mention of fæcal stagnation in the cæcum is evidence that a condition that is not encountered at operation is not observed after death. Clinically, there is found to be gradual progression in the severity of the symptoms of those cases recognized by some as stercoral typhlitis into the symptoms of those cases with unmistakable evidence of serious appendicular lesions and circumscribed and diffuse peritonitis. The occurrence of ulceration and perforation of the cæcum with peri-cæcal suppuration, even in the absence of perforation of the appendix, cannot be considered *prima facie* evidence that the perforation of the cæcum occurred from within outward and that the peri-cæcal suppuration is the consequence of primary disease of the cæcum. In such cases the sequence of events is as follows: There first occurs an inflammation of the appendix, which is usually attended by ulceration, but which may not go on to perforation. There then develops a peri-appendicular abscess, the reasons for which are explained in the chapter on the pathology of the affection. This finally ruptures *into* the cæcum, an occurrence which presents its anatomical proofs in the greater destruction of tissue at the serous, not the mucous, coat. Other cases of perforation of the cæcum are the result of the rupture directly into the cæcum of an appendix that has formed adhesions with it. That perforation of the cæcum the consequence of a primary typhlitis does not occur is indicated by the statistics of Einhorn, who found that among 18,000 necropsies, the very few cases of primary perforation encountered

were all in cases of intestinal stenosis. That stercoral typhlitis may occur I will not deny; that it does occur, I do not believe.

Percussion is of subordinate importance in the diagnosis. In the event of a swelling or tumor forming in the right iliac fossa the note is generally dull and high in pitch. Such note, may, however, be due to causes other than appendicitis with peri-appendicular peritonitis, and these morbid conditions may develop without the occurrence of dullness on percussion. Even large peri-appendicular abscesses may exist with a tympanitic note in the right iliac fossa, particularly if gas has been generated within the abscess cavity. Such note will occur, for instance, if a coil of intestine overlies the abscess. A dull note, of tympanitic quality and high in pitch, may occur in the absence of an abscess if there be excessive rigidity of the abdominal wall. At times there is found an area of tympany intervening between the ilium and the area of dullness. This is generally due to the presence in this region of the cæcum—the abscess being situated toward the median line.

Auscultation reveals little of importance in the diagnosis. Reference has already been made to its value in distinguishing between distention due to accumulated intestinal gas and that due to paralysis of the intestine the consequence of infection. Mannaberg and Nothnagel have drawn attention to an accentuation of the second pulmonic sound of the heart in appendicitis, but do not explain the cause of the phenomenon. Accentuation of the second pulmonary sound has been observed in biliary colic and is explained on the hypothesis that there is reflex constriction of the pulmonary arteries. Auscultatory percussion by means of the stethoscope or phenondoscope may assist in outlining the tumor.

From the commencement of certain attacks of appendicitis **frequency of urination** is often a prominent symptom. In certain cases this is doubtless due to disturbances of the sympathetic nervous system; in others—those in which the inflamed appendix

occupies the pelvis—to an irritation communicated directly to the bladder. In peritonitis involving the serous coat of the bladder retention of urine, necessitating catheterization, may occur. The urine is usually diminished in amount, of high specific gravity, dark in colour and often contains albumin, casts, and an increased amount of urobilin and indican. These alterations are due in part to the fever usually present at the commencement of the attack, but particularly to the direct action on the kidneys of the toxine of the bacteria concerned in the production of the appendicitis. Of the excessive virulence of this toxine in many cases sufficient experimental proof has already been adduced. Its action on the human organism is to produce parenchymatous degeneration of the tissues, especially of the liver, heart, kidneys, etc. In the kidneys it produces acute and subacute toxic nephritis. I have records of numerous cases in which the urine was less in amount than normal, and contained erythrocytes, leukocytes, hyaline, granular, and epithelial casts, desquamated epithelium, granular débris, etc. In most of these cases the urine returned to the normal condition during convalescence, and such may be expected in favourable cases.

Leukocytosis has been observed in a number of cases of appendicitis. Its value as regards diagnosis, prognosis, and indication for operation are discussed in another chapter.

CHRONIC APPENDICITIS.

Chronic appendicitis may develop in one of several ways. It may commence insidiously, with indefinite and vague symptoms, so that the patient is unable to designate any stated time as the date of the beginning of his illness. It may follow a more or less frank attack of acute appendicitis from which the patient recovered by medicinal treatment or by surgical treatment, the appendix, however, not being removed. In certain cases of the second variety the acute attack is partly recovered

from, but the patient does not entirely regain his former health, and attacks of acute exacerbation occur from time to time. This is known as *relapsing appendicitis*. In other cases the patient apparently recovers his former health, and at long intervals—six months, a year, or more—other attacks occur. This is known as *recurring appendicitis*. That recurrences are very frequent is indicated by various statistics. Thus Nothnagel gives the percentage of recurrences in his experience as 16 per cent.; Rotter as 21 per cent.; Sonnenburg as 32 per cent.; and Sahli, from a collective investigation of 4593 cases from private practice, as 20.8 per cent. Of 460 of my own cases, recurrences were noted in 312 (67.8 per cent.). The vast majority of recurrences develop within the first six months; there are less within the succeeding six months. During the following years the likelihood of recurrence becomes gradually less; recurrence may nevertheless occur after a great number of years. The number of recurrences that a patient may suffer is variable. Of the 312 patients previously referred to, 89 had two attacks, 52 had three attacks, 30 had four attacks, 18 had five attacks, 16 had six attacks, 6 had seven attacks, 2 had eight attacks, 2 had nine attacks, 4 had ten attacks, 1 had twelve attacks, 2 had sixteen attacks, 2 had twenty attacks. The number of attacks that the remainder had is not known.

The symptoms of chronic appendicitis are most variable. The most constant of all is pain, which is usually confined to the right iliac fossa. It is of slight or moderate intensity, often persistent, and subject to acute exacerbations of minor intensity. The pain is increased by blows in the region of the appendix, by sudden exertion or undue exercise, and by the presence in the intestinal tract of indigestible food, which, by exciting increased peristalsis, leads to traction upon the peritoneal adhesions. The acute attacks are often of marked severity, incapacitating the patient for work and confining him to bed. At times the acute lesions may progress to ulceration and perforation

of the appendix, with the developement of a peri-appendicular abscess or diffuse peritonitis. The symptoms of such attacks are those described in connection with acute appendicitis. At other times the acute exacerbations are relatively inconspicuous, and the pain is more or less dull and of unvarying intensity. One of my patients had constant pain for fifteen years.

Associated with the pain there is sometimes general debility and indisposition for work or exertion of any kind. There are often the indications of intestinal indigestion—abdominal fullness and distress, tympanites, borborygmi, coated tongue, capricious appetite, mucous diarrhoea with alternate constipation, headache, malaise, hypochondriasis, etc. Neurasthenia is frequently a concomitant condition. Fever is usually absent. When present, it is of importance only when of the hectic type.

Palpation reveals more or less tenderness in the right iliac region. At times, even in the absence of much pain, the tenderness may be exquisite. In the majority of cases, if the tenderness be not prohibitive of deep palpation, an enlarged and thickened appendix can be made out. At times this can be rolled beneath the palpating finger as an indurated cylindrical mass. If there be much exudate and adhesions and especially if the omentum be adherent to the appendix, a distinct mass of rather large dimensions can be demonstrated by palpation. Not infrequently palpation of a chronically inflamed, semiquiescent appendix excites an acute exacerbation of the inflammation. This is especially likely to be the case if the appendix contain a focus of pus. If the latter be present tenderness on palpation is also likely to be more marked than when it is absent.

The danger attendant upon these chronic cases is their tendency to develop suddenly an acute exacerbation, which may go on to ulceration, perforation, gangrene, circumscribed or diffuse peritonitis, etc.

SUMMARY.

There is no constant relationship between the symptomatology and the pathological alterations.

Of acute appendicitis there are "three cardinal symptoms"—pain, tenderness, and rigidity of the abdominal wall.

The pain usually develops after eating. At first it is colicky, and is referred to the epigastrium; later, it becomes localized at the site of the appendix.

Tenderness on pressure is always present, and is sometimes best elicited by rectal or vaginal examination. The point of greatest tenderness is usually over the site of the appendix.

The rigidity of the abdominal wall is usually right-sided. It follows the localization of the pain, and is most marked over the inflamed area.

Vomiting is common at the onset of the attack. It desists in favourable cases. Its continuance is an unfavourable symptom.

In chronic appendicitis the history is important. Localized pain and tenderness are the most constant symptoms. Palpation is a most valuable means of diagnosis.

APPENDICITIS IN CHILDREN.

Although appendicitis is known to arise most often in early adult life, yet it has become recognized as a disease of sufficiently frequent occurrence in children to demand separate consideration under this heading. Among children—including infants, and children up to about fifteen years of age—it occurs with increasing frequency as age advances, as a glance at the following statistics will show:

| AUTHORITY. | UNDER FIVE YEARS. | FIVE TO TEN YEARS. | TEN TO FIFTEEN YEARS. | TOTAL. |
|--|----------------------|-----------------------|--------------------------|--------|
| Manley, ¹ | 5 | 27 | 35 | 67 |
| Brun, ² | 3 | 20 | 22 | 45 |
| Matterstock, ² | 12 | 25 | 35 | 72 |
| Gordon, ² | 5 | 33 | 41 | 79 |
| Jalaguier, ² | 4 | 42 | 64 | 110 |
| New York City, 1890-99, ¹ | 38 | 162 | 201 | 401 |
| Philadelphia, 1900, ³ | 2 | 13 | 17 | 32 |
| Total | 69 | 322 | 415 | 806 |

Thus out of a total number of 806 cases in children under fifteen years of age, only 8.56 per cent. occurred in those of less than five years old, while 40 per cent. were in children between five and ten years of age, and no less than 51.26 per cent. in those between ten and fifteen years. Of the 391 cases, moreover, in those less than ten years old, over 82.3 per cent. were in those children over the age of five years; the 69 cases which occurred in those less than five years old forming less than 18 per cent. of this number. Hence the rarity of appendicitis in infants is

¹ Manley: Journ. Amer. Med. Assoc., June 1, 1901, p. 1547.

² Quoted by Jalaguier: *Traité de Chirurgie* (Duplay et Reclus), Paris 1898, 2e. éd., vi, 637.

³ Report of Penna. State Board of Health, 1900, vol. ii.

readily understood. Griffith was able, in an extended search of the literature, to find only fifteen cases of appendicitis reported in children less than two years old, and very few additional cases have been recorded since his article was written.

The rarity of appendicitis under two years of age may be explained by several facts. In the first place the anatomical configuration of the parts does not so markedly predispose to imperfect drainage and to congestion as it does in later life. The appendix is relatively larger, the drainage is therefore better, obstruction to the lumen being of more unusual occurrence; and the cæcum is as a rule situated higher in the abdominal cavity, there being less tendency towards stagnation in the radicals which carry the blood from the appendix to the superior mesenteric vein. Moreover, the infant's usual position is either supine or prone, and this may possibly tend to prevent congestion. A more important reason is the character of the diet, which, being chiefly fluid, renders the stools soft, and is not so apt to cause serious indigestion as is the food partaken of by older children. The bowels are also emptied oftener in infants, and thus the colon, which becomes more fixed as age advances, is not subjected to such strain.

Sex has less influence in children as a predisposing cause of appendicitis than it appears to exert in adults, since there is practically no difference physiologically in this particular until puberty is reached, when the same causes become operative as in adults; but nevertheless a larger number of cases are reported in boys than in girls. Jalaguier (*loc. cit.*) quotes the following figures for patients under 15 years of age:

| AUTHORITY. | MALE. | FEMALE. |
|--------------------|-------|---------|
| Matterstock, | 51 | 21 |
| Gordon, | 58 | 21 |
| Brun, | 26 | 19 |
| Jacob, | 21 | 8 |
| Total, | 156 | 69 |

That is to say, in children under fifteen years of age appendicitis occurs about two and a quarter times as frequently in boys as in girls. Of the last 200 cases of appendicitis in children, operated on by myself, 178 were in boys, and only 22 in girls, being 89 per cent. and 11 per cent., respectively.

In brief, then, the main reasons why appendicitis in infants is less frequent than in adults are to be found in the anatomy of the parts, the habits of the individual, the character of the food, and the fluidity of the fæcal matters. These same causes are operative, but to a less degree, in explaining the relative infrequency of this disease in older children as compared with adults.

The **pathological anatomy** of appendicitis in children differs in many important respects from that of adults. For some reason or other a palpable mass, inflammatory in character, and often consisting of omentum coiled tightly around the offending organ, forms early. Suppuration, localized in the vast majority of instances, is much more usual than in adults, and general peritonitis, unless from subsequent rupture of the abscess, is correspondingly rare. Perforation is probably less frequent in children, and gangrene also. Foreign bodies and fæcal concretions are found in older children with nearly as great frequency as in adults. Recurrent attacks, though uncommon, are by no means unknown; but when recurrent the attacks are more apt to terminate in sloughing or pus formation than in adults. This proneness to pus formation is well illustrated in almost any series of children's cases. Thus of six cases in children, ranging from twenty months to fifteen years of age, recorded by Weiss and Fevrier, five had progressed to suppuration when first seen, the sixth being a chronic (recurrent) case. In eleven cases in children from three months to twelve years, all of them acute, recently treated at the Children's Hospital of Philadelphia, the authorities of which have kindly allowed access to their records, an abscess was present in seven cases, whereas only three presented gangrene without pus, and only one of the whole series general peri-

tonitis. Possibly an explanation of this tendency is to be found in the proneness to inflammatory changes of cells which have more recently quitted the embryonal type, making them more ready to form pus as well as to contract adhesions.

Spieler's experience, as recorded in a recent elaborate article, has not been altogether in accord with the above statements. During the last two years he has observed thirty-six cases of appendicitis in children, of which twenty-seven came to operation. Of these no less than twenty-three presented either a perforated or gangrenous appendix, and in sixteen cases there was also progressive or diffuse peritonitis. These statistics he found to agree with those of Selter, who asserted that in children diffuse peritonitis occurred in more than half the cases, but was present in only one-fifth of the cases in adults. It seems probable, however, that in the cases of Selter and of Spieler operation was not performed as early as in the cases before referred to, since in Spieler's cases, at least, the average interval between the initial symptoms and operation was, in thirteen acute cases reported in detail, more than three and one-half days. It is certain that in the majority of children who have been under my own observation abscess formation was an early phenomenon, and general peritonitis, except as a consequence of rupture of the abscess, correspondingly rare.

In the year ending December 1, 1904, 77 cases of appendicitis were treated in the Children's Hospital of the Mary J. Drexel Home. Of these 2 were moribund, and died without operation. Of the 75 patients operated on, not one died. Among these there were 64 cases of acute, and 11 of chronic appendicitis. In 36 of these acute cases the abscess had either burst before operation, or no abscess had ever existed, the appendix perforating into the general peritoneal cavity. In 2 cases the abscess was still circumscribed, and was drained extra-peritoneally without removal of the appendix. In the remaining acute cases the disease was confined to the appendix, with serous peritonitis in 3 cases.

Appendicitis.

As regards **symptomatology**, the main difficulties in connection with the subjective symptoms are referable to the inability of the patients to make themselves understood, or even to accurately analyze their own sensations. Pain in the stomach should never be lightly regarded, but even when accompanied by vomiting and fever, is not to be considered pathognomical of appendicitis. For instance, the pain may be colic; the vomiting and fever may be the forerunner of an attack of scarlet fever, or of almost any other of the exanthemata. But if the pain persist, if the child can at all localize it to the region of the appendix, but more especially if tenderness on pressure exist, the attending physician's thoughts should instinctively turn towards inflammation of the appendix. Rigidity is not by any means so valuable a sign as in adults, since it so constantly happens that a child resists with all his might and main any examination of the abdomen. Yet this very fear of an examination may be taken as a rather sure sign of serious trouble, since were the pain merely colicky, pressure would relieve it. The vomiting is more apt to be repeated in children than in adults, for it will often be found that the stomach is not completely evacuated at the first effort. Preceding diarrhoea is nearly as much a symptom as a cause, and often proceeds from some known indiscretion in diet. Fever is usually higher than in adults, and the pulse likewise more rapid. The early developement of a palpable mass aids very materially in making the diagnosis. Rectal touch should never be neglected, as at least a sense of resistance in the right side of the pelvis may be thus detected.

Apart from colic, **differential diagnosis** is most important from intussusception, which of all intra-abdominal surgical diseases probably occurs with the greatest frequency in children, next to appendicitis. Besides the physical signs of an intussusception, there is almost invariably the constant painful discharge of mucus and blood from the rectum; but it cannot be denied that the distinction between the two diseases is one made

at times only with the greatest difficulty, if it be not indeed an absolute impossibility.

Stone in the urinary bladder has at times given rise to much confusion, and cases are even recorded where a calculus thought to have been detected by sounding turned out to be an appendiceal abscess. A much distended bladder, especially in the early days of an attack of typhoid fever, may closely simulate appendicitis; but a surgeon who keeps such possibilities constantly in mind can very readily clear up the diagnosis by the use of the catheter.

Floating kidney is an affection not altogether unknown in children. Manley (*loc. cit.*) refers to twenty-one cases in patients less than fifteen years of age.

Other abdominal affections are so fully discussed in other parts of this book, that it seems necessary to do little more here than refer to those most often met with in children. These are various abdominal tumors, especially sarcomata, either renal or retro-peritoneal in origin; tubercular peritonitis, local or general; coxalgia and psoas abscess. It is not perhaps unnecessary to caution against the injudicious removal of tubercular appendices; a fæcal fistula may result which will kill the patient sooner than the original disease.

The possibility of pneumonia or pleural irritation causing referred abdominal pain must not be lost sight of. Vomiting moreover, often occurs at the onset of a pneumonia. But in the latter disease the symptoms and physical signs practically never point alone to the abdomen, while in appendicitis the clinical picture is not one of thoracic disease in the least. To a physician who has seen many abdominal cases the broad distinction between this class and that of disease above the diaphragm is not usually difficult.

Treatment.—Finally, in cases where no decision can be reached, delay, though very dangerous, is not so to the same degree as in adults, in view of the liability of the process to localization. On the other hand it should not be forgotten that,

where the facilities exist, an early operation with removal of the appendix is practically free from any risk whatever.

Children when they are brought to the hospital are frequently in no fit condition to endure much of an operation; and in these cases it is often the best policy merely to open the abscess and provide for its thorough drainage, postponing the removal of the appendix until the case has assumed the chronic type. If a fæcal fistula forms after the abscess has been opened it is also safer to make no attempt to close it by a formal operation, but to allow the patient to bear the necessary discomfort until convalescence is well advanced, for an operation undertaken then can be completed without hurry, and therefore with more assurance of ultimate success.

The **prognosis** is as a rule favourable. Appendicitis in children is certainly not so fatal an affection as in adults. While early operation is not so often practised in children—owing partly to the difficulty of diagnosis, and partly to the reprehensible habit of some selfish mothers, among the uneducated, of keeping the child out of hospital until an abscess is nearly ready to burst through the distended belly walls, thinned by the long existence of the disease and perhaps by sepsis—yet in spite of this unfavourable condition of the patient, children have such a wonderful power of recuperation, that it is rare to see a death in any case where the operation is in time to prevent the development of septicæmia, even if it be not in time to anticipate suppuration, or to avert the formation of a fæcal fistula.

CHRONIC APPENDICITIS.

Chronic appendicitis is becoming of more interest, if possible, to the surgeon, from the point of view of diagnosis than is the acute variety of the disease. In the latter affection, though the diagnosis is not always easy, yet it is rarely impossible; but the more I, for one, see of chronic cases, the more impressed I am with the danger of jumping at conclusions, and of opening the abdomen to remove an appendix which will eventually be found not to have been the cause of the symptoms. There are, I know, surgeons who think that there is nothing easier in obscure abdominal conditions than to cut a hole in the belly wall and look inside; but they are not surgeons who can claim to have developed their diagnostic powers to the utmost; for while nothing or few things are easier than a simple laparotomy, yet I feel sure that I am expressing the general opinion of the profession in saying that a surgeon who must needs resort to such methods as these to make a diagnosis, unless in extremely exceptional cases, is not a surgeon worthy of the name. We should not rest content with our diagnostic ability until we can say with at least a fair degree of certainty, whether, after the abdomen has been opened, anything further can be done to relieve the patient's disease.

In the case of acute appendicitis, the evidences of peritonitis of greater or less extent are usually unequivocal, and removal of the *fons et origo mali* is indicated at the earliest possible moment. But where the affection is chronic, or at most subacute, the indications for immediate operation are not imperative, and as a rule plenty of time may be spent in discussing the other possible intra-abdominal conditions. Hence it is that the diagnosis, and

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especially the differential diagnosis of chronic appendicitis is so important.

Surgeons are well acquainted with the usual classification of chronic appendicitis into the relapsing and the recurring forms; in the former variety appendicitis may be said to be present all the time, but to smoulder during intervals of time of varying length; while in the latter, the recurrent form, the patient is apparently perfectly well during the intervals, and is conscious of his appendix only during the acute attacks. In the phraseology of the layman, relapsing appendicitis goes away at times, and recurrent appendicitis comes back at times

But besides these two well-known states there is another where the appendix gives constant trouble, but is never the seat of an acute attack, except, perhaps, where the disease first made its appearance as an acute attack. It is, of course, more frequently the case for this third form of chronic appendicitis to ensue upon an acute attack, but there can, I think, be no doubt that in a few instances patients develop chronic appendicitis insidiously, without an acute attack, just as chronic nephritis, hepatitis, or cystitis may be developed.

And it is of this last form of the affection, where the diagnosis is especially difficult, that I wish to speak particularly in the present chapter. If there has been an acute attack it is usually possible by exclusion to determine that its seat was in the appendix, and not in the kidney, the ureter, the gall-bladder, or elsewhere. But where no such attack has preceded, it may be, and indeed is usually difficult, by means of inclusion, exclusion, and by differential diagnosis to make sure that the appendix is the diseased organ, unless it is readily felt.

There are, I regret to say, at this day, patients from whom I have removed appendices which were thought to be the cause of the distressing symptoms, and which were on microscopical examination found to be actually diseased; but these same patients have not experienced relief from their symptoms in the least.

The conclusion is irresistible that the appendix, diseased though it was, was yet not the efficient cause of the symptoms. I have in mind now one patient, a young girl, who gave a history of long-continued discomfort, and of pain, more or less severe, in the right iliac region, whose pelvic organs were proved normal at the operation, and whose appendix was thought to be the source of trouble; but who, even with this microscopically diseased appendix removed, is to-day no whit better than before her operation; yet in her case I was convinced at the time, and am still sure, that appendectomy was the only operative treatment applicable or required.

Another patient I can recall was sent to me for an opinion as to her appendix, which was thought by her family physician to be the cause of her abdominal discomfort, if in sooth there was any cause for it at all. It was considered possible that her neurotic tendency might be more of a cause than her appendix. When I came to examine this young woman, I found an appendix not palpably tender; but I found that the right kidney was proptosed. She gave a history of several acute attacks of abdominal pain. My advice was to anchor the kidney in place, and to leave the appendix alone; but my advice was not accepted, and another practitioner was found who removed the appendix. To-day this patient is still subject to attacks of abdominal pain.

Another instance may be cited: I was asked to see, in consultation, a girl of about sixteen years, who was thought to have chronic appendicitis, although she had never had an acute attack. On examination I could not satisfy myself that the appendix was diseased, and declined to operate. Some time later I was called in consultation by another physician to see a case of supposed chronic appendicitis. I found the patient whom I had previously examined, and told her physician the facts, stating that I was convinced there was nothing wrong with her appendix. I had already been informed that two competent gynæcologists had separately examined her pelvis, and could detect no abnor-

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malities. I asked to be allowed to complete my study of her case by a vaginal examination, but was refused. In accordance, however, with the wishes of her family and her physician I was prevailed upon to admit her to the hospital, and keep her under observation. Although repeatedly urged by her family to do so, I refused to open her abdomen until I was convinced that something could be gained by so doing; and although told, as above stated, that no pelvic abnormalities had been found by previous examination, I felt unwilling to exclude disease of the adnexa except on the testimony of my own senses. Finally the patient's family consented to my making a vaginal examination in person. I found that the right ovary was cystic, and approximately the size of an orange. Feeling that this was a sufficient explanation of her symptoms, I operated, and removed the right ovary and the appendix. Recovery from the operation was uneventful, but the abdominal symptoms present before the operation have not been altered by it in the slightest degree: evidently neither the appendix nor the cystic ovary caused them.

It is on account of disheartening experiences such as these that I have become convinced that the appendix is often unjustly blamed for symptoms which will not be improved by its removal; indeed, I have little doubt that in very many instances, where no symptoms at all exist, microscopical examination would show the appendix to be chronically inflamed. The abdominal cavity, in spite of the enormous strides made by aseptic surgery, is yet a very obscure field, and the removal of the appendix will not quell all the ills to which it is liable.

It appears to me fairly certain that the abdominal discomfort experienced by patients supposed to be afflicted with chronic appendicitis, is in the majority of such cases rather due to intestinal indigestion resulting from defects of renal or hepatic metabolism, and that the appendix has nothing, or at most very little to do with its production. In cases such as these, there is as a rule abundance of time available for making the diagnosis, and

the surgeon should not be content until he has excluded all other possible affections which might with reason be held accountable for the production of intestinal symptoms. Such affections as dilatation of the stomach, gastropptosis, enteroptosis, gall-bladder and gall-duct disease, peri-gastric adhesions, and all the long list of diseases discussed in the chapter on Differential Diagnosis should be borne in mind and such remedial measures as may be indicated should be instituted before deciding on operative treatment. Of course, where an attack of acute inflammation was the starting point of the chronic appendicitis, it is possible that peri-appendicular adhesions may have formed, which interfere more or less with peristalsis, and cause persistent discomfort. In cases such as these experience shows that the removal of the diseased appendix will allow the absorption of these adhesions in a comparatively short time; but when it is probable that adhesions have never existed, as is almost invariably the case in the patients suffering from the form of chronic appendicitis now under discussion—in cases such as these, it appears to me illogical in the extreme to expect the removal of the appendix to cure the symptoms. Granted that the appendix is “chronically inflamed,” as it probably will be found to be on microscopical study, what reason have we to believe that the kidneys, the liver, the heart, the intestines, and the whole vascular system, both blood and lymphatic, would not be found to be similarly “chronically inflamed” were they to be submitted to equally searching investigation? I do not know that there is at present any other than clinical material to use in an argument for and against such a theory, but from the viewpoint of a clinician I think it is sufficiently evident that the appendix is not in such cases the whole cause of the trouble, and that its removal will by no means ensure a cure. Battle and Corner have recently devoted attention to this subject, and their views are worthy of careful consideration. They hold that as a result of the chronic inflammation the appendix and the cæcum, becoming unable to properly empty them-

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selves because of limited peristaltic action, serve as a constant source of intoxication to the whole body ("appendicular constipation"), the evidences of this toxæmia being "lassitude, depression of spirits, heaviness of mind, general depression of health, of mind and body, with dyspepsia, constipation, colitis, etc."; and they think, in patients who have not been suffering from these symptoms for too long a time, that removal of the appendix should effect a cure. A notable instance of such a result in my own practice is that of the patient whose history is recorded at page 428 of this volume; but only too often no benefit at all results from the operation even after prolonged post-operative medical treatment, and the case becomes a reproach to surgery. Such after-treatment should never be neglected, but I do not know that I am prepared to go to the extreme of advocating, with Battle and Corner, a secondary operation to establish a false anus in the ileum, through which to flush out and irrigate the large bowel.

More than this I am convinced that very few abdomens can be opened for whatever purpose without producing such trauma as will result in subsequent adhesions; and these, even after the appendix is removed, will increase rather than diminish the intestinal troubles. It is not impossible that in the cases now under discussion the vital characteristics of the whole peritoneum are altered. With all our scientific knowledge and technical skill, the physiology, and still more the pathology, of serous tissues is very imperfectly understood. The reaction of the peritoneum to irritants has in my experience been extremely unequal and uncertain. At times, where the least injury to the tissues was involved, the adhesions subsequently formed seemed to be the most numerous; while at other times in cases apparently precisely similar, adhesions would be absent, even though in both instances the peritoneum remained aseptic; and with some patients extensive damage to the peritoneum seems to be borne with impunity, and no adhesions form. So I have been forced

to the conclusion that a surgeon who has the best interests of his patients at heart will be very chary about recommending an exploratory laparotomy, and will be anxious to encourage his patients to rather bear the evils they at present suffer, than fly to others that they know not of.

Too much stress cannot be laid upon the matter of physical examination. Even though all the symptoms conceivably indicative of chronic appendicitis are present, and even, I think I may add, though an acute attack of some sort has preceded these symptoms, the diagnosis of chronic appendicitis cannot in my opinion justly be made where physical signs are absent.

And by physical signs I do not think the surgeon should be content to mean tenderness on pressure over the appendix: he should be able to feel the appendix, and to be reasonably sure that what he feels really is the appendix, and not a fatty omentum or mesentery, or enlarged lymphatic glands, or some other structure of the body. It is well known that tuberculous and malignant growths can occur in the appendix; and that the mesenteric lymph nodes can be primarily affected with tuberculosis—and happy is that patient whose incipient malignant or tuberculous disease can be totally removed by laparotomy—but in cases such as these the physical signs at least show the presence of a diseased appendix, or of enlarged glands, and an operation undertaken for their removal cannot be called exploratory in a reproachful sense, since the surgeon will be sure before he begins that the condition demands operation, and he will not be opening the abdomen merely to see whether an operation is required or not.

I would therefore give it as my candid opinion, reached after somewhat painstaking consideration of all the questions involved, and with a not very limited experience of all kinds of appendicitis cases, that where no frank, acute attack of appendicitis has ever preceded the chronic symptoms, the surgeon will do well to decline to operate unless the physical examination shows very positively that the appendix is diseased.

TYPHOID APPENDICITIS.

Many years ago the late Prof. DaCosta called my attention to the connection between typhoid fever and appendicitis; and the more I see of the former disease in its surgical aspects, the more I am convinced of the importance of the lesions of the appendix either caused by it, occurring independently during its course, or simulating it.

Typhoid fever may cause appendicitis either directly or remotely: that is to say, there may be typhoid infiltration, ulceration, or perforation of the vermiform process, just as there may be of any other portion of the intestinal tract; or, on the other hand as a result of ulcerations, such stenosis or kinking of the appendix may ensue—that during convalescence—or even some years after an attack of typhoid fever, appendicitis may occur.

Appendicitis, moreover, may arise as an intercurrent affection during the course of typhoid fever from such causes as would occasion it at any other time. It is, however, very seldom possible, indeed I may frankly confess that I am myself usually unable, to say whether a given case of appendicitis during typhoid fever is merely an intercurrent affection, or directly due to typhoid lesions. Nor do I think that microscopic examination will always clear up the diagnosis; for although the so-called pathognomonic typhoid cells may be found, who can say that these represent the exciting cause, and are not themselves a lesion independent of the appendicitis, just as they would be in a traumatic affection of the intestines arising during typhoid fever? Nor will bacteriological investigation decide the question determinately, since streptococci and other varieties

of bacteria than the bacillus of Eberth are so frequently found in the intestinal tract during typhoid fever in cases in which no suspicion of appendicitis exists.

A further division of this subject is formed by cases of appendicitis simulating typhoid fever; and cases of typhoid fever simulating appendicitis; while finally there are certain instances in which a disease resembling appendicitis in some features, and typhoid fever in others, turns out to be neither of the two, but an entirely different affection.

The subject of the **ætiological influence** of typhoid fever in appendicitis has not received as much attention as the differential diagnosis of the two affections. The best studies with which I am acquainted are those of Hopfenhausen, who made a careful microscopical examination of the appendix in thirty persons dying from typhoid fever. In only twelve cases did she find the appendix practically normal. In four cases it was the seat of chronic disease, evidently dating from before the attack of typhoid fever. In ten cases the appendix was acutely inflamed, but in no more than four instances was it manifestly the cause of death. In these last four cases, where the appendix was held directly responsible for the fatal termination, death occurred in the end of the second or in the third week of the typhoid fever; in those cases showing chronic lesions the patients mostly died in the fourth week or even at more advanced stages; while in those where death occurred early in the disease, the appendix showed only medullary infiltration, or, at the most, very shallow ulceration. Hopfenhausen likewise examined the previous history of 743 cases of appendicitis, and found that 37 had had typhoid fever; but interesting as this fact may be, it is rash to assume the preceding fever to be a cause; for, as she well points out, only were we able to examine the appendix itself, after the occurrence of the typhoid, and before the acute attack of appendicitis, could we be sure, by seeing its state, whether the preceding fever had left lesions sufficient to give rise to inflammation at

some later date. In these 37 cases the interval between the two diseases was as follows:

| | | | | | |
|----|----|-------|----------------|----------|-----------------------|
| In | 5 | cases | an interval of | 25 to 40 | years. |
| " | 24 | " | " | 10 to 20 | " |
| " | 2 | " | " | 3 | years. |
| " | 1 | case | " | 2 | " |
| " | 1 | " | " | 1 | year. |
| " | 3 | cases | " | 3 to 6 | months. |
| " | 1 | case | appendicitis | arose | during typhoid fever. |

Instances of lesions of the appendix during typhoid fever are not, however, at all uncommon, whether occurring then for the first time, or as a recurrent attack. References to 81 such cases are appended to this chapter.

Box and Wallace have recorded a case of appendicitis very closely resembling typhoid fever, in a man of fifty-one years. When he had apparently recovered from an attack of appendicitis, without operation, he was suddenly seized, while out walking, with faintness, and on his return home had a copious intestinal hæmorrhage. He developed a typical typhoid condition. The skin becoming reddened in the right loin, and there being a suspicion of deeply seated pus in this situation, an incision was made down to the kidney, under local anæsthesia by cocaine, but no pus was found, and further interference was deemed inadvisable on account of the extremely weak condition of the patient. Death soon followed, and the autopsy showed peri-appendicular suppuration, with no typhoid lesions of the bowel at any point. The hæmorrhage was believed to have come from erosion by a secondary abscess which had formed between the colon and the liver.

Cases of typhoid fever simulating appendicitis have been recorded by Richardson, among others; and it is scarcely to be doubted, that at some of the operations recorded, appendices were removed which were as nearly healthy as any appendix ever is, the symptoms of commencing typhoid having misled the operator.

In this same article Richardson calls attention to other affections which may resemble both appendicitis and typhoid fever. Those he reports were, in one patient, a band of adhesions across the ileum, with no lesions of the appendix; and in the second, who recovered without operation, a case of simple febricula with severe abdominal contusion produced by a game of foot-ball.

As regards **differential diagnosis**, it is above all things important nowadays for the abdominal surgeon to familiarize himself with the clinical aspects of typhoid fever. An unwary surgeon would many a time open up a patient's belly if the physician were not at hand to exclaim that pain in this case was an everyday occurrence; that that patient constantly stiffened his abdominal muscles whenever any one came near him; and that time and again the number of leukocytes rose to twelve and even fifteen thousand in typhoid fever without the patient being any apparently the worse.

Fortunately it is in the earliest stages of typhoid fever that the diagnosis is most difficult, at a period of this disease when a simple laparotomy is well borne, and hence a mistaken diagnosis is not so serious as it becomes during the third or fourth week of the fever. But even in the early stages a correct diagnosis is not by any means impossible. Pain, tenderness and rigidity, the classical symptoms of appendicitis, may all be present, yet if a history of malaise, headache, epistaxis, and slight diarrhoea is obtained, the case is most probably one of typhoid fever: there may be slight medullary infiltration of the appendicular lymph nodes commencing, but it is not a true appendicitis. The fever is too high and the pulse is too slow. The tongue will often decide the surgeon—in typhoid the typical dry, furred tongue is observed sufficiently early to warrant its being considered a valuable sign. Even a palpable mass may be due not to an inflamed appendix, but to enlarged mesenteric glands. The blood count is relied upon to a very large extent by most surgeons as a differential mark, and such a count, or an inspection at least,

by a well-trained hæmatologist, should be made whenever at all possible. The normal leukopenia of typhoid fever is well recognized, and it is probably safe to say that without an increase in the number of the white blood cells no appendicitis is present, unless the intoxication be overwhelming. This is a matter which is readily determined, as a rule, by the clinical picture which the patient presents.

It has recently been noted by Crile that in a number of cases the onset of peritonitis has caused a marked increase in the blood pressure. This sign might possibly be of service in obscure cases.

From *intestinal perforation*, when this condition is typical, the diagnosis should not be difficult. In appendicitis, even if there be perforation, the shock is not so great as in perforations of other parts of the intestinal tract; the pulse rate does not change so suddenly from the slow beat of typhoid fever to the rapid pulse characteristic of perforation; there is very seldom the fall of temperature which is not infrequently observed in cases of perforation of the bowel; and finally the course of the case, where it is simply watched, and where no operative interference is undertaken, is not so alarmingly rapid to a fatal termination.

From *intestinal hæmorrhage*, which is as a rule unaccompanied by pain, appendicitis is not as difficult to distinguish as it is from intestinal perforation. The hæmorrhage usually declares its presence in the stools in the course of an hour or so; and previous hæmorrhages in the same patient would incline us to favour this diagnosis rather than appendicitis.

Thrombosis of the iliac or femoral veins may be a misleading factor, and may even give rise to a palpable tumor as well as to resistance in the right iliac region. But while this condition presents some of the signs of appendicitis, it has others which are not characteristic of that disease, such as soreness along the trunks of the femoral veins, with œdema of the extremity affected; and it moreover lacks some features of appendicitis, such as the

vomiting, the sudden pain, and the intestinal disturbance so common in that disease.

Affections of the gall-bladder during the course of typhoid fever are not usually difficult to distinguish from appendicitis. The symptoms, as a rule, occur in the upper right quadrant of the abdomen, where a well defined mass may frequently be felt. A history of jaundice with previous similar attacks may possibly be elicited. In any event delay in resort to operative measures during the height of the typhoid fever is even more allowable here than where the appendix is affected.

The **prognosis** of appendicitis during typhoid fever is a matter of much uncertainty, and to the reproach of medicine it must be confessed that it is little influenced by treatment. Yet it may certainly be considered a graver affection than when occurring in an otherwise healthy individual. If the appendix is removed before the inflammation has advanced beyond its first stages, the result will be almost invariably favourable, the influence of such an operation on the typhoid affection in its early stages being practically nil. The inch long wound can be sealed with colloidion over the sutures, and the bath treatment pursued without interruption. If, however, an equally simple operation is undertaken during the second or third week of the fever, it alone may be enough to determine fatally an affection from which, without such interference, recovery would have been uneventful. Still more serious is the case where perforation, gangrene, or suppuration occurs in the appendix, especially during the height of the fever, or in one whose convalescence is not sufficiently far advanced. Yet even such lesions of the appendix during typhoid fever are not so serious as perforations of the ileum: eight cases where only the appendix was perforated, collected by Harte and Ashhurst, gave a mortality after operation of 50 per cent.; while the mortality they give for intestinal perforation in general, when treated by laparotomy, is over 74 per cent. That the stage of the disease at which operation is undertaken has a

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good deal to do with the result, is well seen from the following table, including the cases collected by Harte and Ashhurst, as well as other cases where the lesion is not certainly of typhoid origin. No cases, however, are here recorded in which perforation of another part of the intestinal tract coexisted.

LAPAROTOMIES FOR TYPHOID APPENDICITIS.

| OPERATOR. | PERIOD OF DISEASE. | RESULT. |
|----------------------------|--------------------|---|
| 1. Hall, | First week. | Recovered. |
| 2. Hammond, | " " | " |
| 3. Hutchinson, | " " | " |
| 4. Kammerer, | " " | " |
| 5. Neilson, | " " | " |
| 6. Richardson, | " " | " |
| 7. Deaver, | " " | " |
| 8. Murphy, | " " | " |
| 9. Murphy, | " " | " |
| 10. Murphy, | " " | " |
| 11. Deaver, | Second week. | " |
| 12. Cordier, | " " | " |
| 13. Gerster, | " " | " |
| 14. Hupp, | " " | Death in three days from intestinal hæmorrhage. |
| 15. Kammerer, | " " | Recovered. |
| 16. McReynolds, | " " | " |
| 17. Harte, | " " | Did well, but died in sixth week of perforation of the transverse colon. |
| 18. Williams, | " " | Recovered. |
| 19. Peyrot, | Third week. | " |
| 20. Teller, | Fourth week. | " |
| 21. Harte, | " " | Died. |
| 22. Neilson, | " " | " |
| 23. Pick, | " " | " |
| 24. Alexandroff, | Fifth week. | " |
| 25. Stewart, | " " | Recovered. |
| 26. Hutchinson, | Sixth week. | Died. |

Thus it is evident that an operation to be successful had better be done at once when appendicular symptoms arise early during

the course of the disease; but that if they arise during the latter part of the third week, or later, it is best if possible to postpone interference until recovery from the typhoid fever, when an interval operation will give most satisfactory results.

I have recently had under my care a case of appendicitis during typhoid fever, where the attending physician was urgent for immediate operation on at least two occasions; but as I was unable to say that an operation would not subject the patient to greater risk than would waiting under constant surgical supervision, and as I could detect no evidence of pus formation, I was unwilling to operate; and in each instance, as it happened, the patient shortly had a fearful intestinal hæmorrhage, and very nearly lost his life; and I could not help feeling that with the added shock of a laparotomy, however slight, he would have been unable to recover. Some weeks after complete re-establishment of his health, I removed with perfect success a chronically inflamed appendix from among numerous adhesions.

We have before us then, in these cases, a choice of two dangers—a dangerous delay, or a still more dangerous operation; and it is my firm conviction that that surgeon will best consult his own reputation and the safety of his patients who declines operative interference during the height of the disease, except where there is good evidence of perforation or pus formation.

CASES OF LESIONS OF THE APPENDIX DURING TYPHOID FEVER.

| AUTHORITY. | LESION. | RESULT. | REFERENCE. |
|-------------------------|----------------|---|--|
| 1. Adam, | Pus. | Recovery. No operation. | Australasian Med. Journ., 1887, ix, 182. |
| 2. Alexandroff, . . . | Perf. | Recovery. Laparotomy. | Journ. de Clin. et Thérap. Enfants, Paris, 1894, ii, 735. Also Laetop. Khirurg. Obsht. v. Mosk., 1891, x, 121, in Annals of Surgery, 1897, i, 267. |
| 3. Anderson, | Inflam. | Recovery. Laparotomy. | Pacific Med. J., 1902, xlv, 591. |
| 4. Bernheim, | Inflam. | Died. No operation. | Soc. de Méd. de Nancy, C.-R., Mém., 1895-96, p. xxx. |
| 5. Bogart, | Adhesions. | Died. Laparotomy. | Annals of Surgery, May, 1896. |
| 6. Bontecou, | Perf. | Died. Laparotomy. | J. Am. Med. Assoc., 1888, i, 106. |
| 7. Cordier, | Inflam. | Recovery. Laparotomy. | Therap. Digest, 1898, i, 75. |
| 8. Cushing, | Perf. | Died. No operation. | Johns Hopkins Hosp. Reports, vol. viii, p. 229. |
| 9. Cushing, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 10. Cushing, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 11. Cushing, | Adhesions. | Recovery. Laparotomy. | <i>Ibid.</i> , footnote. |
| 12. Davis, G. G., . . . | Perf. | Died. Laparotomy. | Records of Episcopal Hosp., Phila., 1900. |
| 13. Deaver, | Inflam. | Recovery. Laparotomy. | Am. J. Med. Sc., 1898, cxv, 191. |
| 14. Deaver, | Inflam. | Recovery. Laparotomy. | <i>Ibid.</i> |
| 15. Fitz, | Perf. | Died. No operation. | Trans. Assoc. Am. Phys., 1891, vi, 209. |
| 16. Fitz, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 17. Fitz, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 18. Fitz, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 19. Fitz, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 20. Gerster, | Ulcers. | Recovery. Laparotomy. | Berg: N. Y. Med. Record, 1901, i, 443. |
| 21. Hall, | Pus. | Recovery. Laparotomy. | Trans. Colorado State Med. Soc., 1896, 161. |
| 22. Hall, | Perityphlitis. | | <i>Ibid.</i> |
| 23. Harte, | Adhesions. | Recovery. Laparotomy. | Records of Episcopal Hosp., Phila., 1900. |
| 24. Harte, | Gangrene. | Recovery. Laparotomy. | Records of Pennsylvania Hosp., 1902. |
| 25. Harte, | Inflam. | Died of subsequent perforation of transverse colon. Laparotomy. | <i>Ibid.</i> , 1902. |
| 26. Harte, | Gangrene. | Died. Laparotomy. | <i>Ibid.</i> , 1903. |
| 27. Heschl, | Perf. | Died. No operation. | Schmidt's Jahrb., 1853, lxxx, 42. |
| 28. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 29. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |

CASES OF LESIONS OF THE APPENDIX DURING TYPHOID FEVER.—(Continued.)

| AUTHORITY. | LESION. | RESULT. | REFERENCE. |
|------------------------|-----------|----------------------------|---|
| 30. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 31. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 32. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 33. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 34. Heschl, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 35. Hopfenhausen, . | Inflam. | Died. No operation. | Rev. Méd. de la Suisse Romande, Genève 1899, xix, 105. |
| 36. Hopfenhausen, . | Inflam. | Died. No operation. | <i>Ibid.</i> |
| 37. Hopfenhausen, . | Inflam. | Died. No operation. | <i>Ibid.</i> |
| 38. Hopfenhausen, . | Inflam. | Died. No operation. | <i>Ibid.</i> |
| 39. Hutchinson, . . . | Perf. | Recovery. Lapa- rotomy. | Records of Pennsylvania Hosp., 1902. |
| 40. Hutchinson, . . . | Inflam. | Recovery. Lapa- rotomy. | Records of Episcopal Hosp., Phila., 1902. |
| 41. Kammerer, | Ulcers. | Recovery. Lapa- rotomy. | Seibert: Archives of Pediatrics, 1902, xix, 680. |
| 42. Kammerer, | Inflam. | Recovery. Lapa- rotomy. | <i>Ibid.</i> |
| 43. Keen, | Pus. | Recovery. Lapa- rotomy. | Surg. Compl. and Sequels of Ty- phoid Fever, Phila., 1898, 157. |
| 44. Kelynack, | Ulcers. | Died. No operation. | Pathology of the Vermiform Ap- pendix, London 1893, 123. |
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| 46. Mitchell, C. F., . | Perf. | Died. Laparotomy. | Records of Pennsylvania Hosp., 1903. |
| 47. Moore, | Perf. | Died. No operation. | Trans. Path. Soc. London, 1883, xxxiv, 113. |
| 48. Moore, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 49. Moore, | Ulcers. | Died. No operation. | <i>Ibid.</i> |
| 50. Moore, | Ulcers. | Died. No operation. | <i>Ibid.</i> |
| 51. Morin, | Perf. | Died. No operation. | Thèse de Paris, 1869. |
| 52. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 53. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 54. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 55. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 56. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 57. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 58. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 59. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 60. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 61. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 62. Morin, | Perf. | Died. No operation. | <i>Ibid.</i> |
| 63. Murchison, | Perf. | Died. No operation. | Treatise on the Continued Fe- vers, London, 1873, 2d ed., p. 577. |
| 64. Neilson, | Gangrene. | Died. Laparotomy. | Records of Episcopal Hospital, Phila., 1901. |
| 65. Neilson, | Inflam. | Recovery. Lapa- rotomy. | <i>Ibid.</i> , 1903. |
| 66. Osler, | Perf. | Died. No operation. | Canada Med. and Surg. Journ., 1878, vi, 256. |
| 67. Osler, | Perf. | Died. No operation. | Montreal Gen. Hosp. Reports, 1880, vol. 1, 313. |

CASES OF LESIONS OF THE APPENDIX DURING TYPHOID FEVER.—(Concluded.)

| AUTHORITY. | LESION. | RESULT. | REFERENCE. |
|-----------------------------------|------------|-------------------------|--|
| 68. Pepper, | Typhlitis. | Recovery. No operation. | Univ. Med. Mag., 1889-90, ii, 262. |
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| 70. Pick, | Perf. | Died. Laparotomy. | Trans. Clin. Soc. London, 1898, 234; Brit. Med. Journ., 1898, i, 1328. |
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| 72. Hammond, | Adhesions. | Recovery. Laparotomy. | Proc. Phila. Co. Med. Soc., 1904, N. S., vi, 110, Case 2. |
| 73. Hupp, | Abscess. | Died. Laparotomy. | Journ. Amer. Med. Assoc., 1904, ii, 862. |
| 74. Teller and Behrend, | Inflam. | Recovery. Laparotomy. | Proc. Phila. Co. Med. Soc., 1904, N. S. vi, 253. |
| 75. Murphy, | Inflam. | Recovery. Laparotomy. | Am. Jour. Med. Sc., 1994, ii, 191. |
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| 77. Murphy, | Inflam. | Recovery. Laparotomy. | <i>Ibid.</i> |
| 78. Williams, | Empyema. | Recovery. Laparotomy. | N. Y. Med. Record, 1904, ii, 897. |
| 79. Hutchinson, . . . | Perf. | Died. Laparotomy. | Records of Pennsylvania Hosp., 1904. |
| 80. Stewart, | Inflam. | Recovery. Laparotomy. | <i>Ibid.</i> , 1904. |
| 81. Anderson, | Inflam. | Recovery. Laparotomy. | American Medicine, 1904, ii, 1129. |

N. B.—The above table includes cases where lesions of other parts of the intestinal tract co-existed, as well as those where the appendix vermiformis alone was affected. For permission to make use of the records of the Pennsylvania Hospital and of those of the Episcopal I am indebted respectively to Dr. Richard H. Harte, and to my brother Dr. Harry C. Deaver.

DIAGNOSIS.

The diagnosis of appendicitis is ordinarily attended by few difficulties. When the three cardinal symptoms of the disease are present—that is, sudden onset of acute abdominal **pain**, with or without or followed by **vomiting**, occurring in one previously well; unilateral **rigidity** of the right lower abdominal wall; **tenderness** over the site of the appendix—the diagnosis of appendicitis is warranted in nearly every case. The reasons for the failure of the attending physician to make the correct diagnosis are errors in theory and in practice. The most important error in theory is his disbelief in the existence or at least in the great frequency of appendicitis as a disease. There lurks in the minds of a great many men a persisting belief in a **primary typhlitis**, whether stercoral or idiopathic, and some physicians even at the present day seem averse to the realization of the fact that it has been proved over and over again that the appendix is always the original seat of trouble in acute inflammation of the right iliac fossa. The picture before the eyes of these gentlemen is that of a cæcum loaded with stagnant fæces, their one idea is to empty the bowel by a drastic purge; and they cannot be convinced that purgation from now until doomsday will not check in the slightest degree the progress of the inflammation in the appendix vermiformis. They have the common habit of speaking of all gastrointestinal disorders attended by pain, nausea and vomiting, as “inflammation of the bowels.” They make no attempt to localize the seat of this inflammation, and are prone to consider the pathological conditions present merely an “irritation,” even while they call it “inflammation.”

If from the mental horizon of such individuals as these the cæcum could be eliminated, there would appear looming up in the foreground in the position of prime importance that source and fountain of all evil, the vermiform appendix. And if this little worm-like treacherous structure was ever in mind, the greatest error of all, one which I may almost call a crime, *the neglect of physical examination*, would be absent. Never should any patient who presents pain in the abdomen go unexamined.

Failures in diagnosis, however, may often be explained by the fact that the initial symptoms were insignificant, were lost sight of, or were obscured by the injudicious use of opium. The commencement of an attack of appendicitis may very closely simulate acute indigestion, in that there occur vomiting, colicky pains, often implicating the entire abdomen, and tenderness. But in appendicitis there is nearly always a certain *sequence of symptoms*—pain, vomiting, tenderness—and rigidity of the rectus muscle is nearly universal. If this sequence of symptoms—(1) pain; (2) vomiting; (3) tenderness—is altered, the diagnosis of appendicitis may well be considered doubtful; and where appendicitis is present and these symptoms have not occurred in the order described other signs are generally present which render the diagnosis certain. Fever nearly invariably appears later than the three symptoms first mentioned. If hyperpyrexia occurs first, typhoid fever may be suspected, or pneumonia; if vomiting occurs first, acute indigestion or scarlet fever may be the cause; while where tenderness precedes the other symptoms for some hours or days, pelvic disease, or chronic intestinal ulceration are to be considered. These points have recently received special study by Murphy, and to his masterly exposition of the subject too much credit cannot be given.

Not only is the above sequence of symptoms nearly universal, but each of the symptoms mentioned is different in appendicitis from what it is in other diseases. Thus the general abdominal **pain** which is usually the first symptom, soon settles

to the right iliac fossa, which fact should at once lead to the supposition of more serious trouble than simple indigestion. Although the pain is usually localized to the right iliac fossa it is not always so. It varies with the position of the appendix. But the important point is that it is first, almost universally, general, and then becomes localized; it does not disappear. As already noted in the symptomatology, where the appendix points north the pain may be referred to the lumbar or hepatic region. In certain cases it is referred exclusively to the left side; in such cases the appendix usually points south and occupies the pelvis, but it may point east. The downward and pelvic positions causing pain in the left side must be emphasized, as I have seen a number of cases in which the attending physicians, who were familiar with the general symptoms of appendicitis, were totally misled by the reference of the pain to the left side. The citation of one case, that of the son of a physician, will serve to illustrate the importance of pain referred to the left side as indicative of the pelvic position of the appendix.

Master A., shortly after a meal of indigestible food, was suddenly seized with acute abdominal pain, vomiting and rigidity of the right lower abdominal wall. Symptoms of acute peritonitis developed on the third day, whereupon the father consulted me, stating that he would have regarded the case as one of appendicitis had the pain not been referred to the left side. I told him that in my opinion the disease was appendicitis, and that immediate operation was demanded. Two days later, I was hastily summoned to see the boy, whom I found suffering from a diffuse peritonitis of an active type. He had a pulse-rate of 130 a minute, a "leaky" skin, was constantly retching, and had obstinate constipation. I declined to interfere except to advise discontinuance of opium and all its preparations. Instead, I ordered small repeated doses of calomel to the extent of securing free purgation, believing such medication wiser than operation, at that time. Apparent recovery followed. I then advised operation to prevent recurrence, but the father declined to have his son operated upon when in apparent good health. Within ten days a second attack occurred. I was again summoned, but, being absent from home, other counsel was sought, and operation again deferred. Apparent recovery again ensued. Again I was consulted and again advised

operation, to which objection was no longer made. At operation the appendix, the tip of which contained a collection of pus, and the whole of which was surrounded by a circumscribed abscess, was found occupying the pelvis, adherent to its floor and to the right side of the rectum. The appendix was removed and an uneventful recovery followed.

It is in this class of cases where the appendix is in the pelvis, and the pain is referred to the right side, that rectal and vesical symptoms may be complained of. Hence the presence of tenesmus, or of vesical irritability, frequent urination, or retention of urine, occurring in cases where other symptoms indicate appendicitis, should make us suspect a pelvic position of the appendix.

The pain of appendicitis is further characterized by its tendency to subside gradually in the course of four or five hours. If the pain subsides suddenly at any period of the disease, it is usually an indication of gangrene or perforation and operation should be undertaken without delay. When the pain has subsided in the normal manner, that is, gradually, it may not recur in a few cases. In these the appendicular colic has probably been terminated by the lumen of the appendix freeing itself of obstruction. But in the great majority of cases the pain recurs at intervals of a few hours, and with gradually increasing intensity, becoming finally, after twenty-four to thirty-six hours, nearly constant, and being of an inflammatory, not only of a colicky nature.

The **vomiting**, which is nearly always the second symptom, is a reflex act, and is usually not repeated, unless the stomach is full, and has not been emptied at the first effort. When nausea and vomiting recur at a later period, they are an evidence of progressing peri-appendicular inflammation, and, like the secondary pain, are of bad prognostic import. The first reflex vomiting is also seen, as remarked by Murphy, where other hollow organs attempt to free themselves of impacted calculi, as in the case of gall-stones and nephritic colic, or where a vesical calculus becomes impacted in the neck of the bladder; while the secondary vomit-

ing is comparable to that produced by perforation of the stomach, intestine or Fallopian tube.

The **tenderness** of appendicitis is of much the same general character as the pain. It is at first diffuse, and later becomes localized to the right iliac fossa, and the point of greatest tenderness, usually McBurney's point, generally corresponds with the position of the inflamed appendix. This localized tenderness is one of the most constant and valuable signs of appendicitis. Both superficial and deep tenderness are present at this stage. The superficial tenderness is due to reflex irritation of the cutaneous nerves, as explained in the section on Anatomy; and is best elicited by gently stroking or pinching the skin, beginning in unaffected areas, and gradually outlining the area of cutaneous hyperæsthesia. This superficial tenderness is generally present from the first, but the deep tenderness does not develop until the stage of appendicular colic is passed. As a rule the superficial sensitiveness is confined to the right iliac region in the shape of a triangle, extending nearly to the median line in front, almost to Poupart's ligament below, and having its apex above the anterior superior iliac spine in the anterior axillary line; it may, on the other hand extend back to the spine in the form of a band, or be confined to a small circular area at McBurney's point. I do not think it is so important as some authors would have us believe, nor of nearly such diagnostic value as the deep tenderness due to the inflamed appendix.

In some cases of suspected appendicitis palpation of the abdominal wall will reveal only moderate tenderness; the point of most marked tenderness being detected by vaginal or rectal examination. In acute cases it is usually not at all difficult to elicit tenderness. When asked to locate the point of greatest tenderness, the patient will himself almost invariably direct attention to the site of the appendix. Palpation over this region besides detecting marked tenderness, may provoke wave-like exacerbations of pain. In chronic cases it is more difficult to

locate tenderness, but deep pressure is nearly always successful, and may reveal a thickened organ. Assistance may be had by comparing the conditions upon the opposite side of the body.

There is usually a close relationship between the degree of tenderness and the progress of the disease. As a rule, increase of tenderness denotes progression of the inflammatory lesions, while decrease of tenderness occurring without the administration of anodynes generally indicates subsidence of the inflammation. Unlike pain, tenderness as a rule does not disappear at the onset of gangrene or perforation of the appendix, but usually becomes more marked. If pus is present the pain is usually exquisite, especially if the pus is under tension. Palpation after the first twenty-four hours of an acute attack should be extremely cautious and gentle, as a small abscess not easily detected may be unwittingly ruptured with disastrous consequences. Where the abscess is larger, it is both more evident, and the tenderness is less, as septic absorption may have progressed to such an extent that paralysis of the nerve filaments has occurred. Under such circumstances, however, the other signs of appendicitis are unequivocal. Tenderness is marked in any peri-appendicular suppurative peritonitis, whether it owe its origin to ulceration, with or without perforation, to gangrene, or other cause. In general peritonitis the tenderness is widespread.

The **rigidity** of appendicitis is also a reflex phenomenon, due to the stimulation of motor nerve filaments, as explained in the section on Anatomy. It is a rigidity that is not produced by palpation, but which exists before palpation is attempted; and is hence evident upon very gentle pressure. In the majority of cases it is confined to the right side, and most frequently to the lower half of the rectus muscle of that side. It is well known that the gall-bladder when distended is similarly protected by its overlying muscles, and inflamed joints are held rigid by their enveloping muscles, for the same reason, as long ago pointed out by Hilton. When the pain and tenderness are on the left

side, the rigidity is more pronounced on that side. If the diseased appendix and a consequent appendicular abscess occupy the pelvis, the abdominal rigidity will be bilateral, as is illustrated by the following case:

Miss —, about two weeks prior to my first visit, was suddenly attacked by what at first seemed to be acute indigestion. It did not yield to ordinary medication. In view of the fact that the spleen was enlarged, that spots were present upon the abdomen, and because the temperature was irregular, a provisional diagnosis of typhoid fever had been made. On the other hand, the suddenness of the onset of the affection, the acute abdominal pain, the decided bilateral rigidity of the lower abdominal wall, the irregular temperature, the great pain produced by rectal and vaginal examination, and the characteristic fullness of the pelvis rather indicated appendicitis with a large collection of pus in the pelvis. I advised immediate operation, but adverse opinion of other counsel caused postponement for two days. Operation disclosed a large collection of malodorous pus, and the appendix, which was perforated, occupying the pelvis. The abscess was evacuated, the appendix removed, and an uneventful recovery ensued.

This muscular contraction is at times confined to certain fibres of the flat muscles of the abdomen, for reasons discussed in the section on Anatomy. Where this is the case a hasty examination may lead the surgeon into the error of thinking that the diseased appendix is superficial, and that he feels it just beneath his fingers; on opening the abdomen he will then be surprised to find it several inches distant from the anterior abdominal wall, perhaps even posterior to the cæcum. In palpating for a chronically inflamed appendix other structures may also be mistaken for it; among these are the outer border of the rectus muscle, the semilunar aponeurosis, the inner border of the internal oblique and transversalis muscle, and the anterior crural nerve coursing along the outer border of the psoas muscle.

Elevation of temperature is present in the early stages of acute appendicitis with remarkable uniformity. Murphy says he would not operate upon a case where he was convinced that there had been no fever at any time. But the fever is neither the first

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symptom nor is it marked. Frequently it never is as high as 100° F. It rarely appears for several hours after the onset of the attack. Its sudden disappearance is significant of gangrene or perforation. Its persistence and increase is usually caused by peritoneal involvement without perforation. As pointed out by Murphy, elevation of temperature is indicative of septic absorption; when gangrene occurs or when an abscess ruptures, absorption is temporarily stopped, in the first instance by destruction of the absorbing surface, in the second instance by decrease of tension. A secondary elevation of the temperature indicates involvement of a new tissue.

A careful consideration of the nature and cause of the **local distention** is sometimes demanded. This fullness, as has already been stated, may be due to peri-appendicular peritonitis and to inflammatory lesions—serous and cellular infiltration—of the abdominal wall. In certain cases the œdema of the abdominal wall, associated with symptoms of another disease, may lead to the false impression that the affection is not appendicitis, as is illustrated by the following instance:

Miss H. became ill ten days prior to my examination. She had presented the usual manifestations of acute appendicitis, but owing to slight jaundice and decided œdema of the tissues overlying the hepatic region and the lower right chest, there was some doubt in the mind of the attending physician as to the location of the inflammatory process. Upon pressure there was more pain over the œdematous area than over the usual site of the appendix. From a review of the symptoms of the patient from the onset of the attack, however, I concluded that the case was one of suppurative appendicitis, and that the organ pointed north and was located behind the cæcum. Operation confirmed the correctness of these views. The appendix, gangrenous and separated from the cæcum, was post-cæcal, and surrounded by a collection of pus which extended behind the liver and inward to the vertebral column. Recovery ensued.

While the local swelling is frequently due to an abscess, cases are seen where tympanitic distention of the cæcum or intestines causes the whole right iliac fossa to bulge, and where an abscess

is absent or very small. A palpable tumor is often formed by a mass of infiltrated omentum, coiled around the inflamed appendix; and, as previously mentioned, the band-like contraction of some fibres of the rectus muscle may be mistaken for the appendix.

Peri-appendicular suppuration is thus to be suspected if, after the initial symptoms of appendicitis have been observed, the pain, temperature, but especially the tenderness persist, and when a palpable tumor is present. Gangrene without suppuration or perforation is indicated by sudden cessation of the pain previously localized in the region of the appendix, fall of temperature, increased pulse-rate, anxious facial expression, and more or less relaxation of the skin, perhaps by perspiration. Rigidity often disappears when gangrene occurs, but usually persists when perforative peritonitis develops.

Leukocytosis is of value only as a confirmative symptom. If the patient reacts well to the infection, the white blood count will be high. If on the other hand the system is overwhelmed by the infection the number of leukocytes may not be increased from the normal.

Serum Diagnosis. Acting upon the assumption that the bacterium *coli commune* is the predominant factor in the bacterial origin of most cases of appendicitis, and that the general symptoms of the disease are, at least in great part, due to the toxine of this bacterium, some investigations bearing upon the applicability of the Widal test with this bacterium were undertaken in the Pathological Institute of the German Hospital. It was hoped that this test might prove of some value in the diagnosis of the disease, more particularly in obscure cases, or that it might furnish a clue to the identity of the causative bacteria or to the severity of the infection in individual cases. No definite results, however, were obtained.

SUMMARY.

In the diagnosis the three cardinal symptoms are most important:

1. Sudden acute abdominal pain in one previously well.
2. Unilateral rigidity of the lower abdominal wall.
3. Tenderness over the site of the appendix.

The order of the symptoms—(1) pain; (2) vomiting; (3) tenderness—is very characteristic.

The clinical course of each symptom is characteristic. The pain is first diffuse, and later settles in the right iliac fossa. The vomiting is usually not repeated. The tenderness is general at first, but is soon localized to the region of the appendix. Rectal and vaginal examinations are always valuable, but should never be neglected when abdominal tenderness is not marked or when confusion with tubo-ovarian disease is possible. The fever does not usually appear until after the lapse of some hours; next to never is it the first symptom. It is rarely high at first.

Tenderness is increased in:

1. Pus formation.
2. Gangrene of the appendix.
3. Perforation of the appendix.

Tenderness is decreased:

1. After free evacuation of the bowels.
2. Late in suppurative cases when sufficient toxins have been absorbed to paralyze the peripheral nerve filaments.
3. Upon the subsidence of the disease.

Abrupt cessation of pain may indicate gangrene of the appendix.

Pain and tenderness on the left side indicate that the appendix points south (rarely east) and occupies the pelvis. In these cases vesical symptoms are common.

Pain on the left side with tenderness over the pubes indicates that the appendix points south and that the tip of the organ alone is involved, or that it is the seat of the most intense inflammation.

Pain on the left side with bilateral rigidity indicates that the appendix points south, and that a collection of pus surrounds it, and that a pelvic collection probably exists. Vaginal and rectal examinations are of particular value when the pain is on the left side.

Pain over the hepatic or the right renal region, with tenderness over the course of the ascending colon, indicates that the appendix is either post-colic, or post-colic and post-cæcal, and that it points north.

Fullness appears late—after the development of an inflammatory mass or the occurrence of suppurative peritonitis.

Excessive tenderness is the most reliable sign of pus. A leukocytosis of twenty thousand is confirmatory.

Distention:

1. Localized—is due to localized peritonitis.
2. General—is due to:
 - (a) Constipation.
 - (b) Administration of opium.
 - (c) Intestinal paralysis, the result of sepsis.
 - (d) Mechanical intestinal obstruction.
 - (e) General peritonitis.

A chill denoting pus formation is rare.

A tumor often cannot be detected on account of the tenderness and rigidity. When adhesions and infiltration are present, a tumor is usually palpable. Rectal examination is often successful in determining the presence of a tumor or fullness when abdominal palpation is entirely negative.

An abscess may give a tympanitic note on light percussion due to overlying bowel as well as to gas contained within the abscess (gas bacillus).

The occurrence of a chill or chills early in the disease may be indicative, particularly when followed by high temperature, of gangrene; also may be due to nervousness. Chills late in the disease when followed by sweating are indicative of pus, or of the development of pylephlebitis and hepatic abscess.

DIFFERENTIAL DIAGNOSIS.

While in the majority of cases the recognition of appendicitis is not especially difficult, there are, nevertheless, some affections that in many respects so closely simulate it as to give rise to perplexities in the endeavour to discriminate between them. Of these the most important are various disorders of the gastrointestinal tract, particularly typhoid fever and other morbid conditions attended by ulceration and possible perforation of the bowel; disturbances of the gall-bladder; and, especially in the female, disease of the genito-urinary organs. There are, in addition, other rarer conditions which engender difficulties in the effort to establish a differential diagnosis, and which, in consequence, demand consideration.

ACUTE INDIGESTION.

An attack of acute indigestion resembles an attack of acute appendicitis in that in both there is a history of the ingestion of indigestible food, pain in the epigastrium and umbilical regions, nausea, vomiting and sometimes fever. Such is the resemblance between these two affections that many cases of acute appendicitis have been given, and are still given, slight attention, under the misapprehension that they are cases of acute indigestion. The latter condition, however, in contradistinction to acute appendicitis, never gives rise to rigidity of the right lower quadrant of the abdominal wall, to tenderness on pressure in the right iliac fossa, nor does the pain become localized in the region of the appendix.

A very common cause for the confounding of these two affections is the unwise administration of an opiate for the relief of pain. In the case of an adult suffering from acute abdominal pain the drug most commonly administered is, I regret to state, morphine hypodermically. Morphine undoubtedly arrests the pain, but in doing so it also obscures symptoms which otherwise would serve as danger-signals. As a result of this injudicious course the physician is too often mortified to discover that the case which he originally regarded as one of simple indigestion was in reality one of acute appendicitis. I have no hesitation in stating that many human lives are being daily sacrificed to the pernicious practice of administering morphine in cases of acute abdominal affections, and in mistaking cases of appendicitis for acute indigestion, biliousness, gastritis, or inflammation of the bowel.

In many cases of children attacked by acute abdominal pain and vomiting the household remedy administered, or that obtained by messenger from the nearby druggist, is commonly some cholera or diarrhoea mixture, or some secret nostrum, the chief ingredient of which is probably some preparation of opium. This is quite as pernicious as a hypodermic injection of morphine. It serves well to lessen the chances of establishing a diagnosis early between acute indigestion and acute appendicitis.

BILIOUSNESS, OR ACUTE GASTRO-DUODENAL CATARRH.

Biliousness, or acute gastro-duodenal catarrh, is usually manifested by pain in the epigastrium, nausea, vomiting of food, which later may be mixed with bile, moderate fever, and constipation. At times there may be a slight icteric tint to the skin and conjunctivæ. All patients who complain of "bilious attacks," acute indigestion, or cramp-like pains in the abdomen should be examined for appendicitis. Acute gastro-duodenal catarrh is differentiated from acute appendicitis by the fact that in the former

the pain does not become localized in the right iliac fossa, and that if rigidity of the abdomen occurs it is bilateral and most pronounced in the upper abdomen above the umbilicus. In appendicitis the rigidity in the beginning is confined to the right lower quadrant. Tenderness is greatest where the rigidity is most pronounced. The two conditions may be further differentiated by the fact that the symptoms of acute indigestion and gastro-duodenal catarrh are not progressive if treated rationally, while those of acute appendicitis are.

INTESTINAL COLIC.

The fact that an attack of acute appendicitis is ushered in by abdominal colic may in some instances lead to the physician's confounding the case with one of ordinary intestinal colic or enteralgia. At the onset the affections much resemble each other, but the colic in appendicitis grows more intense with each succeeding return of the pain, and the attacks are wave-like in character. In either affection, the patient usually assumes the recumbent posture and flexes the thighs upon the abdomen. He complains of nausea, and may have vomited. In appendicitis there are present the three cardinal symptoms—pain, tenderness, and rigidity; in ordinary enteralgia there is colicky pain, but no tenderness. On the contrary, the pain is relieved by pressure over the umbilical region—to which the pain is referred. In exceptional cases of appendicitis the pain may be persistently referred to the umbilical region. These are cases in which the appendix holds an easterly direction. Under such circumstances pressure in the umbilical region—that is, over the diseased appendix—increases the pain, reveals tenderness, and may aggravate the nausea. Other unusual positions that the appendix may assume should be borne in mind, and diligent search should be made for points of tenderness in the endeavour to establish the correct diagnosis.

The duration of an attack of intestinal colic depends upon the provoking cause, and often subsides under any rational treatment. An attack of acute appendicitis, on the other hand, usually progresses rapidly, and grave symptoms may manifest themselves early.

ACUTE ENTERITIS.

Besides the various intestinal disorders already considered, a few words must be devoted to acute enteritis, catarrhal enteritis, or "diarrhœa." Although much more frequent in children it occurs often enough in adults and presents certain symptoms closely enough simulating those of appendicitis, to warrant special attention in this connection from the family physician. The causes of the two diseases in a large number of cases are the same, and it may be only by a careful physical examination that a distinction can be made. Given the history of the ingestion of food, either abnormal in quantity or quality, with the subsequent developement of abdominal discomfort, flatulency, eructations and borborygmi, followed by a simple or mucous diarrhœa, the diagnosis of acute enteritis is fairly certain. But the diagnosis once being made it is not sufficient to dismiss the patient with an opiate or emollient prescription: in a certain number of such cases the catarrh of the intestine may spread to the interior of the appendix, and an attack of acute appendicitis supervene.

Hence it is that physical examination, to exclude any local rigidity or tenderness, is so important; and such an investigation should be frequently repeated so long as the acute symptoms continue.

In infants or very young children examination of the abdomen is frequently unsatisfactory, from the impossibility of overcoming the voluntary spasm of the abdominal muscles; so that in these patients on the third or fourth day of such an attack, the attendant

may be alarmed to discover evidences of suppuration, or at least of cellular infiltration in the neighbourhood of the appendix. But cases such as these are rare, both because appendicitis itself is rare in the very young, and because physicians who make a practice of palpating the abdomen in every case of abdominal disorder, will rarely fail from the outset to distinguish appendicitis from less serious diseases.

Besides the history of the case, the initial clinical manifestations, and the physical signs, the courses of the two diseases are not the same. In appendicitis diarrhoea if ever present only exceptionally persists, obstinate constipation being a much more frequent symptom; the pain, instead of being shifting and uncertain, becomes fixed and constant, and instead of its being relieved by pressure, by the patient "doubling himself up" and compressing the abdomen with his hands, the tenderness becomes excessive, and even the pressure of the bed-clothes upon the abdomen may be insupportable.

Finally, the symptoms of enteritis almost invariably subside quickly as soon as the intestinal tract is emptied of its irritating contents; while if true appendicitis is present, inflammation continues in spite of a purge.

INTESTINAL OBSTRUCTION.

In intestinal obstruction the onset is more abrupt than in appendicitis. The pain, remittent in character and of a severe type, may be referred to the site of the obstruction, or more commonly to the umbilicus; in appendicitis the pain is not so severe, it is at first referred to the umbilicus, and later to the position of the appendix. In intestinal obstruction there are absolute constipation and inability to pass flatus; persistent and uncontrollable vomiting occurs early and soon becomes faecal. In appendicitis constipation is not absolute, diarrhoea may be present, and the vomiting ceases after the stomach is emptied.

In intestinal obstruction the temperature and pulse are normal or subnormal until the advent of peritonitis. In appendicitis the temperature is above normal. With the onset of peritonitis in intestinal obstruction regurgitant vomiting begins. This soon becomes faecal—a condition which rarely occurs in appendicitis except in the latter stages. Intussusception is the most common form of obstruction in children, while obstruction from bands and volvulus is more common in adult life. Tumors the result of such forms of obstruction are generally to the left of the linea alba. When obstruction is the result of intussusception, blood and mucus will be discharged from the rectum, and upon examination through this canal a tumor may be felt. The development of peritonitis in acute intestinal obstruction is marked by great abdominal distention. Shock and collapse appear early in obstruction. Such is not the case in appendicitis unless the attack be of the fulminating type, and even then collapse appears later.

INFLAMMATION OF MECKEL'S DIVERTICULUM.

Several cases of inflammation of Meckel's diverticulum, with resulting gangrene of the intestine simulating an attack of appendicitis, have been reported, but the condition is not possible of recognition clinically.

TYPHOID FEVER.

Differentiation between typhoid fever and appendicitis is a not infrequent source of diagnostic perplexity; so much so, indeed, that upon more than one occasion I have seen the surgeon forced to defer operation in appendicitis because the opinion of the majority of the medical attendants was that the disease was typhoid fever. Yet in the early stages of the two affections the characteristic symptoms are distinct. In appendicitis the sudden onset of pain in a person previously well, with vomiting

Appendicitis.

or at least nausea, the rigidity of the right lower abdominal wall, and the tenderness limited to the position of the appendix, are collectively almost pathognomonic. On the contrary, the usually slow onset, attended by headache, lassitude, epistaxis, the characteristic tongue and temperature record, diffuse abdominal tenderness, with relaxation of the abdominal walls, with possible gurgling upon pressure over the cæcum and an enlarged spleen, are distinctive of typhoid fever, and should be sufficient to establish a differential diagnosis with nearly absolute certainty. Digital examination of the rectum in appendicitis will by demonstrating a sensitive mass at once dispel any doubt. Spots may be found in either affection, but only when a typical roseolar rash is present should much reliance be placed on them. It is unusual, moreover, for a blood examination in typhoid fever to show even the normal number of leukocytes, while if the disease has already existed for some days the Widal test may aid the diagnosis. Although typhoid fever cannot be excluded if the test be negative, it is fairly safe to assume this to be the disease when the test is positive. It must not be lost sight of, however, that in patients who have had typhoid fever the Widal test may be positive, yet the present attack not be a second attack of typhoid.

Follicular abscesses of the appendix are responsible for some mistakes in the differential diagnosis between appendicitis and typhoid fever. The minuteness of the collections accounts for the mildness and the prolongation of the sepsis and for the lessened degree of the local symptoms. In this type of appendicitis there are persistent elaboration and continuous absorption of infectious products, with a small amount of tissue involved. In many respects the temperature record and the general condition in such cases closely simulate irregular typhoid, and much care in examination is essential. It is not uncommon to find supposed typhoid fever cases in which operation has demonstrated the presence in the appendix of very small follicular abscesses varying in size from a millet seed to a mustard-seed, an eroded mucous membrane, and a more or less infiltrated organ.

The points to be borne in mind in making a differential diagnosis between appendicitis and the later stages of typhoid fever are of sufficient distinctness, but each symptom must be conscientiously studied. The early history and the entirely local symptoms, with dry tongue, and the temperature record, are quite sufficient to make differentiation clear and distinct. The spleen may be enlarged in both affections. The enlargement, however, due to septic infection from an active suppurative process such as appendicitis is likely to be associated with pain, the result of peri-splenitis. Difficulty, however, exists, and the following case is related to illustrate the fact that follicular abscesses in the appendix are capable of causing a train of symptoms which suggest typhoid fever:

Dr. M. consulted me about his little girl, the nature of whose illness was not clear to him. He related to me the history of the case and showed me the temperature record. I suggested that the symptoms resembled those of subacute appendicitis. An appointment was made with a physician, one of my assistants, and Dr. Frese, of the German Hospital. In consultation the following conditions were noted: There had been slight epistaxis about seven days previous to the date of examination; the temperature record was irregular, dropping suddenly on the fifth day from 103° F. to normal; the tongue was dry and coated, with red borders, and while headache was present the mental condition was quite clear. The spleen was somewhat enlarged and on the abdomen, which was slightly tympanitic, were noticed some indistinct rose-coloured spots. Only very careful questioning of the mother elicited the fact that the child had for several months been ailing with digestive troubles, which, never severe, had always yielded to a purgative dose of castor oil. Examination of the right iliac fossa demonstrated distinct tenderness and gurgling. No mass could be detected. One of the consulting physicians inclined to the diagnosis of typhoid fever and advised delay. The two other consultants diagnosed appendicitis, basing their conclusion on the previous history, the absence of mental symptoms, and the distinct tenderness in the right iliac fossa. On the following day I saw the patient and received permission to operate if I concurred in the diagnosis of appendicitis. This I did, and operated at once. The following conditions were found: The appendix was situated behind the colon, to which it was adherent; the mucous membrane lining the tip of the appendix,

which was club-shaped, contained several follicular abscesses, the largest of which was the size of a split pea. Recovery was uninterrupted and rapid. The symptoms which had suggested typhoid fever disappeared immediately after the removal of the appendix.

Occasionally the error of mistaking a suppurative appendicitis for typhoid is made.

A condition that must be borne in mind in the differentiation of acute appendicitis from peritonitis the result of perforation other than that of the appendix itself is **perforating typhoid ulcer**. The history of typhoid fever, with the characteristic prodromal stage, the nervous manifestations, the enlarged spleen, the characteristic temperature, the presence of spots, and the sudden onset of acute general abdominal pain with general abdominal rigidity, would suggest perforating typhoid ulcer.

Where the perforation of the bowel occurs in ambulatory cases the onset is as sudden as in appendicitis; but in this latter condition, even if the appendix be perforated, there is not such marked collapse as occurs from perforation of the small or the large intestine; and there is not a fall of temperature, which frequently accompanies intestinal perforation in typhoid fever. As a similar operation is indicated in either case, the differential diagnosis is not of ultimate importance.

A case in point is the following:

Dr. F., aged twenty-seven years, was admitted to the German Hospital on November 7, 1897. The diagnosis was enteric fever; perforative ulcer; free pus in the peritoneal cavity.

The family history was good, there being no history of tuberculosis or carcinoma. The patient had had la grippe six years ago, and typhoid fever ten years ago. Ten days before the patient was brought to the hospital he complained of malaise and loss of appetite. He would arise in the morning tired, and in the afternoon would feel worn out. He lived on milk and bread during this time. He complained of headache one week previous to admission. Bowels were rather constipated. He took aloin, belladonna and strychnine pills almost every night. Two nights previous to admission his temperature was 102° F. (Only time that temperature was taken by him.)

The night previous to admission to the hospital the patient partook of a meal consisting of sirloin steak, celery, bread and butter, coffee, a pear and a peach. After eating dinner he went to his office, where a number of patients were waiting. He saw only one, when he was suddenly taken with severe abdominal pain, necessitating his going to bed. For this pain he took sulphate of magnesia, applied hot-water bottles to the abdomen, and drank freely of warm fluids. The pain in the abdomen was severe, requiring morphine. The following morning the entire abdomen was distended, very rigid, and exquisitely tender, especially over the lower right quadrant. I was called by Dr. Eckman in consultation, and after the examination we were convinced that there was a serious intra-abdominal lesion, most probably slow leakage from a perforated typhoid ulcer, as indicated by the history and condition. We were, however, by no means certain that it was not a perforated appendix. I advised operation, emphasizing the fact that delay would be dangerous. Operation revealed a considerable quantity of pus and free gas in the peritoneal cavity. The appendix was intensely congested, and was removed. No attempt was made to locate the perforation, on account of the difficulty experienced in dealing with the intestines, which were greatly distended, so that, notwithstanding the small incision and the use of gauze packing, etc., it was almost impossible to confine them to the peritoneal cavity. I therefore contented myself with thorough irrigation and drainage. The patient went through an attack of typhoid fever of a typical course and of the most severe type, being complicated by several hæmorrhages. He was transferred to my medical colleague, Dr. J. C. Wilson, and eventually recovered. Microscopical examination of the excised appendix revealed ulceration of the mucous membrane lining the appendix.

CHRONIC GASTRIC ULCER.

Appendicitis and gastric ulcer may occasionally be confounded, especially when both have been chronic. The points in common are the occurrence of vague pain, increased by pressure, gastrointestinal disturbances, and an impairment of the general health. In differentiating, a number of points present themselves in favour of the gastric ulcer. The patient is most often a young woman, rather chlorotic, the onset is usually of slow development, and the pain bears a fairly constant relation to the ingestion of food, occurring shortly after it has been taken. The pain and tenderness

in ulcer is more definitely localized in the upper abdominal region, and in typical cases the relief of the nausea and pain by vomiting, the character of the vomited material, frequently streaked with blood, and the occurrence of gastric hæmorrhage are symptoms sufficiently striking to distinguish it from appendicitis. In those cases that do not bleed the diagnosis may at times be more difficult, but strict attention to the clinical course of the disease, and to the localizing symptoms will usually render a correct diagnosis possible.

PERFORATION OF GASTRO-INTESTINAL ULCERS.

The points to be observed in a differential diagnosis between appendicitis and perforated ulcers of the gastro-intestinal tract—including gastric, duodenal, cæcal and colonic, and perforating typhoid ulcer—are the following: The greatest liability to perforation in **gastric ulcer**, according to Barling, is in young women between the ages of seventeen and twenty-five years. There is also a certain liability, though not so great, in males; in adults it occurs chiefly between the ages of forty and fifty. As a rule, a patient with perforated gastric ulcer will have suffered for some time previously from symptoms referable to the stomach. This, however, is not always true, as perforation has occurred in cases in which there has never been a history of indigestion. Savariaud gives the proportion of latent ulcers as 20 per cent. of all cases of gastric ulcer. Perforation of the stomach nearly always occurs in the presence of a full or partly filled stomach, with the patient in the vertical position. Further, a history of exertion in rapidly changing the position of the body, or of coughing or sneezing may be elicited. The perforation is usually attended by sudden acute pain in the epigastric region, followed by faintness or collapse. The pain is of a burning or scalding character, and is referred to the extreme upper abdomen. Recovery from the depression consequent upon the onset of pain

may be followed by bloody vomiting, although this is not universally true. Coincident with the foregoing symptoms there is pronounced rigidity, with a scaphoid abdomen.

Respiration and temperature are both influenced by the condition, the former being hurried and superficial and the latter subnormal. The pulse is rapid and small. The length of time intervening between the occurrence of perforation and a fatal termination will be determined by the size and position of the perforation. The escaped contents of the stomach may be confined between the stomach and diaphragm, the stomach and liver, and the stomach and transverse meso-colon. In such conditions the following peritonitis will be localized and confined to the upper abdomen. These are the more favourable positions for the stomach contents. In any of these situations a localized abscess may result. When the perforation communicates directly with the general peritoneal cavity, diffuse peritonitis rapidly supervenes. This latter is at first associated with general muscular rigidity, but is soon followed by tympanites and the usual signs of this affection. I submit the report of a case:

A. J., a female, aged twenty-nine years, was admitted to the German Hospital on January 4, 1897. The clinical diagnosis was chronic gastritis and ulcer of the stomach; the anatomical diagnosis ulcer of the stomach, perforative peritonitis with abscess.

It was difficult to get a history, as the patient could not speak English, but it was elicited that her parents were well; that two brothers and five sisters were healthy; that one sister suffered from the effects of a twin pregnancy; and that two brothers and two sisters died in infancy.

She had lived in Finland until August, 1895, when she came to this country. She worked very hard on a farm while in Finland, and was greatly exposed. She had plain and good food, but no alcoholic stimulants. Her health as a child was good, but she had been troubled with dyspepsia for the last fourteen years. She had been in a hospital in Sweden five years ago for similar trouble. Menstruation was established at fourteen years of age. She had had leukorrhœa. She complained fourteen years ago of distress in the abdomen after eating. This condition gradually increased in intensity, and was accompanied by frontal headache and flushes, with occasional

nausea and vomiting. Attacks would come on at frequent intervals, especially after eating sour articles. She was always constipated. On coming to this country she was in fair health, her weight then being 175 pounds. She worked hard up to time of admission.

On admission her temperature was normal; her complexion was sallow, with pink cheeks; her lips were pale, her pupils were equal and slightly dilated, and her conjunctivæ were pearly. She was fairly well nourished, but had lost fifty pounds, her present weight being 129 pounds. She sweated freely and frequently. There was no glandular enlargement, but there were persistent tenderness over the epigastric region and some vomiting, especially on taking solid food. There was no blood in the vomited matter. Palpitation of the heart on exertion was complained of.

On physical examination the chest was well formed; the respiratory murmur was clear; the heart, liver and spleen were normal. The stomach contents were acid in reaction and contained no free hydrochloric acid.

March 15, 1897.—Blood (about 15 cc.) was found in the stomach contents.

March 16th.—Blood was again noticed in the stomach contents.

April 5th.—An area of dullness, extending from the ninth to the twelfth rib in the post-axillary line on the left side, and forward to the anterior axillary line, was noted. There was great tenderness over this area. The patient was weak. A diagnosis was made of post-gastric abscess (subdiaphragmatic), which was believed to be the result of slow leakage from a perforated gastric ulcer.

April 7th.—General peritonitis supervened. Operation was considered unwarrantable. The patient died shortly afterward.

The necropsy report, so far as it referred to the abdomen, is as follows: The abdominal walls are of moderate thickness. The omental apron is present, carrying considerable fat and covering the entire intestinal coils. Coils of small bowel in many places are adherent to each other, and many show areas of deep congestion. The appendix is normal in size, very pale and slightly indurated at the tip. The colon is pale, but otherwise normal. The pyloric orifice of the stomach is decidedly thickened at a point on the greater curvature two inches above the orifice. There is an adhesion between the anterior surface of the stomach and the gastro-colic omentum, which fold continues adherent throughout the entire greater curvature and is drawn over the anterior surface of the stomach and anchored by adhesions to the diaphragm and the anterior superior border of the left lobe of the liver. This with the gastro-splenic fold, adherent as it is to the foregoing reflections and the fundus of the organ, forms a new anterior gastric wall which, when opened,

shows ordinary stomach contents and, at its inferior ventral border, an opening in the stomach wall proper about the size of a quarter-dollar. On each side, three-fourths of an inch distant, is an ulcerated area about the size of a silver dollar, with the mucous membrane perforated, deeply congested and hypertrophied, presenting conditions simulating malignant involvement.

The other organs present no marked abnormalities.

Yet, where a patient is seen for the first time with an abscess in the right iliac fossa, arising from gravitation of pus due to perforation of a gastric ulcer, the diagnosis is practically never made before operation; especially where no typical history of chronic gastric ulcer can be elicited. Cases such as these have been recorded by Kammerer and by Harte, who mentions the speed with which fermentative changes occur in the upper intestinal tract, and the consequent presence of gas in the peritoneal cavity, as a sign suggestive of the high location of the perforation. McCosh reports the case of a man in whom epigastric pain was followed by pain localized to the right iliac fossa; general peritonitis ensued; this was found to be due to a gangrenous gastritis, from strangulation of a polypus within the stomach.

In **perforated duodenal ulcer** the general symptoms are similar to those occasioned by perforated gastric ulcer; the history of the case being the greatest help in making a differential diagnosis. Where the ulcer has existed in the duodenum for some time there is usually the history of the appearance in an individual, most commonly men after middle age, apparently in perfect health, of a recurrent intestinal hæmorrhage, followed by anæmia. There may also be hæmorrhage from the stomach, coincident with, or preceding, or following, the intestinal hæmorrhage. Pain in duodenal ulcer occurs two or three hours after the ingestion of food, whereas in gastric ulcer the pain is immediate, unless the ulcer is at the pylorus. The pain may be referred to the back or the shoulder blade; frequently there is a tender spot to the right of the twelfth dorsal vertebra. Frequent attacks of hæmatemesis, associated with neuralgia of the

epigastrium, tenderness situated to the right of the middle line, and bloody stools, may be considered nearly pathognomonic of duodenal ulcer.

When perforation occurs into the free peritoneal cavity, the usual symptoms of intestinal perforation are present. If the perforation be above the transverse meso-colon the pus will gravitate to the right loin and iliac fossa, outside the ascending meso-colon. In such cases the localization of the pain and tenderness over the region of the appendix simulate very closely disease of the latter structure. If the perforation be below the transverse meso-colon general peritonitis will ensue. The most obscure cases of all, however, are those where a retro-peritoneal abscess arises from duodenal perforation: the physical signs may be very vague; but with the previous history of the patient before the surgeon, and with the presence of an obscure abdominal lesion, with evidence of sepsis, mild or profound; with chills, sweating, and progressive emaciation, even though nourishment be retained, and no intestinal obstruction arise, the diagnosis of abscess due to perforation of the duodenum is warranted.

Peptic ulcers of the jejunum are of such rare occurrence that their differentiation from appendicitis need hardly be considered. It is interesting to note that they occur most frequently following the operation of gastro-enterostomy.

The question of the existence of **perforating ulcer of the ascending colon** may arise in the differential diagnosis between appendicitis and the previous conditions. Ulceration of the colon is most likely to be associated with malignant disease, in which event there are present such symptoms as attacks of paroxysmal pain, followed by small bowel movements, containing more or less mucus, which may be mixed with blood; the presence of a mass; the history of slow onset, and cachexia. When obstruction exists, the distended coils of intestine may be made out during a paroxysm of pain by examination of the abdominal wall.

Mrs. R., aged sixty years, was admitted to the German Hospital June 21, 1897. The diagnosis was carcinoma of the cæcum; ileo-colostomy.

Her father died of kidney trouble; her mother in childbed. Five brothers and two sisters were alive. She had been married forty years and had had eight children. Menstruation was regular after marriage. The menopause occurred ten years ago. She had had bladder trouble for some time. A calculus had been removed from her bladder four years ago. In December, 1896, she had the first attack of her trouble. There developed severe lancinating pain in the right iliac fossa, recurring at short intervals; since then she has passed scarcely a day without pain, sometimes having severe exacerbations. She has frequent micturition, without tenesmus, and some ardor urinæ. She states that a small growth was removed from her urethra in May, 1897. There has been no hæmaturia. She has passed gravel at times, but not lately. There is considerable sacral ache. Her appetite is good and her bowels are regular. Her tongue is pale, but not coated. She has not lost flesh and there is no marked cachexia.

Examination revealed extreme tenderness in the right iliac fossa, and the right rectus muscle was very rigid, simulating a mass. There was tenderness also on deep pressure in the right vaginal vault. The uterus was small and atrophied; there was no discharge. Catheterization revealed no blood, mucus nor stone in the bladder. The urethra had evidently been dilated.

Operation.—An incision was made over the region of the appendix. A coil of ileum was found to be adherent to the cæcum. A hard mass being felt about the site of the appendix, the appendix was exposed and found to be completely separated from its cæcal attachment. By its removal with the exudate, a large perforation was found in the ileum, just above its junction with the cæcum. The lower end of the cæcum was involved in a carcinomatous growth. The growth was removed by careful dissection, cut away with the cæcum, and the bowel closed with continuous silk suture. The terminal four inches of the ileum were next removed, as its mesentery was infiltrated. The ileum was closed with silk sutures and another portion anastomosed with the transverse colon by means of a Murphy button. Recovery was uneventful.

Where no history of previous disease of the intestines can be elicited, acute perforation, the result of intestinal ulceration or rupture, may so closely resemble an attack of appendicitis that the differential diagnosis may be impossible.

Appendicitis.

Ordinarily in ulceration of the intestine there is present an area of diffuse pain, confined to that portion of the abdomen overlying the site of the affected bowel. There is also usually a trace of blood or slight intestinal hæmorrhage (hæmorrhoids, of course, being excluded), and pus may be found in the stools. There may be diarrhœa and mucous stools. These may, however, all be absent. The cardinal symptoms of appendicitis may be of value in forming a differential diagnosis between intestinal perforation and appendicitis, since in appendicitis these are usually well marked; they may also, however, be well marked in intestinal perforation or rupture. The lesions in both instances being similar, like symptoms are produced, particularly if the part affected is the terminal portion of the ileum, the cæcum or the ascending colon. The symptoms of intestinal perforation in one previously well are marked: namely, sudden acute abdominal pain, referable to the seat of the lesion, usually accompanied by shock, which in some instances is very profound. There is a leaky condition of the skin and an anxious expression of the face; the pulse is rapid and thready, the temperature subnormal. With reaction the acute abdominal pain increases, and, if the case be not recognized as an acute intestinal perforation, and cathartics be given, peritonitis of the infective type supervenes more rapidly than it would if no laxatives had been administered.

Contrast these symptoms with those of early appendicitis—the acute abdominal pain, the tenderness, the rigidity of the abdominal walls, nausea and sometimes vomiting. Ordinarily these symptoms occur after the ingestion of indigestible food, or after exposure in some manner. The mere fact that such conditions closely resemble each other, and that it would be impossible under certain circumstances to arrive at a differential diagnosis except by operation, merely emphasizes the propriety of operation in most cases of acute abdominal disease having the symptoms of pain, rigidity and tenderness occurring suddenly in one previously well. The following is a case in point which

I deem of sufficient value to relate, in order to show the inability to form a differential diagnosis at times between this condition and appendicitis.

M., aged twenty-eight years, a short time after eating a hearty meal was suddenly seized with acute abdominal pain. The pain was referred to the right hypochondrium at about the region occupied by the gall-bladder. The pain radiated from this point to the umbilicus; there was nausea and vomiting. He took some medicine to allay a sick stomach. The same evening a physician was called, who discovered the foregoing state of affairs. There was disturbance of the urinary secretion, the urine being highly coloured, scanty and bile-stained. A diagnosis of acute cholecystitis was made. The patient was given calomel in fractional doses, ice was applied to the abdomen, and milk with whiskey in small quantities was given at intervals of three hours. The following morning the area over the gall-bladder was not so sensitive on pressure, nor quite so rigid as the night previous. The patient presented an anxious appearance, the skin was bluish and leaky, and there was excessive thirst. On account of slight amelioration of the symptoms in the hypochondriac region and the patient's constitutional depression, surgical interference was postponed. The same evening the patient was advised to go to the hospital for operation on account of the symptoms not improving. He did not go, however, until the following morning. Upon consultation the diagnosis was made of acute appendicitis with general peritonitis. The patient's condition was such that operation was deferred until he should react. The usual treatment for appendicitis was instituted. From the first attack or seizure of pain the patient was obstinately constipated, and although castor oil, salts and calomel had been administered, it was impossible to obtain a bowel movement. An attempt was made at the hospital to secure catharsis, but this likewise failed. The patient died from general peritonitis.

The necropsy revealed the appendix and gall-bladder normal. There was a perforation of the ileum about one and a half to two inches from its junction with the cæcum. The abdomen contained fæces. The other organs were normal.

MALIGNANT DISEASE OF THE CÆCUM.

This should not be confounded with chronic appendicitis; its distinction from acute appendicitis is usually easy. **Carcinoma**

may be primary in the appendix, and when operation is undertaken before further development occurs, the diagnosis is made only by microscopical examination. In carcinoma of the cæcum there is usually a history of recurrent pain at the site of the disease, with alternating constipation and diarrhœa and perhaps occasionally blood in the stools, for some twelve or eighteen months before a tumor is palpable. There is, as a rule, absence of inflammatory symptoms; there may be history of traumatism; palpation reveals the presence of a nodular swelling of slow growth, and attended by progressive loss of flesh; there is absence of marked rigidity of the overlying abdominal wall, and of decided tenderness. Blood examination is of little value, except that it may show an anæmia. The age of those affected varies, carcinoma of the intestines being less rare in the young than any other form of the disease. The tumor in time becomes adherent, and intestinal obstruction may develop, preceded by an aggravation of all the earlier intestinal symptoms, such as paroxysmal pains, alternate diarrhœa and constipation, with mucus and blood in the stools. The peristaltic wave can be excited by manipulation of the growth, and can be seen through the thin abdominal walls.

The diminution in the amount of uræa excreted in the urine, which occurs in all cases of carcinoma, is a valuable point in the differential diagnosis.

The following clinical history of a patient in the service of Dr. Harry C. Deaver at the Episcopal Hospital is of value as showing the close resemblance to recurrent and relapsing appendicitis presented by certain cases of carcinoma of the cæcum:

The patient, a man of forty-one years, was first attacked, about three years ago, with spasmodic pain, rather dull in character, in the right iliac fossa. For a month or more at a time he would be free from all abdominal symptoms. He was habitually constipated, and soon noticed that he was especially costive before one of these attacks. The pain of these attacks lasted as a rule several hours, and was accompanied by nausea and vomiting.

His appetite had been failing for a long time, and he had been growing progressively weaker and more anæmic. He thought he had lost forty pounds in weight in the last three months.

Examination showed him to be anæmic and wasted in appearance. His skin had a slightly yellowish tinge. The chest presented no abnormalities. His abdomen was uniformly rigid on palpation, but an indistinct mass could be located on deep pressure over the right iliac fossa. Some tenderness was thus elicited. There was no dullness on percussion. The urine was negative. Examination of the blood showed that there were 15,000 leucocytes and that the hæmoglobin was 45 per cent.

On the fifth of September, 1904, the abdomen was opened over the appendix. This was found on examination to be apparently normal. A mass was felt, however, in the cæcum, which was accordingly delivered through the abdominal wound. The serous coat of the cæcum was smooth and unaffected, but there was a carcinoma involving the entire circumference of the cæcum and part of the ascending colon. The tumor extended almost six inches longitudinally. There appeared to be almost complete obstruction of the lumen of the bowel; and it became evident that the periodical attacks of pain, nausea and vomiting were due to the damming up of fæces on the proximal side of the stricture. The corresponding mesenteric glands were slightly enlarged. This fact, together with the somewhat wasted condition of the patient, made it seem wise to perform a palliative rather than a radical operation. Lateral anastomosis was accordingly done, with a Murphy button, between the lower ileum and the ascending colon; and the abdominal wound closed. The progress of the case after operation was uneventful. No vomiting occurred; gas was freely passed by the rectum; and the highest temperature recorded was 99.6° F. The button was passed by the rectum in due time. It is proposed to excise the growth and the involved glands so soon as a reasonable degree of strength shall have been recovered.

Sarcoma may also occur in the cæcum, and may closely resemble chronic appendicitis. The symptoms, however, approach more nearly those of carcinoma, as just described, though the development may be more rapid. Sarcoma of the ileum has also been mistaken for appendicitis (Brewer).

Tuberculosis of the cæcum may simulate appendicitis. The cardinal symptoms, however, are not the same; some other tuberculous lesion can often be found in the same patient—the history of the case, the family history, the tuberculin test, and the

Appendicitis.

early developement of ascites if the disease becomes generalized over the peritoneum—all these features aid in differentiating one from the other. Leukocytosis is absent in tuberculous disease. Some of the points noted in the paragraph on tuberculous peritonitis will also help the surgeon to reach a conclusion. From carcinoma of the cæcum tubercular disease can be distinguished by the less rapid enlargement of the lymph glands in the neighbourhood, and by the slight tendency to suppuration present in the former affection.

DYSENTERY AND COLITIS.

While dysentery may resemble some of those rarer and unfavourable cases of appendicitis in which diarrhoea with bloody stools and tenesmus is added to the three cardinal symptoms, yet differentiation can be established by local examination. In dysentery, though there is diffused abdominal pain, the localized tenderness is over the region of the colon, particularly the sigmoid flexure, and no mass is palpable. Digital examination of the rectum reveals the characteristic tenderness of proctitis. *Mucous colitis* may as a rule be readily distinguished from appendicitis by attention to the same points observed in connection with dysentery, by the absence of very acute onset, fever, mass, rigidity, or local tenderness, and by the presence of mucus in the stools.

ACUTE CHOLECYSTITIS.

Acute inflammation of the gall-bladder, with or without the presence of gall-stones, has frequently been a source of confusion and difficulty in diagnosing between these affections and appendicitis. Both are sudden in onset, infectious in origin, and are accompanied by pain, tenderness and rigidity, a varying leukocyte count and a tendency towards progression.

The great importance of a carefully elicited history is no-

where more apparent than in the differentiation between these affections. The sufferer from appendicitis is apt to have been constipated at the onset of the attack, to have had one or more attacks of pain referred to the right iliac fossa, to complain of a more diffused abdominal pain in the beginning and later to have a more perfect localization of the pain and tenderness to the right side and most frequently to the right iliac fossa. The gall-bladder patient may give the history of one or more previous attacks with slight transient jaundice; and the attacks more frequently follow indiscretions in eating and especially drinking than is the case in appendicitis, because a duodenal catarrh is a fertile cause for obstruction of the duct and the extension of infection. The pain has not the same tendency in the beginning to diffuseness as in appendicitis, and frequently, beginning in the epigastrium, the coeliac plexus being the source of nerve supply, rapidly becomes localized to the right hypochondrium and epigastrium, sometimes with radiation to the right shoulder region. In certain cases the catarrhal swelling of the mucous membrane of the cystic duct obstructs the gall-bladder and may cause distention of this organ, in which case, a rounded, tense, markedly tender tumor, moving with respiration, may be felt beneath the liver margin. In the presence of infection acute cholecystitis may progress to empyema, ulceration or gangrene.

CHOLELITHIASIS.

Acute calculous cholecystitis offers but few additional symptoms. While the gall-stones may have been forming for some time in the gall-bladder they frequently give rise to no symptoms whatever indicative of their presence, until a fresh infection or a relighting of the old and latent one attacks the biliary passages. Some mechanical action then drives a stone into the duct and, as in appendicitis, the onset is sudden with acute pain accompanied by persistent vomiting, which is more

severe and prolonged in biliary colic than in appendicitis. A chill is frequently one of the early symptoms. The previous history must be considered, and it may be observed that following some infection, such as enteric fever, attacks of biliary colic will have occurred probably at intervals of several years. These may have been accompanied by jaundice, and this, with characteristic colour and pruritus, may persist in a slight degree during the entire interval between the attacks. The finding of gall-stones in the stools settles the diagnosis. The location and degree of pain differ from that of appendicitis, being in biliary colic more continued and severe, and radiating usually from the lower right chest margin to the umbilicus. Although in the latter stages the pain may become constant, and involve the entire epigastric region, or extend even lower, it will, nevertheless, usually at intervals of two or three days, become localized and more acute in the region of the gall-bladder. In appendicitis the localization of pain is always toward, if not directly in the right iliac fossa, while between severe paroxysms there is marked tenderness at this point and characteristic rigidity of the overlying abdominal wall.

The co-existence of appendicitis and cholelithiasis in the same patient should be remembered, the infection easily extending from one to the other in those instances of nondescent of the cæcum.

The following case is illustrative:

Some two years since I operated upon Mrs. ———, who was the subject of acute appendicitis, when I found a gangrenous appendix lying north. The appendix being removed the fundus of the gall-bladder presented; it was distended, deeply injected with exudate surrounding it. While the gall-bladder was found in an inflammatory condition I did not disturb it. On the seventeenth day after the appendix operation, however, it broke down and discharged its contents, pus with bile and finally pure bile. The sinus closed in a comparatively short time, the patient recovered promptly and remains well.

EMPHYEMA OF THE GALL-BLADDER.

The points to be considered in making a differential diagnosis are the history, the onset, the location and character of the pain, the area and degree of muscular rigidity, and the character and position of the tenderness. The former paragraphs explain the early symptoms and it should be remembered that empyema is always due to infection of a gall-bladder preceding or following obstruction of the cystic duct.

One of the most important points in the differential diagnosis between empyema of the gall-bladder and appendicitis is that, if the patient be seen early in the affection, before adhesive inflammation occurs, the distended gall-bladder will be found to move with respiration and to present itself beneath the margin of the ribs as a fluctuating, rounded swelling. General constitutional disturbances are usually present, though often slight in degree. The temperature may or may not be increased, pain may be mild in character or quite severe and necessitating the recumbent position in order to avoid movements which increase the pain. In the more severe cases with absorption of toxic products, the rise in the temperature is marked from the onset of the disease, and when associated with chills and a leukocytosis is indicative of pus-formation. The patient, especially if the temperature be high, rapidly grows emaciated, and becomes weak, owing largely to the loss of appetite. Jaundice is not always associated with empyema of the gall-bladder, and is present only when there is catarrhal inflammation of the bile-ducts or an impacted stone in the common duct, or one in the cystic duct pressing upon and obstructing the common duct. On account of the localized peritonitis, tenderness is an almost invariable sign.

If the gall-bladder ruptures, the pus takes one of several directions. It may escape externally by ulcerating through the abdominal wall directly over the tumor; by following the course

of the suspensory ligament of the liver, and evacuating itself through the umbilicus; or, as has not unfrequently happened, by rupturing externally in the right iliac region over the cæcum or pubes. The contents of an empyema of the gall-bladder may be evacuated spontaneously into the duodenum or transverse colon; the pelvis of the kidney or the ureter; the stomach; or the inferior vena cava, or portal vein.

The differentiation between rupture of an empyema of the gall-bladder, with or without involvement of the ducts, and a ruptured appendicular abscess is extremely difficult, and in most cases the condition will be revealed only by operation. The points to be noted are the previous history and the fact that in cases of ruptured gall-bladder the rigidity is most marked in the upper portion of the right rectus muscle.

ACUTE PHLEGMONOUS CHOLECYSTITIS AND GANGRENE OF THE GALL-BLADDER.

The differential diagnosis between these affections and acute appendicitis may be extremely difficult, particularly when the former affections are not associated with or due to gall-stones. There may be vomiting in both, although in appendicitis it is not so persistent. In acute phlegmonous cholecystitis or in gangrene of the gall-bladder the symptoms follow in rapid succession. The pain is acute, is located high up on the right side, has a tendency to radiate towards the right scapular region, and later rapidly becomes general. The pulse is quick, of small volume; there is elevation of temperature, though this is not of much diagnostic value; rapid and shallow respiration, thoracic in character; and great depression, amounting almost to shock. The peritonitis, localized at first, soon becomes general, unless adhesions have formed to limit the escaping contents of the gall-bladder. Jaundice is not always present. In acute phlegmonous inflammation of the gall-bladder a fatal termination most fre-

quently follows shortly after the onset. In subacute varieties an abscess may be localized around the gall-bladder with adhesive peritonitis, thus simulating an appendicular abscess.

It must be recollected that in appendicitis the point of greatest tenderness is usually located at a spot along the outer border of the right rectus muscle, where it bisects a line drawn from the anterior spine of the ilium to the umbilicus. In acute phlegmonous cholecystitis, on the other hand, and in gall-bladder inflammation in general, the point of greatest tenderness is most frequently at the junction of the upper two thirds with the lower third of a line drawn from the end of the ninth rib to the umbilicus. Early in the disease the differentiation between the two affections calls for the greatest care.

HEPATIC AND PERI-HEPATIC ABSCESS.

Appendicitis can be confounded with abscess of the liver or abscess about the liver only when, late in the disease, a circumscribed collection of pus is in close relation with an appendix which holds a post-colic position and points toward the liver. The previous history, the hectic temperature of hepatic or peri-hepatic abscess, and the absence of a history characteristic of an acute appendicitis will be sufficient to establish the diagnosis of hepatic or peri-hepatic abscess.

RENAL IRRITATION BY APPENDICITIS.

Too much stress cannot be laid upon the importance of urinary examinations, not only in all kidney affections, but also in cases of appendicitis.

In most cases of appendicitis examination of the urine reveals slight abnormalities, such as traces of albumin, cylindroids, hyaline casts, renal and ureteral epithelium, leukocytes and, rarely, red blood corpuscles. In the affections in which the kidney and

Appendicitis.

its adnexa are involved early the urine will show characteristic peculiarities. The renal manifestations of appendicitis are no doubt toxic; in rare instances they may be, partly at least, the result of actual contact of the appendix with some part of the urinary tract. I have operated upon a patient whose urine contained pus and epithelium from the pelvis of the ureter. There was present a swelling in the right loin, and tenderness, which extended in the direction of the attachment of the appendix; and the history of the three cardinal symptoms of appendicitis was elicited. The right iliac fossa was opened. The appendix, which pointed north, was post-colic and contained pus. It was adherent to and in communication with, the pelvis of the ureter (kidney), through which the contents of the appendix were being emptied into the bladder, thus explaining the urinary symptoms. The recovery was uneventful. Bevan reports a case where sharp pain in the lower abdomen was followed by a microscopic amount of blood in the urine; a diagnosis of renal colic was made, but when, a few days later, an abscess formed around the appendix, this organ was removed and proved to be the true seat of the disease.

MOVABLE KIDNEY.

Floating kidney is indicated by the occasional presence of an abnormal depression in the right flank, by a movable tumor, characteristic in shape, which by properly directed pressure can be restored to its normal position. The best position of the patient in which to detect and replace a movable kidney is lying upon the side opposite to that of the organ supposed to be affected. The legs should be flexed upon the thighs, the thighs strongly flexed upon the abdomen, and the vertebræ flexed so as to bend the trunk as far forward as possible. The patient is now requested to take one or two deep inspirations, so that if the kidney be movable, displacement of the organ will be assured. In this position the kidney is readily detected and returned to its

normal position. If not thus detected trial may be made by examination of the patient standing, but stooping far forward, and resting the hands on the back of a low chair or bureau. Another way is to have the patient assume the horizontal position and inspiring deeply hold the breath. The loin below the chest is grasped with the hands and thumbs and the kidney is felt in the abnormal position when the patient slowly empties the lungs.

In arriving at a correct diagnosis between movable kidney and appendicitis, first in importance is the fact that movable kidney is most commonly seen in neurasthenic women who have gastro-intestinal disturbances. The attacks of pain in movable kidney are associated with nausea and vomiting, fever and often chills. In the majority of instances the urinary function is disturbed—as instanced by frequent desire to urinate, the act of which may be painful—and the urine is large in amount, pale, limpid and of low specific gravity, particularly if the patient be of a nervous disposition. The urine may contain blood, and, as I have seen in some attacks, pus; and sometimes be of high colour, usually due to the presence of an excess of uric acid or oxalates. The differentiation between the local disturbance during an attack of pain in a movable kidney which is dragging upon its pedicle and appendicitis is, to say the least, highly important. From the history can be learned the frequency of the attacks of pain, the nature of the pain, and the part of the abdomen to which it is referred; whether it is confined to one point or is migratory; whether or not it occurred after the ingestion of a heavy meal, after exposure to cold, or during the period of digestion, or after unusual movement or position or indirect violence. The degree of illness following must be ascertained, as well as the tendency of the patient to constipation or diarrhoea. During or following an acute exacerbation of pain due to movable kidney, occurring in either a nervous or a robust individual, local examination will show pronounced rigidity of

the overlying abdominal wall, with tenderness, the degree of which is in direct proportion to the muscular rigidity.

The important differential points between appendicitis and movable kidney are these: In appendicitis there is the sudden onset of acute abdominal pain, which most commonly follows the partaking of indigestible foods, and which, at first, is referred to the epigastrium or to the region of the umbilicus, and later becomes localized in the right iliac fossa. The presence of fever and an increased pulse rate are more indicative of appendicitis. In appendicitis, also, the rigidity of the lower portion of the right rectus muscle, and of the flat muscles of the abdominal wall immediately overlying the inflamed appendix, differs from the rigidity present in movable kidney, in that it does not involve so great an area. The most acute tender point, which corresponds to the position of the inflamed appendix is, at least early in the inflammation, more circumscribed than the tenderness in movable kidney. The tender area over a movable kidney is not so painful to slight pressure and extends over a greater region. The pain, which, as a rule, is not so intense, is at once referred to the site of the kidney or is reflected along the course of the ureter. Movable kidney attended by both pain and rigidity requires very delicate manipulation in order to detect it. By having the patient breathe with the mouth open, and with the thighs slightly flexed upon the abdomen gentle pressure enables us to detect the kidney slipping away from the examining finger. There are cases, however, in which nothing short of anæsthesia will clear up the question of a movable kidney. The presence of nausea extending over days is one of the most prominent symptoms in certain cases of movable kidney.

The operator may be thrown off his guard by acute indigestion occurring in a nervous individual suffering at the same time from acute paroxysms of pain due to movable kidney, which was previously not recognized by the patient or physician. Under these circumstances the kidney may become temporarily

anchored in its abnormal position. Under the foregoing conditions I have been called upon to operate for acute appendicitis, and could not say definitely that the case was not acute appendicitis until the patient was fully anæsthetized; then, upon palpation, the diagnosis at once became clear. Again, in the presence of both conditions—*i. e.*, movable kidney with acute symptoms and an enlarged appendix due to chronic inflammation—examination under ether will disclose not only the abnormal condition of the kidney, but also the presence of a palpably enlarged appendix. If, under these circumstances the patient has been suitably prepared, an appendicular operation should be performed.

Edebohls, in a series of interesting papers, has insisted upon movable kidney as a cause of appendicitis. He claims that a movable kidney, by dislocating the duodenum and pancreas, compresses the superior mesenteric vessels and thus causes chronic passive congestion of the appendix, since its blood is returned through the superior mesenteric vein. Movable kidney being more frequent among women, he thinks that of 100 women with chronic appendicitis, 81 have movable right kidney as well, and that therefore treatment of either disease alone will be ineffectual in removing the symptoms; hence he proposes and has practised the performance of nephropexy and appendicectomy through the same lumbar incision. Only in a few cases has he found it impossible to reach the appendix through this wound. Personally I think such an operation is a dangerous procedure and cannot recommend it, as I regard separate incisions for the appendix and kidney operations a far safer method. I do not believe that Edebohls's explanation of pain in the region of the appendix is always correct nor that the appendix should be removed in the large percentage of cases of movable kidney which he advocates. I consider that the pain in the right iliac fossa and the tenderness that can be elicited by palpation over the region to which the pain is referred can better be explained by colic due to the

pressure of the displaced kidney against the colon. I have been able to demonstrate this in a number of cases where fixation of the kidney alone has relieved the symptoms referable to the right iliac fossa.

FLOATING KIDNEY WITH A TWISTED URETER.

Floating kidney with a twisted pedicle may cause abdominal pain, nausea, vomiting, and chills and fever, which symptoms may suggest appendicitis. This condition may be diagnosed from appendicitis by pain which radiates in the line of the ureter and is not increased to any marked degree by pressure; a history of a movable tumor prior to the attack; a possible depression in the right loin corresponding to the site of the kidney; the presence of blood in the urine; possibly symptoms of uræmia; and absence of the cardinal symptoms of appendicitis.

NEPHRITIC COLIC.

Ordinarily, it should not be difficult to differentiate between nephritic colic and appendicitis, but misleading conclusions may be reached, owing to the fact that, in exceptional cases of appendicitis, there exist together pain referred to the umbilicus, retraction of the testicle associated with vesical tenesmus, and painful and frequent micturition. Error, however, can occur only in the early stages of appendicitis, as later the symptoms of the two conditions are entirely dissimilar.

Renal colic is usually ushered in by a distinct chill, followed by excruciating pain in the loin posteriorly, which is usually increased by pressure. The pain extends along the course of the ureter, and is much diminished by the voiding of urine, which often amounts to large quantities. In appendicitis the pain at the onset is more diffused, is increased by pressure, and is in no way affected by micturition, unless the appendix is situated

in the pelvis and adherent to the bladder. In these cases rigidity is often bilateral but the tenderness is found in the region of the appendix, while in renal colic it is felt in the flank. A rectal examination is of the greatest value in such cases. In renal colic there is no tender mass in the right iliac fossa on palpation, and examination of the urine shows characteristic alterations: *e. g.*, uric acid or phosphatic deposits, blood, etc. The application of the X-ray to the diagnosis of stone in the kidney is not as satisfactory as could be wished, but advantage should always be taken of this means of diagnosis in obscure cases when delay is of little importance.

I recall the case of a physician in whom the diagnosis of renal colic had been made, and in whom the ureter was supposed to have been ruptured by the passage of a calculus. The autopsy revealed a gangrenous and perforated appendix with diffuse suppurative peritonitis.

PYO-NEPHROSIS.

From abscess of the kidney appendicitis differs in that in the former the onset is gradual, and may be preceded by disease of the bladder, particularly if tuberculosis has caused the kidney lesion. The pain radiates from the kidney or ureter to the umbilical region, groin and testicle, and retraction of the latter may occur. In appendicitis the onset is sudden, and the pain begins in the peri-umbilical region and soon localizes itself in the appendix. Palpation of a mass which moves with and is continuous with the kidney, with tenderness, is the most reliable symptom in abscess of the kidney; it is elicited by pressure over the renal region, while in appendicitis the tender mass is detected over the appendix, the tip of which seldom reaches the level of the kidney, even when it is directed upward. In pyonephrosis there is irritability of the bladder and diminished excretion of urine, which contains pus, possibly blood, and some-

times the tubercle bacillus. In the absence of urinary symptoms abscess of the kidney, particularly if it be a floating kidney, necessarily presents greater difficulty in differentiation. In the latter instance, however, the tumor will be movable. I have operated on a case of acute suppuration of the kidney in which the urine was normal and the diagnosis was made on the anatomical situation of the swelling, in the absence of the characteristic symptoms of appendicular inflammation. Nausea, sometimes associated with vomiting, is a fairly constant symptom in the renal cases, though it is not of positive diagnostic value.

PERINEPHRIC ABSCESS.

When the appendix holds a retro-colic position or occupies the ileo-cæcal or subcæcal fossa, and inflammation of the organ has progressed to the formation of pus, the collection may be mistaken for a perinephric abscess. The presence of intestinal disturbance and of the cardinal symptoms of appendicitis, however, should be sufficient to justify a diagnosis of appendicitis. When the appendicular abscess is in relation with the right kidney, an incision through the loin, such as is made for the evacuation of a perinephric collection, may be followed by the discharge of purulent matter. It must be borne in mind, however, that the evacuation of a supposed perinephric abscess in this manner does not prove that the collection of pus was not in reality of appendicular origin. A case in point is the following:

The original diagnosis was appendicitis, and on account of the desperate condition of the patient, an incision for the evacuation of the collection was made through the loin. Recovery, with repair of the wound followed. The patient, however, was unable to resume his occupation on account of localized pain, referred to and above the posterior half of the crest of the ilium. Six weeks after recovery from the operation for the evacuation of the abscess he was again referred to me. Upon examination the incision was found intact, but tender. Upon palpation of the tender point distinct resistance was noted. Removal of the appendix was recommended. When the patient

was under the anæsthetic and was being placed upon the operating table, a distinct fæcal odour, which was thought to be due to a bowel movement, was noticed. Upon the removal of the antiseptic dressing which covered the proposed field of operation it was found that the cicatrix had broken down at one point and that fæcal matter was escaping from it. Believing this to be a fæcal fistula, the result of an original attack of appendicitis, I opened the abdomen, isolated the field of operation by gauze packing, and located the appendix. The tip of the organ was perforated and its lumen was found to be in direct communication with the fæcal fistula. The appendix was removed and the wound was treated in the usual manner. I have treated other cases of like character.

TUMORS OF THE KIDNEY.

Neoplasms of the kidney are recognized by palpation of the loin space, absence of inflammatory symptoms, continuous dull pain, frequent micturition, hæmaturia, and pyuria. The cardinal symptoms of appendicitis are absent.

Harsha observed a case where symptoms of a large abscess in the right iliac region had existed for some time. For rupture of this abscess laparotomy was done, and the condition found to be one of suppurating sarcoma of the right kidney, adherent to the abdominal wall over the cæcum.

URETERITIS.

Inflammation of the ureter occurs always as a sequel to inflammation of the bladder, or in connection with tuberculous or calculous disease of the kidney. The differential points are: The history, the presence of tenderness at the bladder extremity of the ureter, as made out by vaginal or rectal examination; the presence of deep-seated tenderness along the line of the ureter; the absence of rigidity of the abdominal wall; and the presence in the urine of pus, blood, and ureteral epithelium.

PAINFUL MENSTRUATION.

A condition which may be misleading in the differentiation from appendicitis is the sudden onset of pain occurring in young unmarried women of neurotic temperament at the beginning of the menstrual period. The onset is sudden and the pain is paroxysmal and accompanied by nausea. There may be more or less unilateral or bilateral rigidity of the lower abdominal wall. The presence of rigidity of the abdominal wall and its degree depend upon the amount of congestion of the ovaries, whether one or both be involved. The pain, at first paroxysmal, is most severe during the first day of the menstrual flow. After this it may become continuous, and, in some instances, may last during the entire period. The tenderness, like the rigidity, corresponds to the amount of ovarian congestion. If both ovaries are involved, the tenderness will be bilateral. McRae has called attention to the frequency with which painful menstruation obscures appendicitis, and is of the opinion that many such patients would be cured by the removal of their appendices.

The pain at the onset differs from that of appendicitis, being noninflammatory and localized from the beginning, while in appendicitis there is general abdominal pain, which later becomes localized in the right iliac fossa, while marked intestinal symptoms are present. Vaginal and rectal examination will assist very materially in arriving at a correct conclusion.

MENOPAUSE.

Some women during the climacteric occasionally complain of symptoms which resemble appendicitis. They suffer from localized pain in the right side, gastric and intestinal disturbances, and irregular temperature. As absence of the menstrual flow often exists, some difficulty may be experienced in reaching a correct diagnosis, particularly in those cases associated with

obesity. The exact condition, however, may be established by inquiry into the previous history and by local examination, which latter demonstrates absence of rigidity of the abdominal wall and no tenderness or palpable swelling about the appendix. The flushes, backaches, and mental symptoms incident to the menopause will clear up the diagnosis. In this connection hysteria may be referred to, particularly as appendicitis has become a more or less "fashionable" disease. The mere mention, however, of the nervous affection, with its ubiquitous symptoms, will suffice.

VARICOSITY OF THE VEINS OF THE BROAD LIGAMENT.

A varicose condition of the veins of the broad ligament may simulate chronic appendicitis. A differential diagnosis should be easy to make, however, because there is an absence of inflammatory symptoms, and a characteristic dull aching pain, with nausea, which disappears when the veins are emptied, after the patient has assumed the recumbent position. Again, in chronic appendicitis there is the history of one or more acute attacks, a palpably enlarged organ can be detected, and the symptoms of chronic appendicitis are present. A vaginal examination may reveal the dilated veins as a soft, doughy, painful swelling.

UTERINE FIBROIDS.

Appendicitis may be confounded with a local inflammation of a portion of the broad ligament overlying an intra-ligamentary fibroid tumor. The main points in the differential diagnosis are that in the latter there may be a history of metrorrhagia; the presence of a growth can be detected upon vaginal examination, and in some instances through the abdominal wall; tenderness and pain are elicited by bimanual palpation, and are confined to the part of the abdominal wall overlying the mass; and the history of appendicitis is absent.

Appendicitis.

A peritonitis of an overlying fibroid of small size and of sufficiently long pedicle to allow its migration into the right iliac fossa, or in close proximity thereto, also an infected fibroid of this character due to a contortion of its pedicle may simulate an appendicitis. I have observed a case where the diagnosis was made only by a very careful vaginal and bimanual examination:

A married woman of 38 years, without children and with no previous menstrual irregularities or dysmenorrhœa, was seized with acute pain across the lower part of the abdomen, localizing in a few hours to the right iliac fossa. Two weeks later she noticed a mass about one inch below McBurney's point. Medical advice was sought, appendicitis with abscess diagnosed, and operation advised. She then sought the opinion of a gynæcologist in this city, who confirmed the diagnosis. Eight weeks after the onset of the acute attack she was referred to me at the German Hospital. Examination of the abdomen revealed a mass in the right iliac fossa about the size of an orange, slightly tender and hard to the touch. There was no rigidity and no vesical symptoms. Vaginal examination revealed a mass in both *cul-de-sac*, more marked on the right side, and on the same side a small nodule could be felt. Bimanual examination moved the mass in the abdomen and the nodule in unison, and a diagnosis of fibroid uterus was made, with no appendiceal abscess, but with inflammatory exudate around the fibroid nodule which occupied the right iliac fossa.

Operation confirmed the diagnosis. Evidently the fibroid was locked in the pelvis, and at the time of the "acute attack" of circumscribed peritonitis the fibroid had slipped up over the brim of the pelvis. The appendix was small and buried behind the cæcum and in no way related to the inflammatory trouble.

EXTRA-UTERINE PREGNANCY.

The history of cases of extra-uterine pregnancy is usually that of partial or complete cessation of the menstrual flow for one, two or more periods, generally accompanied by other symptoms of pregnancy, and collapse supervening upon an attack of acute abdominal pain. The pain is long continued and paroxysmal, but not of the nature of intestinal colic. An irregular,

bloody, vaginal discharge, generally lighter in colour than the normal menstrual flow, and containing shreds of tissue—portions of the decidua—is present. Vaginal examination reveals a tender and sensitive mass in Douglas's *cul-de-sac*, unless the pregnancy be an abdominal one. In the majority of these cases there is a history of sterility for five or six years previous to the abnormal conception. If rupture should occur and the resulting hæmatocele become infected the diagnosis is rendered more difficult, unless the patient can give a clear description of the character of the pain and the collapse at the time of rupture. In a robust individual the anæmia and weakness would be more marked than in appendiceal disease.

In the case of pelvic hæmatocele consequent on ruptured extra-uterine pregnancy becoming infected the interval between the rupture and the infection will necessarily be longer than that between the onset of the attack of appendicitis and the formation of pus. It is very important here, as in all cases, to elicit a most careful history.

When the product of conception occupies the fimbriated extremity of the right tube, the points of differentiation are more difficult, owing to the close proximity of the lesion to the appendix, and the negative result of examination per vaginam prior to rupture. Should the two conditions occur coincidentally, it will be well nigh impossible to differentiate between them. The chief points to be borne in mind, however, are the history, the absence of inflammatory symptoms prior to the rupture of the extra-uterine sac, and the presence of inflammatory symptoms in appendicitis. Appendicitis complicated by normal pregnancy in its early stages has been mistaken for extra-uterine pregnancy, yet the normal birth of a child within a reasonably short time previous, and the absence of decidual discharge from the vagina, should incline the diagnosis to appendicitis.

ACUTE SALPINGITIS.

There frequently is a close relationship between acute appendicitis and right-sided acute salpingitis, and the symptoms of each affection may closely resemble those of the other. In acute salpingitis, however, a history of some infection can almost always be obtained, either from the retention of decomposing placental tissue within the uterus, the introduction of a septic sound, the use of a douche, or examination by a physician who had neglected to sterilize the examining hand. A previous history of gonorrhœal infection is also of great importance. There is only a slight degree of abdominal rigidity; there is an absence of vomiting and of other gastro-intestinal symptoms; and the location of the pain may as a rule be readily ascertained by vaginal examination to hold a relation to the uterus which it does not in appendicitis. In cases of appendicitis we find, as a rule, that the pain migrates from the epigastric or umbilical regions to the right iliac fossa, that there is decided rigidity of the overlying rectus muscle, that the tenderness is more or less accurately confined to the neighbourhood of McBurney's point; we can often, moreover, detect perhaps a palpably enlarged appendix, and by vaginal examination exclude disease of the adnexa; while the suddenness of the attack, its accompaniment by vomiting, and the absence of a history of infection, all incline the diagnosis towards appendicitis. In inflammatory affections of the uterine appendages the most tender external point is just above the middle of Poupart's ligament, while in appendicitis it is usually in the right iliac fossa.

PYO-SALPINX AND OVARIAN ABSCESS.

The presence in the recto-uterine *cul-de-sac*, in intimate relation with the uterus, of an inflammatory mass which renders the uterus partly or completely immovable, and which can be clearly

outlined by vaginal, bimanual, or combined vaginal and rectal examination, together with a history of a vagino-uterine infection, especially gonorrhœa, and the presence of a septic fever, establishes the diagnosis of pyo-salpinx or of tubo-ovarian or ovarian abscess. Still, an inflamed appendix directed into the pelvis, and lying in relation with or adherent to the right tube and ovary, will simulate pyo-salpinx or tubo-ovarian or ovarian abscess of the right side in that there will be an inflammatory mass near the uterus, and pain and tenderness upon vaginal or rectal examination, or both. The diagnosis of appendicitis will be established if there can be obtained a history of previous attacks, characterized by a sudden onset of abdominal pain, usually becoming localized in the right iliac fossa, and rigidity of the abdominal wall. Tenderness in the right iliac fossa is present in both diseases, but in appendicitis the tender area occupies the higher position.

OOPHORITIS.

Inflammation of the right ovary may be confounded with appendicitis, as it is attended with pain, tenderness in the right iliac fossa, nausea and fever. It is always, however, accompanied by disturbances of the uterine functions, and is demonstrated by vaginal or bimanual examination. The pain in appendicitis is at first in the peri-umbilical or epigastric region, and becomes localized in the right iliac fossa. The tender area in appendicitis is situated in the iliac fossa, further to the right than in inflammation of the ovary, whereas in the ovarian affection the tenderness is never so intense as in appendicitis, and is not accompanied by a perceptibly enlarged appendix.

SUPPURATING OVARIAN CYST.

An appendicular abscess and a suppurating ovarian cyst on the right side present some symptoms in common which may

give rise to difficulties in diagnosis. There are found a painful tumor in the right iliac fossa, which may be made out by vaginal, bimanual, and external examinations; vague symptoms of septicæmia; hectic temperature; and a history of previous gastric and urinary irritation. By careful consideration, however, the differences are sufficiently marked. In ovarian cyst the onset is gradual, and a history of some infection can generally be elicited. The pain is constant and dull in character; by pressure the significant "ovarian pain," which differs from the colicky appendicular paroxysms, may be produced, the rigidity of the abdominal walls is not so marked as in appendicitis, while the tumor itself is more elastic, less firmly fixed, and apparently has thinner walls and a more regular outline. If the abscess be of appendicular origin, there will usually be a history of one or more attacks which presented the characteristic symptoms of appendicitis, while if ovarian these will be absent.

OVARIAN CYST WITH TWISTED PEDICLE.

An ovarian cyst with a twisted pedicle gives, as a rule, a history of a slowly growing tumor, which is so frequently unaccompanied by pain that its presence is often unsuspected until the accident occurs. The onset of the acute symptoms of a cyst with a twisted pedicle is sudden, and is usually caused by an excessive peristalsis of the intestines or by sudden change of the position of the body, causing the tumor to rotate on its pedicle. A migrated daughter cyst becoming attached to the omentum in the neighbourhood of the cæcum, has, on its pedicle becoming twisted, very closely simulated appendicitis (Brewer). If the twisting be complete enough to shut off the circulation, the walls of the cyst quickly become gangrenous, and the patient's condition rapidly grows profoundly septic, while the localized peritonitis soon becomes generalized. Here again is seen a resemblance to an attack of appendicitis with abscess formation; but the differ-

ence in the shape and the elasticity of the swelling, the slow growth preceding the sudden onset, the difference in the character of the pain and tenderness, and the more general rigidity of the abdominal wall should enable one to distinguish between these affections. If, however, for any reason it be impossible to make a differential diagnosis, I would advise that at operation the lateral incision be the one chosen, because appendicitis is so much more common an affection that the chances are in favour of its being the cause of the symptoms. The median incision for appendicitis is illogical, unwise, and will in many instances hinder, if not entirely prevent, the proper treatment of the appendix. Even through the ordinary incision the removal of an adherent appendix from behind the cæcum may be extremely difficult; and through a median incision it will often be impossible. These difficulties are generally increased when there is pus formation, and under such circumstances any other than the lateral incision usually multiplies the danger of peritoneal infection.

SPLENIC ABSCESS.

This rare affection may sometimes be confounded with those exceptional cases of appendicitis in which the pain is referred to the left hypochondriac region. In both there are gastric disturbances, pain, tenderness on pressure, rigidity over the affected area, and similar irregularities in temperature. The previous history of the two diseases is, however, unlike. Traumatism is the most frequent cause of splenic abscess, but is rarely the cause of appendicitis. Moreover, splenic abscess, when not traumatic in origin, occurs in general septic infections, and in those constitutional diseases in which enlargement of the organ takes place, and is due to embolism in the parenchyma of the spleen.

DISEASE OF THE PANCREAS.

The affections of the pancreas that are most likely to be mistaken for acute appendicitis are hæmorrhage into the pancreas,

acute hæmorrhagic pancreatitis, suppurative pancreatitis, and gangrene of the pancreas. As these various conditions are rather rare, and frequently follow one another in the same person, it seems scarcely necessary to enumerate the factors of importance in their differential diagnosis. It is sufficient to say that any of these disorders of the pancreas, rather than appendicitis, is suggested by the patient being an obese, alcoholic individual of middle life; by a history of previous attacks of severe pain in the region of the pancreas, attended by vomiting, collapse, and fever; by the presence of very marked prostration, with sweating and perhaps chills; by tenderness and rigidity of the abdominal muscles of the epigastric region; by the presence in the region of the pancreas, of a deep-seated tumor, which does not move with respiration, and which may reveal an indistinct sense of fluctuation; by the possible occurrence of jaundice, fatty diarrhoea, and glycosuria; by the absence of the cardinal symptoms of appendicitis; and by the rapidly fatal course of the disease in many cases.

TUBERCULOUS PERITONITIS.

The greatest difficulty of diagnosis in these cases is where the tuberculous process is still localized, and especially where it starts in the appendix. In cases such as these the cardinal symptoms of appendicitis may be present. Here the endeavour must be to determine the tuberculous nature of the affection. This can frequently be done by attention to the previous and family history of the patient, and by painstaking examination for evidences of tuberculosis elsewhere in the body. This search should include the chest, sputum, glands, bones, joints, etc. The typical irregular or hectic temperature and night sweats are of value in the diagnosis of tubercular disease. The tuberculin test may be applied. The most significant symptom, however, is the presence of ascites, which in tuberculous peritonitis appears

early. Though often considerable in quantity, its recognition is sometimes obscured by distention and adhesions of the intestines. The pain and tenderness usually tend to diminish with increase of abdominal tumescence. The case of H. W. (Plate XXIV) is a typical illustration of the disease, which possibly originated in the appendix.

CIRCUMSCRIBED PERITONITIS DUE TO INFLAMMATION OF RIGHT SPERMATIC CORD.

Differentiation between appendicitis with circumscribed peritonitis and peritonitis due to extension of inflammation from the right spermatic duct can be made by observing the following points: Inflammation of the right spermatic duct follows urethritis, prostatitis, or epididymitis. Consequently there is, or there recently has been, discharge from the urethra; and there is tenderness of the prostate, tenderness and enlargement of the epididymis, and tenderness and swelling of the spermatic cord. The history and the three cardinal symptoms of appendicitis are absent. In the circumscribed peritonitis associated with inflammation of the spermatic duct the most tender point corresponds to the position of the internal abdominal ring, while in appendicitis it is most commonly at McBurney's point. In a terminal appendicitis when the appendix is directed downward and curved, the most tender point may, however be immediately above the middle of Poupart's ligament. I have seen cases in which the two conditions have been confounded. Were rectal examination more frequently employed in the diagnosis of abdominal lesions, such confusion would be less likely to arise.

PSOAS ABSCESS.

The difficulty attending the diagnosis between chronic appendicitis and incipient psoas abscess—that is, before the pus has

Appendicitis.

passed any distance down the psoas sheath—has been forcibly brought to my mind. The chief points in favour of a forming psoas abscess are the appearance of the patient, usually suggestive of tuberculosis; the information to be obtained by an examination of the spine; a complete temperature record; and a tendency to flexure of the thigh of the affected side. While the flexure of the thigh may be and is present in some cases of chronic appendicitis, it is, nevertheless, a far more frequent accompaniment of psoas abscess. Palpation will, in the great majority of cases of chronic appendicitis, determine the presence of an enlarged appendix, while deep pressure over the right iliac fossa will, in cases of psoas abscess, reveal tenderness of the psoas muscle, but fail to disclose either the presence of an enlarged appendix or the characteristic rigidity of the flat muscles of the abdominal wall. A history of a previous acute attack may nearly always be obtained in cases of chronic appendicitis, while the development of psoas abscess is usually gradual. Attention to the family history, the clinical course of the disease, and the possible existence of tubercle elsewhere in the body, will all aid the surgeon in making his diagnosis.

LUMBAR ABSCESS.

In this affection the history of spinal disease, the position of the swelling, the œdema of the overlying tissues, the slow onset, and the absence of the acute tenderness, rigidity and abdominal symptoms will suffice to make the differential diagnosis from appendicitis.

ABSCESS OF THE ABDOMINAL WALL.

Between abscess of the abdominal wall and appendicular abscess there should be little difficulty in making a distinction. If the collection be in the superficial fascia, it will be circum-

scribed; but if between the abdominal muscles, it is likely to be diffused. The purely local character of the abdominal abscess, the swelling moving with the abdominal wall, the absence of intestinal symptoms, the presence of local and constitutional evidence of pus, coupled with the history of the case, should be enough to render a differential diagnosis possible.

ANEURISM OF THE ILIAC ARTERY.

Where a collection of pus is in relation with the iliac artery, and occurs as a result of appendicitis, it may be confounded with aneurism of that vessel. The histories of the two cases, however, are not the same, and though the pus collection may be the seat of transmitted pulsation, it is not the typical expansile pulsation of an aneurism, nor is bruit present. Circulatory disturbances in the lower extremity may be present from the pressure of the pus, but they are not those which are specially characteristic of aneurism.

ENLARGED MESENTERIC GLAND.

Enlarged mesenteric glands may be mistaken for the appendix when palpating the abdomen in cases of supposed appendicitis. Their presence, however, is not significant unless accompanied by the evidence of acute inflammation. Even with fairly acute symptoms, the enlargement may be due to typhoid fever in its earliest stages. The abdominal pain which occasionally precedes the development of acute gonorrhœal epididymitis may be due to involvement of pelvic glands, as well as to inflammation of the spermatic cord. Both these causes should be borne in mind in doubtful cases. In a case reported by Hamann, a tumor formed by an acute tuberculosis of the iliac lymph glands was mistaken for a peri-appendiceal exudate. Richardson's observations in connection with typhoid lymphadenitis are referred to elsewhere.

MESENTERIC HÆMATOCELE.

As a result of traumatism rupture of the mesenteric blood vessels sometimes occurs, and is followed by the formation of a mesenteric hæmatocele. Under ordinary circumstances absorption takes place. When the hæmatocele undergoes suppuration, symptoms which closely resemble chronic appendicitis may be observed. By bearing in mind the history, the character of the onset, and the absence of the cardinal symptoms of appendicitis, a diagnosis is readily made.

MESENTERIC THROMBOSIS.

This condition, which has only recently received adequate attention from surgeons, is of rather obscure origin. It sometimes occurs in typhoid fever, and at other times as a result of some form of sepsis. If the circulatory obstruction be arterial the symptoms are not very definite, and no peritonitis may occur, the affected bowel becoming the seat of dry gangrene. If venous obstruction arises, however, the symptoms are more acute: there are vague abdominal pains, continuous, but paroxysmal; a little fever; possibly vomiting; sometimes bloody stools; and finally, the evidence of peritonitis. In either case, however, there is usually no history of an abrupt onset, the pain does not settle to the right iliac fossa, the tenderness is neither marked nor localized, and the rigidity, even if present at all, is very slight.

LEAD-POISONING.

The symptoms of appendicitis and lead-poisoning are to a certain extent similar, yet a differential diagnosis should not be difficult.

In appendicitis there are present the cardinal symptoms—pain, tenderness and rigidity. The pain in appendicitis, like

that in lead colic, is at first paroxysmal, but, unlike the pain in lead-colic, is not relieved by pressure. The tenderness in appendicitis is usually confined to the affected area, unless peritonitis be present, while the tenderness in lead colic is referred to the entire abdomen. The rigidity is localized, as a rule, in appendicitis, and bears a relation to the position held by the appendix. The rigidity in lead-poisoning is diffused. The bowels are usually constipated in appendicitis, although diarrhoea may be present. Upon thorough catharsis the symptoms of appendicitis may to a certain extent abate. In lead-poisoning obstinate constipation is the rule, and movement of the bowels is seldom followed by cessation of the pain or colic.

In lead-poisoning the constitutional evidences of the affection are in evidence, viz., the blue line on the gums, the anæmia, and the palsies, either localized or general, while in appendicitis the constitutional evidences of the disease are those secondary to an acute inflammatory affection.

History of exposure to the cause is usually not difficult to obtain in lead colic; and an examination of the blood will show basophilic granular degeneration of the red cells. This degeneration has, however, also been noted in sepsis, and in long standing suppurative lesions—conditions which may be present in some cases of appendicitis.

INCIPIENT INGUINAL HERNIA.

The discomfort attendant upon a chronic appendicitis must not be confounded with that of an incipient inguinal hernia. I have frequently seen cases of marked intestinal indigestion, in the absence of a palpably diseased appendix, and accompanied by more or less discomfort, if not pain, in the lower abdomen, described in some instances as being dragging in character. In these, a careful examination of the inguinal canal showed weakness of the abdominal wall at the site of the internal ring, and

the wearing of a light truss was soon followed by the disappearance of the symptoms.

HIP-JOINT DISEASE.

The presence of the characteristic deformity; inability to execute the normal movements of the joint; pain referred to the knee; arching of the lumbar spine when the thigh is brought into the fully extended position; and the absence of abdominal symptoms, should determine the diagnosis of coxalgia. The absence of the cardinal symptoms of appendicitis and the difference in the mode of onset will exclude appendicitis in suspected cases.

DISLOCATION OF THE HIP.

That acute appendicitis can be mistaken for dislocation of the hip can hardly be conceivable, yet this error has occurred, and is illustrated by the following case:

A very muscular, adult male, a negro, while riding a bicycle fell, striking his right hip. During the night after the accident he suffered pain in the region of the injury, which disabled him. The next day he ate heartily of ice-cream. Acute abdominal pain soon followed. A neighbouring physician was sent for. He found the patient in the dorsal decubitus, and the right thigh strongly flexed and adducted, and made a diagnosis of dislocation of the hip. Morphine was given freely. Three days later the patient was admitted to the German Hospital. The following condition was noticed: The abdomen was generally distended, tender and rigid. The rigidity and tenderness, however, were more pronounced immediately above the crest of the right ilium, just behind the anterior superior spine. In this location the tenderness was most excruciating upon slight pressure. The thigh was in the position previously noted, and any attempt to manipulate it excited unbearable pain. The bowels had not been moved since the accident. The pulse was 88, the temperature 99.4° F. Careful examination of the hip convinced me that the accident bore no relation to the case. A diagnosis of acute appendicitis with retro-cæcal abscess was made. Immediate operation exposed a gangrenous terminal appendicitis, with the appendix holding a

retro-cæcal position, lying upon the psoas muscle and surrounded by a small collection of offensive pus.

SCIATICA.

Scarcely less remarkable is the following case, occurring at the Episcopal Hospital, in the service of Dr. Harry C. Deaver:

A man of sixty-one years walked into the medical dispensary on July 7, 1902, complaining of pain down the course of his right sciatic nerve. He was lame, and had no other complaint to make. Some tenderness existed in the right loin, and above the crest of the ilium in the posterior axillary line; but there was no tenderness, only great pain, along the course of the great sciatic nerve. His temperature was 102° F. Pulse 100-120. There was leukocytosis, the blood count showing 15,200 white cells. He gave the following history: On June 24th, after drinking some "five-cent whiskey" he was sent to jail for disorderly conduct. On June 28th he washed the floor of his cell, and slept on the damp floor all night. The next day, after drinking cocoa, severe abdominal cramps developed, he was nauseated, but did not vomit. His bowels had previously been regular, but after this attack did not move again until July 3d. At the same time as the severe abdominal pain, the patient had suffered from pains down the back of his thigh and in his loin. The abdominal pain lessened, but that in his right loin and thigh remained. He was released from jail on July 3d, and went home to bed. He had some fever, anorexia, and persistent agonizing pain along the course of the right sciatic nerve. Not until July 7th, however, did he apply at the dispensary for treatment.

Operation revealed the appendix lying transversely across the psoas and iliacus muscles, behind the cæcum, subserous, and its tip nearly reaching the iliac crest. There was a large abscess running up toward the liver. Free drainage was established through the loin. On recovery from ether the pain in the thigh had disappeared. Death from septicæmia occurred on the fourth day after operation.

PNEUMONIA AND PLEURITIS.

The onset in these two diseases is sometimes very acute, and the pain in the side may be so severe as to cause rigidity of the

abdominal muscles on the side affected. If this be the right, the diagnosis is sometimes quite difficult, especially in children, who are unable to describe their pain accurately. In pneumonia, however, the predisposing cause is more often exposure to inclement weather, a preliminary chill is frequent, vomiting is less usual, there is cough, and the pain is probably never limited to the abdomen; while in appendicitis there has usually been some indigestible food eaten, a chill is very unusual, vomiting is the rule, and the pain is generally umbilical at first, later settling to the right iliac fossa. There is seldom in appendicitis any thoracic pain, nor a cough. Physical examination will usually clear up any doubt by the revelation of the pathognomonic subcrepitan râle at the end of inspiration in pneumonia, or by the friction sound in pleurisy. In pulmonary disease the abdominal rigidity is easily overcome and the tenderness is not marked, if palpation be done with the palm of the hand rather than the finger tips. Guinou insists upon this means of differentiating the two affections, having found that deep but gentle pressure with the palm of the hand caused a cessation of the pain at McBurney's point if the affection was thoracic.

Brewer has recorded the case of a patient who, having had several attacks of appendicitis, complained, when recovering from a pneumonia, of sudden pain "in the right inguinal region." Symptoms of general peritonitis followed; the precarious condition of the patient forbade any operation. At the autopsy not a trace of abdominal inflammation was found, but cultures from the heart and spleen, showing the pneumococcus, proved it to be a case of pneumococcic septicæmia.

HYSTERIA.

Under certain circumstances, such may be the manifestations of hysteria that appendicitis may be suspected. Examination in these cases, however, will usually reveal the patient to be neuro-

pathic. On palpation of the abdomen there may be detected exquisite skin hyperæsthesia and immediate rigidity of the abdominal muscles. Upon the patient's attention being diverted, however, deep palpation may be made without eliciting pain or tenderness, and no enlargement of the appendix will be determinable. In addition, it will be ascertained upon inquiry that the so-called acute attacks are unaccompanied by vomiting or fever, and that in the supposed chronic cases there is no disturbance of the gastro-intestinal tract. Further examination will reveal the knee-jerks and other reflexes exaggerated, diminution of the visual fields, and various areas of anæsthesia of hysterical type. The condition may be improved or cured by local electrical treatment.

It must, however, be borne in mind that appendicitis and hysteria may be concomitant conditions, and that chronic appendicitis may give rise to aggravated neurasthenia.

PTOMAIN-POISONING OR FOOD INFECTION.

The symptoms the result of ptomaine-poisoning or food infection often much resemble those of appendicitis, and give rise to many perplexities in the effort to discriminate between them. In both the onset is similar; that is, there develops suddenly acute abdominal pain, nausea, and vomiting. In appendicitis, however, inquiry will elicit a history of the ingestion of indigestible food, whereas in ptomaine-poisoning it may be ascertained that the patient has partaken of food known to be capable of causing food infection. Of these may be mentioned canned meats, sausages, oysters, especially during the summer months, ham, cheese, ice-cream, cream-puffs, etc. In ptomaine-poisoning there is usually a period of incubation after the ingestion of the deleterious food, that varies usually from twelve to thirty-six or forty-eight hours. During this time the patient may be seemingly well, or there may be fleeting pains in the abdomen

and more or less malaise. In appendicitis, on the contrary, the first manifestations come on suddenly. The pain in ptomaine-poisoning is usually violent, referred to the region of the stomach, and associated with nausea, vomiting, diarrhoea, and great constitutional depression, as indicated by clammy skin, subnormal temperature, a facial expression of anxiety, and a marked sense of prostration. The pain is unlike that of appendicitis, in that it is continuous, not paroxysmal; and in that it is referred to the epigastrium, and then becomes diffuse and not localized in the right iliac fossa. Rigidity of the abdominal muscles and tenderness on pressure are also diffuse and do not become localized in the right iliac fossa. Vomiting is usually present, though it may be absent; and when present, usually affords temporary relief, and the same is also true of diarrhoea. In some cases diarrhoea is more likely to occur than is vomiting, and it may be entirely unrestrainable. In other cases, particularly of tyrotoxon poisoning, the vomiting is more likely to be the obtrusive symptom. The evidences of collapse coming on almost immediately after the onset of the first manifestations are most significant of ptomaine-poisoning. Indeed, the rapid occurrence of such collapse, with diffuse abdominal pain, tenderness, rigidity, and distention; nausea, vomiting and diarrhoea; and the history of the ingestion of unwholesome food or of food that may be looked upon as possibly unwholesome, are quite characteristic of the condition. In appendicitis, on the contrary, there is a regular sequence of events—abdominal pain, tenderness, and rigidity, with nausea and vomiting usually ceasing after the localization of the symptoms in the right iliac fossa. The profound collapse is never seen in appendicitis so early in the attack as in ptomaine-poisoning, but, as already mentioned elsewhere, may develop later. In ptomaine-poisoning the temperature is usually subnormal early in the attack, and may remain so, but sometimes it rises to 103° or 104° F.; in appendicitis it usually rises with the commencement of the attack. In ptomaine-

poisoning with a low temperature the pulse may be rapid. The distention of the abdomen is due to paralysis of the intestines, and may be so marked that absolute constipation may occur, and the case much resemble intestinal obstruction, for which it has been mistaken. In addition, there are usually present pains in various portions of the body, irregular muscular twitchings, cramps in the calves of the legs, excessive perspiration, somnolence, and delirium. Finally, the condition sometimes does not yield to any treatment, and the patient speedily dies. At operation, if such be undertaken with the idea that the case is one of appendicitis or intestinal obstruction, the appendix is found normal, but the intestines are usually the seat of irregular distention and more or less congestion.

SKIN DISEASES.

It should not be forgotten that certain affections of the skin, whose pathology is still very obscure, are at times attended by gastro-intestinal crises, which may simulate appendicitis. Pond has recently reported a case in a child of nine years, in which the development of vomiting, abdominal pain and high fever, subsequent to the administration of a purge, were considered indicative of appendicitis, until on the fifth day, coincident with the subsidence of the local symptoms, the rash typical of erythema exudativum appeared. On further inquiry a family history of rheumatic, cardiac and skin affections was obtained; and on reviewing the case it became evident that no true appendicitis could have at any time existed. The temperature was too high to be characteristic of appendicitis, the tongue was very red and furrowed, the gums were spongy and bled easily. There was slight leukocytosis; suppression of urine occurred, and other evidences of a toxic nephritis helped to clear the diagnosis.

Osler, Sutherland, and Burrows have also reported cases where the visceral crises of this erythema group may be mis-

taken for appendicitis. Particular care in children, who have colic, should be taken to inquire into a possible previous history of skin lesions, arthritis or abdominal crises.

The occurrence of purpura, angeioneurotic œdema, erythema, or urticaria with recurring colic, and often albumen in the urine, are the symptoms most significant of the skin disease.

LOCOMOTOR ATAXIA.

The gastric crises of this disease are well known, and the other symptoms of the disease are usually sufficiently marked to prevent mistake; but the cautious surgeon will not forget that true appendicitis may occur even in these cases.

INTUSSUSCEPTION OF THE APPENDIX.

This rare affection, of which only about twenty-two instances are recorded, is usually encountered as a part of an ileo-cæcal or an ileo-colic invagination, but in at least nine cases was found to be the only portion of the intestinal tract intussuscepted. The invagination of the appendix may be either partial or complete, and it appears that in the former case there is more apt to be a second and colic intussusception formed. It thus seems as if inability on the part of the appendix to completely invaginate itself caused the cæcum to become invaginated. In seven cases (Ackermann, Brewer, Hogarth, McKidd, O'Connor, Pitts, and Westermann) the inversion of the appendix into the cæcum was complete, among which a second and colic intussusception was present in only three (Ackermann, Hogarth and O'Connor); while in fourteen cases the inversion was only partial (Chaffey, Enderlein, Haasler (two cases), Haldane, Lees, McGraw, Montsarrat, Neilson, D'Arcy Power, Rolleston, Grieg Smith, Waterhouse and Wright), among which a second and colic intussusception was present in all but five (Haldane, Neilson, Rolleston,

Waterhouse, and Wright), this point not being noted in the case of D'Arcy Power, and the report of Bishop's case not being accessible in the original.

Of the twenty-two cases of appendiceal intussusception which have been found in searching the literature, the sex is known in nineteen, ten being male, and nine female. Sixteen out of these nineteen patients were less than nine years of age, one male and two female patients being adults.

When forming a part of a larger intussusception, the symptoms of the latter affection predominate. When invagination of the appendix alone exists the symptoms somewhat resemble those of appendicitis, but usually fever, marked tenderness, and rigidity have not been observed. In a few cases a palpable mass has been detected. In no case has the diagnosis been made before opening the abdomen.

The causes of this affection, like those of intussusception in general, are very obscure. In some cases, notably Rolleston's, a concretion within the appendix has seemed to excite such violent peristalsis as to cause prolapse of part or all of the appendix into the cæcum. In Rolleston's patient, who died from perforation of a duodenal ulcer, without operation, only the mucous membrane of the appendix was found prolapsed into the cæcum, a coprolith being impacted in its orifice. It is of course probable that when partial inversion has occurred the protruding portion acts as a polyp does in irritating the rectum or the uterus, or like an elongated uvula, as suggested by Corner, in irritating the pharynx to renewed contractions. In no case were there evidences of previous attacks of appendicitis. Indeed, as remarked by Battle and Corner, it seems reasonable to suppose that previous attacks of inflammation would have rendered the appendix less liable to become intussuscepted, both by the stiff and unyielding condition of its walls thus induced, and by the production of peri-appendicular adhesions. Abnormal length of the mesentery and the ascending meso-colon is considered by some a predisposing

PLATE XXIX.

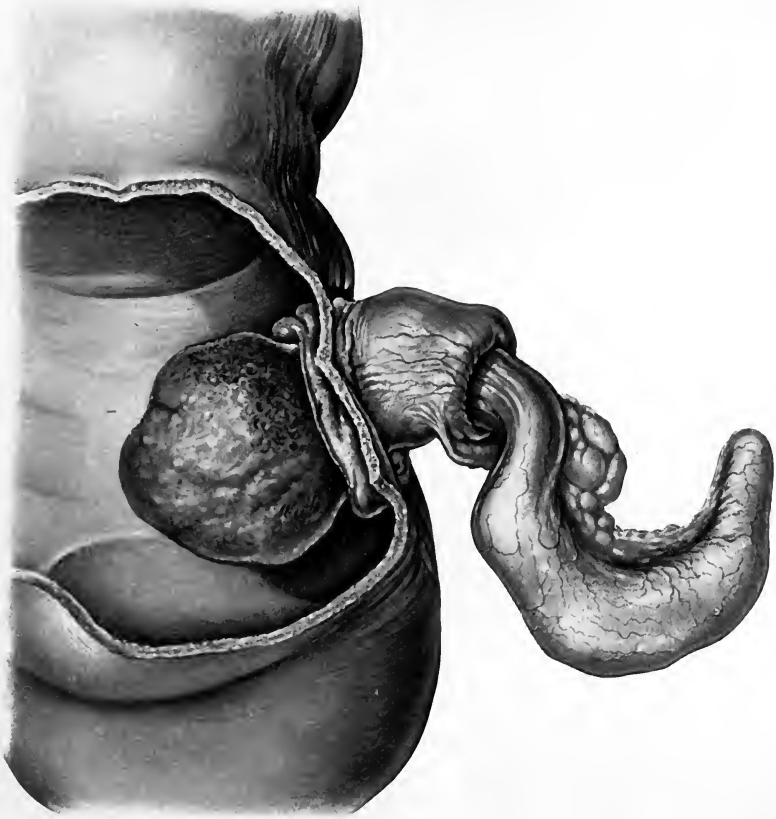
CASE OF DR. THOMAS R. NEILSON.—INVAGINATION OF APPENDIX.—
G. B., a little girl five years of age, admitted to St. Christopher's Hospital, under Dr. Neilson's care, December 26th, 1903. Four days previously the child had been attacked with severe abdominal pain causing her to crouch down on the floor, scream, double up and hold her abdomen tightly with her hands. This attack was followed by pallor, and the child seemed greatly fatigued. On the night of the 25th the attacks became more frequent, recurring at short intervals. There was no nausea or vomiting at any time; the bowels moved very frequently, the stools being small. Examination revealed only very slight rigidity of the lower segment of the right rectus muscle; there was no tympany; there was slight tenderness in the region of the appendix.

Dr. Neilson's diagnosis, accordingly, was chronic appendicitis with adhesions.

Operation by Dr. Neilson January 1, 1904: The appendix was found invaginated into itself and into the cæcum for upwards of one inch. There was no evidence of any other pathological condition thereabouts. The drawing on the opposite page accurately illustrates the condition found. The mucosa of the cæcum surrounding the intussusception was markedly congested.

An attempt was made first to draw out the intussuscepted portion of the appendix, but this failed, and accordingly the whole mass was excised from the cæcum and the opening closed by ordinary methods.

The child made a complete and uneventful recovery.



INTUSSUSCEPTION OF THE APPENDIX.
From a patient under the care of Dr. Neilson.

cause of appendicular intussusception. Two patients had tuberculous disease of the peritoncum.

Fifteen of these patients were operated upon, five died without operation (Chaffey, Enderlein, McKidd, Rolleston, and Grieg Smith) and in two instances (Bishop, D'Arcy Power) the question as to whether an operation was performed is not known. Of the fifteen patients operated on, the result is not known in Haldane's case, and Waterhouse's patient died. The remaining thirteen cases treated by operation recovered. Where possible to do so the intussusception was reduced. The appendix was excised in every case. Where reduction of the intussusception was impossible, the irreducible portion was excised, including in some cases (Haasler (2 cases), Lees, and Waterhouse) the lower part of the ileum, the cæcum and more or less of the ascending colon, a secondary ileo-colic anastomosis being made. In Brewer's and McGraw's patients, the cæcum was incised longitudinally, and the irreducible appendix removed from within its interior. In only four cases (Haldane, Hogarth, Montsarrat and Wright) could the appendix be completely reduced before it was excised. In most cases too prolonged efforts at reduction resulted in perforation of the cæcum, necessitating resection.

The treatment, therefore, to be advised for these cases, when met with, consists of laparotomy and gentle attempts at reduction, and if these fail, of excision of the appendix and so much of the cæcum and ileum as shall be found to be irreducible. The appendix should always be removed, to prevent a recurrence of the trouble.

CASES OF INTUSSUSCEPTION OF THE APPENDIX.

1. Ackermann: *Beitr. z. klin Chir.*, 1903, xxxvii, 579. F., four years. Complete inversion of appendix and ileo-cæcal intussusception. Recovered after excision of appendix and cæcum. Compare Cases 9 and 15.
2. Bishop: *Chironian*, N. Y., 1902, 3, xix, 81; quoted by Corner, *Annals of Surgery*, 1903, ii, 708. No details are given.

3. Brewer: *Annals of Surgery*, 1904, ii, 1015. F., twenty-two years. Complete inversion of appendix, no ileo-colic intussusception. Stricture of ascending colon. Recovered after excision of appendix. Compare Cases 12, 16 and 21.
4. Chaffey: *Lancet*, 1888, ii, 17. M., three years. Partial inversion of appendix and ileo-colic intussusception. Died without operation. Compare Cases 5, 6, 7, 10 and 13.
5. Enderlein: *Münch. med. Woch.*, 1900, ii, 1021. Male, two and one-half years. Same lesions as Cases 4, 6, 7, 10 and 13. Died without operation.
6. Haasler: *Archiv f. Klin. Chir.*, 1902, Bd. lxxviii, S. 817, Fall 4. F., forty-two years. Same lesions as Cases 4, 5, 7, 10 and 13. Recovered after excision of ileum, cæcum and appendix.
7. Haasler: *Ibid., loc. cit.*, Fall 9. M., nine years. Same lesions as Cases 4, 5, 6, 10 and 13. Recovered after excision of ileum, cæcum and appendix.
8. Haldane: *Scottish Medical and Surg. Journ.*, 1903, xii, 333. F., three years. Partial inversion of appendix, no ileo-colic intussusception. Recovered after excision of appendix. Compare Cases 14, 20 and 22.
9. Hogarth: *Brit. Med. Journ.*, 1903, i, 850. F., six years. Same lesions as Cases 1 and 15. Recovered after excision of appendix.
10. Lees and Silcock: *Lancet*, 1898, i, 1400. M., four and one-half years. Same lesions as Cases 4, 5, 6, 7 and 13. Recovered after excision of ileum, cæcum and appendix.
11. McGraw: *Brit. Med. Journ.*, 1897, ii, 956. M., seven years. Partial inversion of appendix and of cæcum into cæcum. Recovered after excision of appendix and cæcum.
12. McKidd: *Edinburgh Med. Journ.*, 1859, iv, Part 2, p. 793. M., seven years. Complete inversion of appendix, no ileo-colic intussusception. Died without operation. Compare Cases 3, 16 and 21.
13. Montsarrat: *Liverpool Med.-Chir. Journ.*, 1901, xxi, 68. M., four years. Same lesions as Cases 4, 5, 6, 7 and 10. Recovered after excision of appendix and cæcum.
14. Neilson: See Plate xxix. F., five years. Same lesions as Cases 8, 20 and 22. Recovered after excision of appendix and cæcum.
15. O'Connor: *Lancet*, 1903, ii, 600. M., nine years. Same lesions as Cases 1 and 9. Recovered after excision of appendix and cæcum.
16. Pitts: *Lancet*, 1897, i, 1602. F., two and one-half years. Same lesions as Case 12; also tubercular peritonitis. Compare Cases 3 and 21. Recovered after excision of appendix.

17. Power, D'Arcy: Brit. Med. Journ., 1897, ii, 1319. Partial inversion of appendix. No other details given.
18. Rolleston: Edinburgh Med. Journ., 1898, iv, 21. M., thirty-two years. Partial prolapse of mucosa of appendix into cæcum. Died, without operation, of perforated duodenal ulcer.
19. Smith, J. Grieg: Quoted by Montsarrat, *loc. cit.*, p. 70. Partial inversion of appendix and ileo-colic intussusception. Died without operation. No other details.
20. Waterhouse: Trans. Path. Soc. London, xlix, 108; Lancet, 1897, ii, 1319. F., four years. Same lesions as Cases 8, 14 and 22. Died 30 hours after excision of ileum, cæcum and appendix.
21. Westermann: Wieblad v. Niederlander Tydschr. v. Geneskunde, No. 24; quoted by Ackermann, *loc. cit.*, S. 585. F., six years. Same lesions as Case 12. Compare Cases 3 and 16. Recovered after excision of ileum, cæcum, appendix and ascending colon.
22. Wright and Renshaw: Brit. Med. Journ., 1897, i, 1470. M., three years. Same lesions as Cases 8, 14 and 20. Also tubercular mesenteric glands. Recovered after excision of appendix.

THE BLOOD COUNT IN APPENDICITIS.

The blood count—percentage of hæmoglobin, red corpuscles and white corpuscles or leukocytes—has been used to clarify the diagnosis, to determine the extent of the lesion, to estimate the resistance of the patient and to judge as to the probable prognosis.

Under these headings the subject will be discussed.

But first a few words upon the meaning and significance of the term leukocytosis are essential, because upon the count of the white cells a much greater value is placed than on the hæmoglobin estimation, or red-cell count: "Leucocytosis may be described as an increase above the normal standard in the number of leucocytes in the peripheral blood, this change either (*a*) involving both an absolute and relative increase in the polynuclear neutrophile cells with a consequent relative diminution in the proportion of mononuclear or nongranular forms, or (*b*) affecting all varieties of leucocytes alike" (DaCosta).

As an aid to diagnosis the count of the leukocytes has been justly considered of the utmost value, and has on the other hand led to grave errors. When the place of origin and the function of the leukocytes have been more accurately determined the significance of their increase will be more fully understood.

The literature of the past few years has been burdened with lengthy arguments for or against the value of the leukocyte count and with tabulated series of cases differing widely in the individual count but made to support the views of the compiler because of the average count which is obtained. If the count of the white cells, performed once, was considered as of no more or less importance than the degree of temperature recorded once on the temperature chart, we should have less confusion of ideas upon this interesting subject. As the temperature curve is more

valuable than the single observation, so the repeated count of the leukocytes would be of more moment than the single one if it were not for the fact that the successful treatment of appendicitis depends on an early diagnosis. Within an hour after observing the case the diagnosis must have been made and the treatment outlined, operation being advised or postponed. In deciding the diagnosis of cases seen early the blood count is equal to the temperature in value, both frequently being normal and often fluctuating widely.

Of the conditions which may simulate appendicitis in its early stages there are but few which can be ruled out by the count of the white cells. Enteric fever, ovarian cyst, movable kidney and those peculiar diseases known as enteralgia, gastralgia and ovarian neuralgia, which are more often due to adhesions following an inflammatory lesion in the appendix, gall-bladder or Fallopian tube than to functional disorders, are the few exceptions.

In cholecystitis, pyosalpinx, ectopic pregnancy, etc., and through a long list of abscesses, leukocytosis is the rule. In the majority of cases the leukocyte curve is coincident with the extent of the pathological lesions within or without the appendix, but in a very respectable minority there are exceptions to this rule. It is useless, at the present time at least, to argue that repeated examinations and frequent differential counts will solve the problem, because the time of election for operation is in the pre-purulent stage or in the interval, and the leukocyte count during these periods varies too widely.

One does not wait for the appearance of gall-stones in the stools to clinch the diagnosis of cholelithiasis, the finding of sugar in the urine to be certain of chronic pancreatitis, the detection of the tubercle bacillus in the sputum to affirm the presence of tuberculosis. These findings are of infinite value, as is the presence of leukocytosis in appendicitis, but are not essential for a correct diagnosis, being merely a corollary of the clinical picture of the disease.

The following extract from DaCosta's "Clinical Hematology" succinctly states the position which seems most assured. After reviewing 600 counts upon cases of appendicitis in the German Hospital, he states: "The simple fact of the presence or absence of leucocytosis is more often misleading than useful in the diagnosis of appendicitis, for this sign, to be of any value, must invariably be correlated with other more definite clinical manifestations. Appendicitis should never be ruled out because leucocytosis is absent, nor should a moderate leucocyte count be considered an indication of the benignancy of the lesion. A count in excess of 20,000, particularly if it persists or increases, may be relied upon as a certain sign of pus or its consequences, and is sufficient to warrant operative interference if the symptoms point to the appendix as the seat of the trouble. Counts of less than 20,000 cannot be depended upon to reflect the character of the local lesion, since an increase to practically this figure may be found occasionally in mild catarrhal cases, as well as in those with purulent foci. In the writer's experience the behavior of the leucocytes throws a much clearer light upon the progress of the disease, in both operative and nonoperative cases, than it does upon the initial diagnosis, which should be determined chiefly by other clinical methods."

The value of the differential count in appendicitis has been much exaggerated and the presence or absence of a relative leukocytosis can be safely disregarded when attempting to diagnose a case seen early. The normal standard of the polynuclear forms varies from 50 to 75 per cent.—so wide a variation that any conclusions as to the individual case must often be erroneous. In the later stages the ordinary count is quite sufficient for diagnostic purposes. I have in several instances found no relative or absolute leukocytosis in small walled-off abscesses.

To Determine the Extent of the Lesion.—The presence of appendicitis without abscess or peritonitis should never be inferred from the presence of a leukocytosis of 12,000–15,000, without re-

gard to the clinical symptoms. In over 50 per cent. of the purulent cases examined at the German Hospital the count was below 20,000, and these cases varied from ulceration with interstitial abscess up to perforation, gangrene or spreading peritonitis. But even with these results we have learned to place a much higher value upon the leukocyte count in determining the amount of the lesion, than when making the initial diagnosis, or in differentiating from other conditions. The clinical symptoms must, however, always be associated.

In case of a moderate leukocytosis (15,000), with no temperature, no mass, but with localized pain and tenderness, distinct rigidity, and after eliminating the influence of digestion—we judge that the infection is confined to the appendix without the occurrence of abscess. The presence of a mass must be rigidly excluded by abdominal, vaginal or rectal palpation because in many cases a large collection of pus has been found with but little increase in the number of leukocytes. This, of course, is a well-known clinical observation and is explained by the nonabsorption of the pus. Occasionally with a leukocyte count below 10,000 and without any palpable mass, pus is encountered, but such collections are small and are found behind the cæcum, perfectly walled off.

If, in a case such as the one described, operation should be postponed for any reason, the leukocytes should be frequently counted. The onset of fever and an increasing leukocytosis would mean that the infection was spreading; if the leukocytes exceed 25,000 and remain at that figure after subsidence of the temperature, an abscess can with safety be diagnosed; if the leukocyte count subsides with the temperature, the patient can be considered as recovering, provided the *general symptoms and abdominal condition* also point to such a conclusion; if the leukocytes decrease while the condition of the patient becomes more serious a spreading peritonitis is probable, without resistance on the part of the organism.

Appendicitis.

The following table is offered with some hesitation as a guide in determining the extent of the disease. No claim whatever is made for its completeness nor absolute reliability, because frequently the leukocyte count fluctuates so much and varies in individual cases from the average so widely, that rules do not hold and error may occur. It represents fairly well the result of a somewhat extended observation and must always be correlated with the clinical symptoms.

| | FIRST COUNT. | INCREASING ON SECOND, THIRD, ETC., COUNT.. | DECREASING ON SECOND, THIRD, ETC., COUNT. |
|---------------------------|---|--|---|
| 5,000-10,000 | { Chronic appendicitis. Mild acute appendicitis confined to appendix. Localized abscess. | — | — |
| | | Localized peritonitis. | Recovery. |
| | | Same, extending. | Localized abscess, if small, possible absorption. |
| 10,000-15,000 | As above but more difficult of interpretation. | | |
| 15,000-25,000 | { Acute appendicitis confined to appendix (interstitial, ulcerating). Acute appendicitis with local peritonitis. Abscess. | Increasing. | Recovery. |
| | | Extension of infection, abscess formation. | Formation of a fibrinous exudate (adhesions). |
| | | Absorption of toxins and extension of abscess. | Localization. |
| 25,000 and over | { Large abscess or free pus. Occasionally, severe acute ulcerative appendicitis with local exudative inflammation. | Same. | Localization] into one or more abscesses. |
| | | Suppurative lymphadenitis and lymphangitis or perforation. | Gangrene, and local abscess formation. |

Note that low initial counts may be observed in patients profoundly septic, the clinical symptoms being the guide to the real condition. Occasionally the number of leukocytes decreases while the general condition becomes more severe, denoting a lessened systemic resistance.

The resistance of the patient can usually be accurately gauged from the leukocyte count. The most constant rule in the study of the blood in appendicitis is that a low count is the rule in mild cases and in those of great severity.

The anatomical limitations to the lymphatic apparatus of the appendix prevent more than a slight degree of absorption until the peritoneal surface has been infected, so that a low count is often experienced despite serious lesions in the appendix itself. As the infection invades the walls of the appendix from within outward, the leukocytes escape from the blood-vessels and gravitate from without inward, the battle usually being fought in the submucosa. It is possible that the continued exit of leukocytes from the circulating blood into the appendiceal tissues exerts some stimulus upon the place of origin of the polynuclear cells with their consequent overproduction—leukocytosis. Such overproduction under stimulus is common to all cells of the body.

If, on the other hand, the absorption of toxins from the infected appendix or peritoneum is so rapid or so severe as to paralyze the defensive power of the body, or if the leukocytes are rapidly destroyed, the count is low.

To Determine the Prognosis.—Beyond the estimation of the resisting power of the patient to infection and a certain limited determination of the probable extent of the lesion, the leukocyte count is worthless as a reliable indication for the need of operation with one valuable exception. If the figure 20,000, as given by most writers, means pus there is nothing else to do but to evacuate the abscess and watch the leukocyte count rise or fall while the pus is draining. If the count is below 20,000, the clinical picture alone can be considered and operation performed in all cases seen early. But when a spreading peritonitis is diagnosed from the clinical evidence the leukocyte count is of great value as an indication of the patient's resistance. This has been referred to in the previous paragraph, and it suffices here to state that operation upon a patient with a swollen, tympanitic abdomen, fever, increased pulse, etc., and a *low leukocyte count* is but to court disaster; the sufferer usually dies in a few hours from the shock of operation added to the great toxicity. Frequent counts have

been advocated as a means of determining the time of operation. While it is true that, as the infection increases in intensity, and as the destructive lesions in the appendix become greater and the surrounding peritoneum becomes involved, the leukocytes will continue to rise until they may reach 18,000, the figure at which operation is advised by many writers; yet the fallaciousness of such procrastination has been repeatedly reiterated in previous chapters of this book.

The iodine reaction is of little value, except as a means of studying the degenerative changes in the leukocytes by circulating toxins. It must always be taken in conjunction with other physical signs, and usually bears a direct relation to the presence of leukocytosis. Iodophilia without leukocytosis indicates toxæmia, with leukocytosis the presence of pus.

According to Locke "The reaction has both a positive and a negative value as a diagnostic sign. Thus **septic conditions** of all kinds, including septicæmia, abscess and local sepsis, except in the earliest stages, appendicitis accompanied by abscess formation or peritonitis, general peritonitis, empyema, pneumonia, pyonephrosis, tonsillitis, gonorrhœal arthritis, and hernia or acute intestinal obstruction where the bowel has become gangrenous, have invariably given a positive iodophilia, and by its absence all these cases can be ruled out in diagnosis."

It will thus be seen that the actual diagnostic aid of the iodine reaction in appendicitis is little. In conjunction with leukocytosis, a mass in the right iliac fossa could be determined to consist of thickened omentum only or to be an abscess, but such refinements of diagnosis are rarely needed. It is in the early stages of appendicitis that we need the most assistance, and yet must depend entirely upon the bedside diagnosis.

Dr. Warren is at present investigating the iodine reaction in appendicitis cases at the German Hospital and has given me the following tentative statement: "The iodine reaction was found to have the same meaning as leukocytosis in most of the cases,

and the increase of the white blood corpuscles usually went hand-in-hand with the intensity and extent of protoplasmic colouration of the leukocytes by the iodine stain.

“In catarrhal appendicitis, uncomplicated, the reaction is negative, and in cases of abscess, gangrene or peritonitis the reaction is most pronounced.

“With the complete blood count and the clinical symptoms, the presence of iodophilia is more to be depended upon as an index of toxæmia than is an increase of leukocytes.

“The latter condition is modified by the reaction of the individual, the degree of sepsis and other factors often unexplainable and hence at times unreliable. On the other hand the affinity of the degenerated protoplasm of the leukocytes for iodine is seen in all toxic cases of appendicitis and the intensity of staining is usually in direct relation with the degree of toxæmia.”

Erythrocytes and Hæmoglobin Change.—The red cells are unaltered in quantity and quality, except in cases of long standing abscess when necrobiotic changes and oligocythæmia are observed. The hæmoglobin is more easily influenced by the presence of suppuration, frequently falling 30 per cent. in a few days. Neither of these changes is of any importance in the subject of appendicitis.

POST-OPERATIVE CHANGES IN THE BLOOD.

After operation, even upon nonsuppurative cases, a leukocytosis may be observed. An increase of 5,000–15,000 is commonly observed over the count before operation, but this subsides in about three and a half days (Frazier and Holloway). If the increase is sustained certain complications are to be feared:

I. The opening of new avenues of infection by the breaking up of limiting adhesions during the operation. Such a cause may result in a leukocytosis lasting a week or more. The iodine reaction is also of some value as indicating the amount of septic

absorption from the focus of infection and may be intense even without marked leukocytosis.

II. Decline of the leukocytes to the normal followed by a rise usually means a secondary abscess, spreading peritonitis, pylephlebitis, liver abscess, etc., which must be differentiated by the clinical signs and symptoms. For instance, chills, fever, and no leukocytosis would require a diligent search for the malarial plasmodium; with leukocytosis the question of pylephlebitis or liver abscess would have to be considered.

III. Intestinal obstruction is always followed by a rise in the leukocytes. Bloodgood states that if there is a count of over 20,000 within the first twenty-four hours, the chances are that gangrene is present, and that later the count will fall.

PROGNOSIS.

The prognosis in a given case of appendicitis has reference, first, to the attack from which the patient may at the moment be suffering, and, second, to the future health of the patient. There can be no question that under all circumstances appendicitis is a most serious disease. It resembles certain other diseases—typhoid fever, for instance—in that at the time of examination of the patient the local and general conditions may be such that the unwary would give a favourable prognosis, whereas the judicious and conservative physician or surgeon, from his knowledge of the morbid processes at work, states that the present condition of the patient is favourable, but at the same time frankly acknowledges his inability to foretell what may occur within the coming hour. An attack of typhoid fever may be pursuing a favourable course until, entirely unannounced, intestinal hæmorrhage or perforation occurs and completely alters the aspect of the case. Similarly, a patient suffering with appendicitis may be progressing favourably, when suddenly gangrene or perforation of the appendix or rupture of a circumscribed peri-appendicular abscess may occur, and his condition may become most serious.

With reference to the attack of appendicitis from which the patient may at the moment be suffering, it is doubtless true of appendicitis, as of other diseases, that a certain proportion of cases will do well and ultimately recover under any treatment dictated by reason and the requirements of hygiene. It is claimed that from 80 to 90 per cent. of all cases will recover under medicinal, as opposed to surgical, treatment. But too frequently

I have seen patients who were apparently recovering, or who were accounted as having already recovered, suddenly lapse into a critical condition, and sometimes die in spite of the most heroic measures to prolong their lives. The reason for this sudden change, and the possibility of its occurring at any moment, must be evident to all who have the slightest acquaintance with the pathology of appendicitis. The likelihood of the subsidence of the inflammatory phenomena in an appendix and of the return of the organ to a healthy condition decreases, moreover, with the increase in the number and severity of the attacks. The reasons for this will be evident to those who read the chapter on the Pathology of the affection

Specifically, the prognosis in many of the cases that are characterized clinically as mild, in which there is no demonstrable tumor, but little tenderness, and slight fever, and in which the lesions are probably catarrhal or a minor grade of interstitial alterations, is good with reference to the subsequent health of the patient. The prognosis with reference to the recovery from the attacks is good only with the important reservations that it becomes progressively worse with each succeeding attack, and that we are unable to state at what moment the pathological alterations may become much aggravated, and perforation or gangrene of the appendix ensue. Then it must also be borne in mind that relatively mild clinical manifestations may be associated with serious anatomical lesions, and that from the presence of the former we are not warranted in assuming the absence of the latter. The prognosis as to recovery from the attack is good, particularly in those of this class of cases in which a rapid amelioration of symptoms follows the institution of rational medical treatment. These cases often terminate favourably without recourse to operative measures, but the appendix remains in a diseased condition, and is liable at any time to develop most acute exacerbations of inflammation, with all their attendant dangers. The general health of the patient, moreover, can-

not be considered a reliable guide in the question of prognosis; the robust and healthy are quite as liable to develop unfavourable symptoms as are the weakly and ill-developed. But age and sex have some bearing upon prognosis, although their importance is often exaggerated; children and females have in my experience been more fortunate in recovering from appendicitis than have adult males.

Those cases that present evidences of suppuration or cellular infiltration are next in severity to those characterized clinically as mild cases, where no tumor can be detected. These cases with demonstrable tumor, marked tenderness and rigidity of the abdominal muscles are always most grave; and the careful physician or surgeon is always most cautious in his prognosis where such symptoms exist. In most of these cases we are warranted in assuming the presence of pus, but we are unable to state whether the appendix is perforated or gangrenous, whether rupture of a peri-appendicular abscess into the general peritoneal cavity or into the intestine or other intra-abdominal organ is imminent, or whether erosion and necrosis, or thrombosis of one of the iliac vessels is developing, etc. Such is the serious import of these conditions, concerning which we can state nothing definitely, that the prognosis, under such circumstances, is at most a mere hazard.

Such being the condition of affairs, it is evident that the prognosis in a given case of appendicitis depends more upon the form of treatment instituted at the onset than upon any other factor. If the appendix be skillfully removed within twenty-four hours from the commencement of the attack, the prognosis is favourable, and recovery will ensue in all but the most exceptional cases. As will be seen in the chapter on the Treatment of appendicitis, the mortality from this disease itself, before peritoneal complications have developed is, when treated by removal of the appendix, less than 1 per cent. This gives therefore a very much better prognosis both as to immediate and as to ultimate recov-

ery than does any other form of treatment. It is however, undeniable that a few cases will recover from their first acute attack without operation, and that a small percentage of these few cases may have no return of symptoms. As has been repeatedly urged in these pages, the surgeon cannot usually tell from the symptoms whether a case is progressing favourably or not; and in those apparently mild cases where it seems evident that the progress is favourable, he cannot be sure that perforation or gangrene will not occur without warning in the course of the next hour or two. This uncertainty is particularly present in cases where the opium treatment is adopted. Such is the apparent amelioration of symptoms that follows the use of this drug that the surgeon is often led to infer that the progress of the disease has been checked or that recovery has resulted. In many of these patients, however, despite the abeyance of symptoms, the disease is steadily progressing, and the physician's attention is finally attracted to the serious condition of the partly narcotized patient by the distended and tympanitic abdomen, the "leaky" skin, and the rapid, irregular and weak pulse.

The prognosis is materially influenced by the conditions found at operation. These are discussed at considerable length in the chapter on the Complications and Sequels of Appendicitis, under the heading of Complications of the Operation.

If the appendix is but slightly altered, and there is only a small amount of serous or sero-fibrinous exudate about the appendix, the outlook is most favourable. Patients with such conditions should not die; and it will be found that deaths following an operation undertaken at this stage of the disease are as a rule due to some extraneous and independent cause, such as croupous pneumonia, pulmonary or cerebral embolism, or other unavoidable disease.

If there is a circumscribed peri-appendicular abscess, shut off from the general peritoneal cavity by a firm fibrinous exudate, no matter whether the appendix be perforated or gangrenous,

the prognosis, with certain reservations, is good. These reservations have reference to the kind of treatment adopted prior to the operation, to the condition of the patient at the time of operation, to the care practised in the administration of the anæsthetic, to the skill exercised in the operative manipulations, to the thoroughness with which all purulent foci are evacuated, together with the preservation of the general peritoneal cavity from infection; to the presence in the patient of other diseases, such as tuberculosis, heart disease, nephritis, etc.; to the character of the drainage established and that of the after-treatment adopted. If before the operation the patient has been either weakened through excessive purgation, or narcotized with opiates, his general condition at the time of operation will usually be such that the outlook is grave; he will be unable to endure a thorough operation, and at times all that can be done is to evacuate the abscess without either removing the appendix or breaking down the adhesions to search for outlying collections of pus, and to make sure that leakage of the abscess into the peritoneal cavity beyond the adhesions has not already taken place. Where heart disease or nephritis is present the operative risk is naturally much increased, not alone from the conditions surrounding the appendix, but from the anæsthetic as well; and where tuberculosis is present, even if no active abdominal form of the disease is noted, yet the tendency towards prolonged suppuration and at times the formation of a fæcal fistula is marked.

If there is a general peritonitis of whatever variety, the outlook is ominous. Such conditions are sometimes found that it can be stated with positiveness that the patient will certainly succumb. In some rare cases the inflammatory process is of such a fulminating character that it may be impossible to secure the services of a surgeon sufficiently early to prevent a fatal termination. In some cases it seems as if the fatal termination was inevitable from the outset, and that no matter how early or how skillfully an operation had been performed, it would not have

availed to rescue the patient. Such cases are exceptionally rare.

Presuming that a patient recovers from an attack of acute appendicitis, the prognosis with regard to his subsequent health varies with a number of circumstances. The chief factor to be considered is whether or not the appendix was removed at the primary attack. Even if it was removed it does not unfortunately follow that the patient will necessarily be free from all further abdominal trouble. In cases operated on in the early stages, however, the likelihood of the formation of any adhesions sufficient to produce even the slightest discomfort is quite remote. When adhesions were already present at the time of operation, however, the case is very different. In my experience intestinal obstruction has occurred in nearly 2 per cent. of the cases, at some time or other after the operation. Where the appendix has not been removed during or immediately subsequent to the first attack, the prognosis is much more gloomy. Nearly 80 per cent. of my cases have had more than one attack of appendicitis, and while there are some cases in which each successive attack becomes milder in character, yet a large majority of patients sooner or later are compelled to undergo an operation, either because the constantly recurring attacks incapacitate them for work, or because suppuration, gangrene, perforation or general peritonitis finally supervenes. A few patients have a mild or even a moderately severe attack, recover, and never have any further symptoms. In general the milder the primary attack, the more is the likelihood of such being the case, but this is by no means an invariable rule. In the majority of cases recurrences sooner or later develop. Most of these occur within the first six months after the first attack; there are fewer within the succeeding six months; and the likelihood of recurrence decreases with each succeeding year. Occasionally, however, a recurrent attack is noted after an interval of fifteen or twenty years. Multiple recurrences are extremely common, and such

is the natural course of the disease that it may be stated that an appendix once the seat of inflammation is prone to be again affected. As it is impossible to presage either the time or the severity of the recurrence, a diseased appendix is a menace to life as well as to health as long as it remains in the body. If the danger from adhesions is present even after removal of an appendix during the first attack of the disease, it is evident that this danger is very much increased as long as the appendix remains in the abdomen. Adhesions to the parietal peritoneum, omentum, cæcum, colon, small intestine, bladder, pelvic organs, etc., may occur and give rise to a diversity of distressing symptoms, and these adhesions when firm and of long standing necessarily complicate the secondary operation and render the prognosis more unfavourable. In general it may be stated that the milder grades of appendicitis which subside with the formation of extensive adhesions exert more of an influence upon the prognosis than those cases of suppurative appendicitis in which the abscess ruptures spontaneously into the bowel or where the operation has been limited to the extra-peritoneal evacuation of such pus collection. The latter group of cases do not cause symptoms referable to the appendix region, nor do the lesions recur with nearly the same frequency as those with extensive adhesions. In some of these fulminating cases it is possible that the appendix is destroyed by the intensity of the primary inflammation, and that this fact explains the subsequent freedom from recurrence.

TREATMENT.

The treatment of appendicitis is based upon one of two sets of principles that are popularly known as the medical and surgical respectively. That adopted in the individual case will depend in great measure upon the preconceived ideas of the attending physician or surgeon, upon the peculiar circumstances of each case, and upon the accessibility of special treatment. Aside from my own observations and experience, it can be definitely stated that nearly all surgeons and most clinicians agree that the best results are obtained by removing the diseased appendix as soon as the diagnosis of appendicitis has been made—provided the diagnosis has been made early and there are no complications that render immediate operation unjustifiable.

In my own practice I urge operation even in the so-called preinflammatory stage, that of appendiceal colic, in preference to facing the risk of a perforated appendix, abscess or diffuse peritonitis.

It is essential that physicians appreciate the importance of early operation, as although there may be a few patients who for one or several reasons cannot or will not have the benefit of operative procedure, the vast majority will depend upon the attending physician for advice. While it is impossible to formulate rules that shall govern the treatment of all cases of appendicitis, I am nevertheless convinced that it may be stated as a maxim that unless there are some constitutional contraindications, the appendix should be removed immediately if the diagnosis has been made early. Those physicians and surgeons who advocate the employment of medical treatment exclusively, or who postpone operation

until it is no longer a matter of choice but of necessity, do not claim a recovery rate under medical treatment of more than 80 or 85 per cent., at the most. They freely acknowledge that the remaining 15 or 20 per cent. will sooner or later either require an operation, or will die without one. In cases that demand operation because medical treatment fails to cure them, the disease has spread beyond the appendix, and the mortality from operation, instead of being less than 2 per cent., as it is when operation is undertaken at the proper time, varies from 10 to 12 per cent. in the cases where suppuration is only local, to 30 and 33 per cent. where general peritonitis has developed.

It is a fact that a certain percentage of cases will temporarily recover without operative procedures; some patients even may never have more than a single attack. But it is nevertheless true that no one can foretell which case will terminate favourably or which will progress to gangrene and the attendant peritoneal and other complications and sequelæ.

The first question that arises after the diagnosis of appendicitis has been established, is that concerning the character of the attack, the nature of the pathological process at work, and the probable outcome. It is in this connection that we have to face a condition not a theory. As already stated we cannot foretell with even the slightest amount of assurance the issue of an attack of appendicitis, nor can we be certain of the nature of the lesions of the appendix from the clinical manifestations. The main point to consider then, is, shall we risk the patient's life, or shall we adopt the only alternative and remove the diseased organ in its incipient inflammation? In this affection early operation is a truly conservative procedure, while at the same time it removes the disease by its roots. We are not governed by the same reasons that influence us to perform the radical operation for the cure of a simple hernia, or for the removal of the uterus for a fibromyoma. In appendicitis we face the probable consequences of suppuration, gangrene and perforation of the appendix and various

lesions of the peritoneum, to say nothing of the lethal complications and sequelæ. The proportion of patients who have but one attack of appendicitis and remain perfectly well after its subsidence is so very small as compared with that great army who have repeated attacks, with intervals of more or less invalidism, that the exception should not interfere with the operation of the rule. In my experience from 75 to 80 per cent. of patients have had more than one attack of appendicitis. This justifies the statement that in all cases of appendicitis the diseased organ should be removed, and, as has already been stated, this is most safely done in the earliest hours of the attack.

It is sometimes advised to delay operation until there is evidence of the presence of pus; to defer it also, if there is any doubt as to the pus formation, or to wait until the leukocyte count rises or falls. But a knowledge of the exact condition of a diseased appendix within the unopened abdominal cavity is possessed by no one and can only be surmised from the clinical symptoms observed. How often the latter are fallacious guides has been clearly shown in the preceding chapters, and it is difficult to conceive why it should be advised to await the formation of pus, since this event adds greatly to the danger of the operation, in that the most extensive absorbing surface—the peritoneum—is involved. In every case of fatal appendicitis I believe there was a time when operation would have been followed by recovery. One need only picture to himself the two operations—the one for the removal of the appendix without the association of pus; the other the excision of an appendix bathed in pus—to arrive at the only reasonable conclusion. In the first instance there is a clean abdominal incision; the appendix is readily removed; the opening in the wall of the cæcum is sutured, and the abdominal wound is aseptically closed—an ideal operation. In the second instance there is opened a collection of foetid pus, which, in its escape, comes in contact with the incision and its contiguous parts; the appendix is excised under unfavourable circumstances and with the possibility

of infection of the general peritoneal cavity; the abdominal wound cannot be closed, but must remain wholly or in part open to afford drainage; and there is the subsequent tedious healing by granulation, while the later developement of a ventral hernia is sure, to say nothing about intestinal obstruction, which occurs in one of fifty or sixty cases, or the various forms of sepsis. Moreover, in cases where suppuration with its complications, has occurred, convalescence is prolonged to a period varying from six weeks to six months or more, and at the end of this time a secondary operation may be required for the cure of a ventral hernia or a fæcal fistula.

That delay is dangerous in the great majority of cases is certain; that a few patients will recover from the disease without operation cannot be denied; that some patients will experience more or less subsidence of the acute symptoms must also be granted; but that anyone can foretell the outcome of an attack I most emphatically deny. Those who are least decided upon the question of operation are they who have been most limited in their experience.

The practice of deferring operation for a few days, in the hope that the limiting membrane that forms the partition between the collection of pus and the general peritoneal cavity will become stronger, is a procedure that is usually unwise and may be attended by risks both immediate and remote. Where, however, the disease shows an undoubted tendency towards localization, delay, though dangerous, may be less so than immediate operation. Such a decision calls for the exercise of the ripest judgement, and must be made on the merits of the individual case. The immediate risks of such delay are general septic infection of the peritoneum, metastatic abscesses, pylephlebitis, abscess of the liver, etc. The remote risks are gangrenous perforation, spontaneous separation of the appendix from the cæcum, spontaneous division of the appendix in its continuity, necrosis and perforation of the cæcum from pressure of the suppurating focus against its walls, fæcal fistula, etc.

In a book purporting to be a guide, not only for the experienced surgeon, the expert diagnostician, or the occasional operator, but also for the great multitude of conscientious physicians in all parts of the country who are striving to alleviate the sufferings of their patients, any description of treatment must be outlined to the fullest extent. It must comprise that appropriate during an attack and that to be practised during the intervals between attacks, and discuss in an intelligent and impartial manner, as far as personal experience can permit strict impartiality, the various methods of medical and surgical treatment.

In the light of an extensive personal experience—several thousand cases—the principle may be stated: *That in every case of appendicitis, seen early, operation is indicated regardless of the mildness of the attack and regardless of the severity of the attack (in the absence of a spreading peritonitis).*

In stating as the principle of the treatment of appendicitis that the diseased organ should be removed immediately if the diagnosis has been made early, I am not unmindful of the fact that, speaking broadly, the attending circumstances are of great significance in determining the treatment to be adopted in many cases. It is sometimes impossible to institute early operative procedures for one of several reasons. The patient may not live within reach of a competent surgeon; he or his family may not be willing to have surgical treatment pursued until it has become evident that the patient's only chance of recovery is by operation; or there may be some serious accompanying or underlying disease, such as pneumonia, or advanced nephritis, diabetes, tuberculosis, etc., that forbids active measures. Under such circumstances expectant or so-called medical treatment is the only alternative.

THE MEDICAL TREATMENT.

The medical treatment of those patients upon whom operation is impossible or contraindicated must comprise that appropriate

during an attack, and that to be practised during the interval between attacks. The first includes the general management of the case, attention to the diet, local applications for the relief of pain, and the administration of laxatives, enemas, and such other medical remedies as the occasion may warrant. The treatment to be pursued during the intervals is chiefly of a hygienic nature.

In the general management of an **acute attack** of appendicitis it is most important to insist upon absolute rest in bed. As soon as the first indications of appendicitis manifest themselves, even if the diagnosis is not positive as yet, the patient should go immediately to bed and remain there until complete recovery has resulted. He should be cautioned not to move about too much in bed, and strict quiet must be enjoined, in the early hours of the attack at least. Too early and too vigorous movements have been known to result in relapse of the condition, attended by most serious consequences. The patient should make use of the bed pan and urinal, under no circumstances being allowed to sit even on a *commode*.

The general management of the sick room does not differ from that appropriate in any other serious disease.

During the first few hours of the attack all *nourishment and liquids* must be withheld, the object being to secure rest of the alimentary canal, thus preventing peristalsis. For the same reason purgatives are contraindicated, except as will be mentioned presently. If vomiting persists, as it does in some severe cases, the stomach should be emptied with the stomach tube, and thoroughly washed out with warm water or warm saline solution. In children this is not always practicable, but may be attempted. No nourishment should be administered by the mouth, and when vomiting is persistent even water should be withheld. In the meantime, if the patient's condition necessitate it, nutrient enemas should be administered. They are often given needlessly soon. It is to be remembered that almost every individual has a certain amount of reserve nutriment stored up in his tissues; and the

senseless thought that seems to possess some physicians that food must be immediately forced into every sick man, in quantities nearly approaching those of health, even if the quality be different, is an idea neither founded in reason nor justified by experience. The old adage of our forefathers, to starve a fever, is a good one, and may be advantageously recollected at the present day. It is rarely requisite to administer nutrient enemas until eighteen to twenty-four hours after the onset of the attack; frequently they are not advisable until forty-eight hours have elapsed.

Nutrient *enemas* may consist of from four to six ounces of milk, peptonized for half an hour, to which may be added the whites of one or two eggs, and half an ounce of brandy. Some of the commercial preparations of beef, or predigested meat may be substituted for the brandy, if this proves irritating to the rectum; and the whole quantity of nutriment may be diluted up to the limit of a pint with the saline solution. Such an enema may be administered every six or eight hours, according to the circumstances of the case; and at least once in twenty-four hours the rectum and lower colon should be irrigated with warm water or normal salt solution, to remove the accumulated residue. It is usually better to give small quantities of nourishment by the rectum at frequent intervals, than to risk having the whole enema rejected, which will be the case if it is too large. It may be well to state that enemas which have been given judiciously may act injuriously by occasionally causing marked peristalsis, and even, in a case which I have observed, be forced backward to the cæcum and empty into the peritoneum through a perforation.

After the vomiting has ceased nourishment should not be given by the mouth for at least thirty-six to forty-eight hours, and then only in small quantities with two hour intervals. The most appropriate nourishment to commence with is egg albumen, and then if the stomach remains tolerant, animal broths may be administered, and later, milk, plain, with lime water, or peptonized. Milk to be taken into the stomach should not be peptonized more than five or

ten minutes, since when the process is longer continued the mixture becomes exceedingly bitter and nauseous; nor does the stomach require, for ready absorption, the advanced stage of peptonization demanded by the colon. Natural milk is as a rule contraindicated, because of the likelihood of the formation of indigestible curds, and because it tends to constipation and tympanites, but when given is best combined with lime water, one part of lime water to three of milk, or in weaker dilution. A small amount of weak tea may also be permitted, if especially desired by the patient. Thirst may be alleviated by simply rinsing the mouth, and by saline enemata; water is not absorbed by the stomach, but a pint of salt solution is readily absorbed by the colon in an hour's time.

As convalescence becomes established the quantity of food may be increased and the intervals lengthened, and calvesfoot jelly, milk-toast, soft boiled or poached eggs, etc., may be added to the dietary. The return to ordinary diet should be gradual. After convalescence, and in cases of chronic appendicitis, the diet must be chosen with especial care, and must be easily digestible.

If this line of treatment is carried out strictly, the pain usually subsides very soon, and is rarely of such severity as to require morphine for its relief. The question of the administration of morphine in appendicitis is discussed in detail at page 361.

If there is a clear history of the ingestion of indigestible food, a *cathartic* is evidently indicated, if the patient is seen at the outset of the attack, to rid the intestinal tract of the irritating residue. The best drug for this purpose is castor oil. It may be given from a spoon that has been chilled by standing in ice water, or by overlaying it with the froth of porter. So taken it is not nauseating; but if for any reason it cannot be taken, small and repeated doses of calomel, in powder form, may be administered. Any purge, if given, should be taken early in the attack of appendicitis. At a later stage, or if repeated, it will only produce added irritation by provoking unnecessary peristalsis. The per-

sistent use of salts in this disease I have come to regard as harmful in the extreme; they produce repeated and watery stools, with well-marked peristalsis, and any beneficial action derived from the drainage of the cæcum which they may produce, is completely over-balanced by the excessive peristalsis caused, which by its churning movements not only gives the inflamed appendix no chance to become resolved, but may spread infection throughout the abdominal cavity.

Of the local applications which exert a favourable influence when applied to the right lower abdominal quadrant, an *ice-bag* is by far the most suitable. The use of the ice-bag should be commenced in the incipiency of the attack, and it may be kept on continuously until convalescence is well established. By continuously, I mean without interruption: only too often the patient is left without any ice-bag while the melted ice is being replaced by fresh, with the result that his abdomen is alternately frozen and thawed, and the purpose for which the ice-bag is applied is not attained. Dry cold, in the form of an ice-bag, a Leiter's coil, or Petitgand's apparatus, is much preferable to moist cold; it acts as a local anæsthetic, and may possibly lessen the congestion of the appendix and neighbouring peritoneum. One most important result of the use of the ice-bag should never be forgotten, and this is that like opium the ice-bag may allay the pain and tenderness, obscure the other symptoms, and mask the clinical picture of the true pathological lesion. The too prolonged use of cold may also result in superficial necrosis of the skin and subcutaneous tissues; but this rarely occurs if care is taken to interpose a fold of lint between the ice-bag and the skin, and to keep the skin dry. It is indispensable that the ice-bag be water-tight; otherwise the clothing and bedding of the patient will be wet, and he will be exposed to the risks of pleurisy, pneumonia, etc. If the weight of the ice-bag produces discomfort, it should be slung from a cradle, so that it is just in contact with the skin, but does not rest upon it.

Occasionally *hot applications* will be found more grateful to the

patient, and selection may be made of a hot water bag, various sorts of hot fomentations, etc. The topical application of tincture of iodine, blisters, leeches, and other forms of counter-irritation, is especially contraindicated, not only because they do no good, but because they add materially to the patient's discomfort. Blisters and leeches are the most objectionable of all because of the macerating effect they exert upon the skin, thus making a septic field for operation, if such be undertaken.

Of all the therapeutic agents that have been used in the treatment of appendicitis, *opium* is the one that has been most frequently responsible for mistakes in diagnosis, and there is a percentage of deaths in appendicitis that, beyond a doubt, is due to the indiscriminate and injudicious use of this drug. It is claimed by the advocates of the opium treatment that this drug relieves the pain, and, by the inactivity of the intestine that it induces, favours adhesive inflammation of the peritoneum, and thus permits of the protection from infection of the general peritoneal cavity. These are facts which it would be extremely difficult to gainsay; but that they constitute a valid argument for the adoption of the opium treatment, I think no modern surgeon will admit. The aseptic removal of the origin of the disease in its incipiency cures the patient immediately and without chance of relapse, the mortality of such an operation in the hands of competent surgeons being no greater than 0.5 per cent.; while delay, even with all the benefits claimed for the opium treatment—and these are by no means always present—will expose at least fifteen or twenty patients out of every hundred to the dangers of perforation, gangrene, abscess formation, or general peritonitis, with the very much greater mortality from operation under such circumstances; and the remaining eighty or eighty-five patients who recover will still have in their abdomens an appendix ready at the slightest instigation to become re-inflamed. When localized suppuration was the only form of intra-abdominal disease successfully amenable to surgical treatment, it was a very great advance in thera-

peusis, as has been pointed out in the chapter on the History of Appendicitis, to be able to convert nearly all serious cases of right iliac inflammation into abscesses; but for surgeons with the advanced facilities of abdominal surgery of the present day to cling to this form of treatment, is to me incomprehensible in the extreme.

Opium is said to relieve the pain. Certainly it does. No one can deny it. But it does not cause a cessation of all cell activity, and the process of cellular infiltration, ulceration, perforation, or gangrene, continues uninterruptedly. Even if cell activity was entirely checked by the opium, still it would not cure the disease; it would merely keep the appendix stationary in its primitive condition of inflammation. The pain, moreover, is relieved with very nearly as much certainty by clearing the bowels (if overloaded) by one purge or by an enema, and by rest in the recumbent position with the local application of cold, as already described. If the pain recurs, this is a symptom which constitutes, as previously mentioned, one of the most urgent indications for immediate operation; yet, if the patient has had his sensibilities obtunded by opiates the pathological changes which produce this secondary pain in the sensitive patient will in him pass unheralded by any clinical manifestations whatever, and the patient may die in the uncomplaining quiescence of an opium stupour.

The battle of opiates *versus* purgatives has been so thoroughly waged during the last decade or two, that it seems useless to continue the discussion further. Surgeons who were extremists have gradually abandoned their advanced positions on both sides of the question, and I think I may truthfully say that it is extremely rare at the present day to find any surgeon who employs only the opium treatment, or one who never uses opium in any of its forms in the treatment of appendicitis. For many years I was myself an ardent advocate of the treatment of appendicitis, both before and after the operation, by means of saline purgatives, while insisting in season, and possibly it will be thought out of season at

times, upon the earliest possible removal of the appendix. My conviction as to the paramount necessity of early operation has only been deepened by a much extended experience with this disease; but I have come to regard the use of purgatives as not only useless in the majority of cases, but as positively harmful in some. While I have advised on a previous page that a laxative should be employed where a history of the ingestion of indigestible food was obtained, I have insisted that it be given only early in the attack. I have seen a great many too many cases of appendicitis sent in to the hospital for operation in which there was little room for doubt that the excessive peristalsis caused by the persistent administration of salines had only more widely diffused the septic matter in the abdominal cavity, and was in large measure directly responsible for the presence of diffuse peritonitis. The mortality of cases which have reached this stage is only too well known. On the other hand patients who have had opium administered to them usually are brought to the hospitals with localized inflammation or an abscess; and the mortality of such cases is decidedly less than that of those attended by general peritonitis. Let it not be thought that this is an argument in favour of the opium treatment—far from it—but I think the conclusion cannot be avoided that of the two, the purgative treatment is the more harmful. If the pain is severe, and is not relieved by the methods already indicated, I do not think it unjustifiable to administer a hypodermic injection of morphine, *provided* the diagnosis of appendicitis has been conclusively made, and preparations for the operation are under way. But I do think the employment of morphine for a suspicious pain before a diagnosis is made is a procedure most dangerous to the patient and inimical to the reputation of the physician.

Treatment Between Attacks.

If a patient under the above or similar treatment is so lucky as to recover from his first acute attack of appendicitis, it is in

my opinion the duty of his attending physician to advise the removal of the offending organ as soon as his convalescence has passed. The appendicular inflammation has become chronic, and in nearly all cases the patient will be subject to recurring attacks, and will be more or less of an invalid during the intervals. It must also be borne in mind that there are certain results of the inflammation that are not manifest to the patient, such as bands of peritoneal adhesions; that these may cause obstruction or chronic inflammation of the intestine, etc.; and that they may inaugurate their deleterious consequences at any moment.

Hence under no circumstances should any one who has once had an attack of appendicitis, and whose appendix has not been removed, ever consider himself safe from recurrence; and he should never deprive himself of the facilities for operative treatment, which may at any moment be imperatively demanded. To indulge the hope that the lumen of the appendix has become obliterated is, to say the least, worse than foolish.

To prevent recurrence of an attack, the patient positively refusing operation, he must live by rule, considering himself a semi-invalid. He should be cautioned to lead a regular, hygienic and abstemious life, and to avoid dietetic and other indiscretions.

Attention must be directed to the *clothing*, which should be changed to suit the varying conditions of the weather, and which should afford sufficient protection without exciting the skin to undue activity. The feet especially must be protected against the inclemencies of the weather. Only the simplest and most easily digested *food* should be eaten, and of a kind that will leave least residue in the intestinal tract. All coarse food, such as grits, coarse oat-meal, tough meats, etc., must be scrupulously avoided. Not only must the food be selected with care, but it must be taken at regular intervals, and should always be eaten slowly, and be thoroughly masticated. There can be little doubt that the lunches of many business people—which usually consist of indigestible food, bolted without mastication, and at irregular hours—are a

fruitful source of recurring attacks of appendicitis. The condition of the *teeth* must be examined into, and, if necessary, a set of false teeth should be procured. Regular action of the *bowels* must be insisted upon. This may best be accomplished by the cultivation of regular habits in this particular, whether there be an inclination to stool or not; by a diet carefully selected for this purpose, including various laxative fruits, raw or stewed, such as prunes, apples, and dates, or oranges, figs, etc. There seems no reason to believe that the seeds of figs and other fruits lead to appendicitis. All purges should be avoided if possible, and attention should rather be directed to the treatment of the intestinal indigestion, which is usually the basis of the intractable constipation which is seen in some of these cases. If the constipation itself does not become the exciting cause of another attack of appendicitis, the use of cathartics and purges to overcome this constipation will be extremely apt to produce a recurrence; hence enemata are to be preferred whenever practicable. It must be borne in mind, however, that the intestinal indigestion which is present in these cases, and which is blamed for the chronic constipation, is not infrequently engendered or maintained by the associated appendicitis, and that relief cannot be expected under such circumstances until the offending appendix is excised.

It is barely possible that if any patient could be found who would be induced to lead a life of such exemplary regularity as is enjoined upon him, he might be free from further attacks of appendicitis for the rest of his life; but as such patients are the rare exception, it is not wonderful that from 75 to 80 per cent. of patients become subject to recurring attacks of greater or less severity. It is also the exception for the subsequent attacks to be milder than those which preceded; and when we consider the added difficulties in operation caused by the old adhesions, it is simply one more argument in favour of the removal of the appendix at the commencement of the first attack.

SURGICAL TREATMENT.

Surgical treatment may commence at any stage of the attack of appendicitis, but there are some stages in which immediate operation will do more harm than good. In every case in which it is proposed to resort to operation the medical treatment already described should be inaugurated at the earliest possible moment. Even under the most favourable circumstances some hours may elapse before the operation can be commenced, and during this time not only may much be done to alleviate the distress of the patient, but the preparation of the patient for the operation can be completed, so that as soon as the surgeon is ready for the patient, the patient will be ready for operation. The preparation required will be discussed in a later paragraph.

A question frequently arises as to whether it is safe to transport patients with appendicitis from their homes to the hospital before proceeding with the operation. I am firm in the conviction that any patient who would be rendered unfit for operation by the careful transportation in an ambulance, which is now nearly universally possible in cities of any size, would be equally unfit for operation in his home. The removal of patients who are already moribund with peritonitis and toxæmia is by no means to be advised; but if when seen in their homes they appear to be in fit condition to withstand even the least extensive operative procedures, I think their chances of recovery will be diminished rather than increased by undertaking in unfamiliar surroundings an operation which, though slight in itself, is yet, when the disease has passed into its graver stages, one of considerable risk. In such cases, moreover, it is extremely difficult, if not impossible, to satisfactorily carry out the after-treatment at the patient's home; and the chances of recovery will nearly always depend as much on the subsequent management of these patients as on the operation itself.

When the diseased appendix is removed early in the attack,

that is, within the first twenty-four hours, or preferably within the first twelve hours—the attack is at once terminated, the patient is subjected to the least possible immediate risk, and the remote complications are avoided. Among the latter may be mentioned perforation, gangrene, abscess formation, general peritonitis, faecal fistula, protracted convalescence, secondary operation, and the long list of complications referred to in the chapters on the Pathology and on the Complications and Sequels. When marshaling the evidence that decides us in favour of an early operation, we must bear in mind that, as already stated, it is impossible in the vast majority of cases to form a clear conception of the lesions of the appendix from the clinical manifestations. If the initial symptoms are severe, we may surmise a severe infection, and prompt surgical interference is imperatively demanded. On the other hand, apparently mild cases are often most deceptive as regards the lesions of the appendix. With a low pulse-rate, normal or subnormal temperature, pain diminished or absent, and lessened tenderness and rigidity, ulceration of the appendix, progressing to perforation and gangrene, may be making rapid headway. Only too often sudden cessation of the symptoms is indicative of gangrene. Operation under such circumstances is, of necessity, performed with much increased risk to the patient, and always offers a less promising outlook. An operation in the early hours of an attack of appendicitis is inadvisable only in the presence of some constitutional condition that would forbid the performance of any operation. Unwillingness of the patient or his friends, while a valid reason for delay, does not alter the indications for operation.

But after the early hours of the attack have passed by, and there is uncertainty as to the pathological condition present, the resort to operation becomes a much more serious thing. Where a well localized mass can be made out, the rest of the abdomen being soft and negative on examination, I advise immediate operation. It is not safe to leave these patients unopened more than a few

hours at the outside; for although the limiting membrane may not yield, and general peritonitis may not develop within this space of time, yet systemic absorption, slow but steady, is occurring, and septicæmia is imminent. Even if such a termination does not occur, the chances are great that pressure necrosis of the cæcum or some neighbouring coil of small bowel will be progressing, and that fæcal fistula will result. I regret to say it, but it is a fact which has, I am confident, been observed by every surgeon of experience, that physicians as a class, and as individuals, too, have not their tactile sense so developed as to be able to recognize the presence of pus, which is nevertheless to the surgical sense very apparent. The attending physician time and time again will say to the surgical consultant either that he thinks no pus has formed yet, or that he fears suppuration is impending, and will then stand by the operator's side and see the belly opened and behold pus spurt out in a stream; yet this same individual physician will still rely on his own ability to detect the earliest evidences of suppuration, and will continue to treat his patients by medical means to the great risk of their lives, and to the scandal of the medical profession. Even if medical men cannot be convinced of the propriety of early operation, I say it is a shame if they are not willing to call in a surgical confrère who has the judgement and the *tactus eruditus* to determine the moment when an operation is no longer a matter of choice but a crying need to save the patient's life.

Where physical examination after the first forty-eight hours detects no mass, exquisite tenderness may still be present, even when rigidity has disappeared. This may be taken as a pretty sure indication that gangrene of the appendix is progressing, and that delay in removal of the diseased organ will result in the development of peritonitis. There is rarely an abscess present if rigidity is absent, unless there is a mass palpable. Hence, if rigidity persists operation is as urgently demanded as when a mass is palpable.

If palpation detects neither rigidity nor a mass, it may be

still possible to elicit tenderness on deep pressure, or to feel the inflamed appendix itself, at the same time excluding the presence of peri-appendicular exudate. Under such circumstances the inflammatory process may be subsiding, or the appendix may have become gangrenous and sufficient time may not have elapsed for the development of spreading peritonitis. In the former case it will be safe to delay operation and to remove the appendix during an interval between attacks; in the latter case delay will allow general peritonitis to develop, and will jeopardize the patient's life. Unfortunately I do not think it is possible to tell from physical examination and the symptoms alone which of the two is the state of the appendix. Where it is gangrenous the tenderness will probably be more acute, but if the gangrene is complete tenderness may be insignificant. Hence in either case it is wisest to resort to immediate operation.

Where physical examination gives no clue as to the state of the appendix, I am in the habit of placing more confidence in the constitutional symptoms as a guide, in deciding whether an operation shall be undertaken or not.

When it is clear that the inflammatory process is no longer localized, but that peritonitis is spreading or is already diffuse, it is more difficult to lay down a rule of conduct for resort to operation. The reaction of the peritoneum is, at first, a mere exudation of serum, and formation of a fibrinoplastic exudate; but when the infectious material escaping from the perforated appendix radiates from the right iliac fossa toward the general peritoneal cavity a succession of pathological lesions results which interferes materially with the chances of a successful operation. The peritoneum reacts strongly against this infection, with the formation at first of a serous exudate, as emphasized by Moskowitz, and later by a fibrinoplastic material, which we call adhesions. The wave of infection radiating from the right iliac fossa towards the general peritoneal cavity may be halted at any time by these adhesions, and the infectious material confined

to a more or less circumscribed area. The resistance of the patient, the ability of the peritoneum to react, the number of micro-organisms, the virulency of their toxins, together with the position which the appendix occupies, determine the rapidity with which localization will occur.

The position of the appendix is of great importance in the prevention of a spreading peritonitis and has been more fully discussed in the earlier chapters of this book, and, as it will be remembered was noted there, the position where the appendix lies to the inner side of the cæcum predisposes more to infection of the general peritoneal cavity.

While definite rules can be easily formulated for the treatment of the localized abscess, the propriety of surgical intervention where the infection is spreading has been subject to much dispute and disagreement. It is impossible from a physical examination to state the pathological changes which are occurring when peritonitis is spreading, so that we must place much more reliance upon the constitutional symptoms than upon the physical examination of the patient. If we could see through the abdominal wall and know the exact condition of the peritoneum it would be more easy to speak positively upon this subject. If we could see that the peritoneum was more or less widely inflamed and the intestines were red, injected and lustreless, that there were few or no adhesions and that there was a sero-purulent exudate present, we could state with authority that the proper course to pursue would be to open the abdomen, rapidly remove the appendix and introduce thorough drainage. If we could look through the abdominal wall and were to see that the form of peritonitis was that known as the progressive fibrino-purulent, where abscesses are formed one after another and continue to spread their infectious material by continuity, I think we could positively say that the abdomen should be opened, the original focus of infection removed, secondary collections opened and evacuated and the regions of infection thoroughly drained.

The peritoneum has a vast absorbing surface, as great as the surface of the body, and when the infection from the appendix surges through the peritoneal cavity without check or hindrance, without effusion or exudate, we have to deal with a form of peritonitis, intensely deadly, and where but little is gained by immediate operation. The appendix is diseased perhaps, but the entire peritoneum is absorbing bacteria and bacterial toxins and nothing is gained by removal of the organ; to remove the source of systemic infection we should have to remove the entire peritoneum with most of its underlying tissues; moreover, there is nothing to drain. In such instances, operation should not be undertaken until all acute symptoms have subsided, when the appendix may be removed to prevent recurrence. But, as I have said before, we cannot always know until the abdomen is opened just what the state of affairs inside really is; we must in many cases rely more upon the constitutional condition of the patient and the evidences of systemic infection than upon the physical examination.

It is not usually very difficult to determine whether or not the patient has a spreading peritonitis, the uncertainty being as to the form of reaction on the part of the peritoneum. The principle of all nonoperative treatment of appendiceal peritonitis depends upon the fact that in the great majority of cases the infection will cease to spread after involving a variable area of the peritoneal cavity. The resistance offered by the leukocytes, the fibrinoplastic barriers, the neutralizing action of antitoxines, all combine to check the bacterial invasion and to endeavour to beat it back. If the vital organs of the patient were proof against *absorbed* poison the success of nonoperative treatment would be assured. But the effect of such poisons upon the cardiac, respiratory and vasomotor mechanisms is such that the patient succumbs about the time that the extension of the peritonitis has been checked, or from the additional shock of a later operation employed as a last resort. For these reasons the decision to employ a temporary nonoperative treatment must only be made after carefully con-

sidering the condition of the patient and the probable course which the disease is pursuing. I do not myself believe that delay is the proper treatment in all cases of spreading peritonitis, believing that until the gravity of the lesions of the general peritoneum exceeds that of the appendiceal condition, a surer remedy for the disease is to be found in removal of the original focus of infection, with drainage of the peritoneal cavity. But when it has become evident that the primary condition—appendicitis—is entirely overshadowed by the secondary condition—peritonitis—and that any operation will only hasten the fatal termination, then I think that a form of treatment based upon the withdrawal of food by mouth, the substitution of nutrient enemas and hypodermic stimulation, is the only one which gives these patients even a fighting chance for recovery.

It is difficult to draw a clinical picture of a type of peritonitis requiring operation and of one which is better treated by palliation. Distension, bilateral rigidity, general pain and tenderness are the most reliable symptoms in determining the presence of a spreading peritonitis; the temperature, the rate and quality of the pulse, and the leukocyte count, together with the appearance of the patient and the opinion of the surgeon as to the patient's resistance, are all matters of importance in deciding for or against immediate operation.

If, after the usual onset, the pain and tenderness having become localized to the right iliac fossa, the abdomen slowly distends, rigidity becomes bilateral and slight colicky attacks begin, the inference that leakage of the infection has commenced is justified. The patient and his family must again be warned against the danger of delay and advised that *peritonitis* has occurred. Operation is urgently indicated and while the mortality in such cases is not insignificant, yet it does not nearly approach that of the more diffuse peritonitis.

If the radiation of infection continues a time soon arrives when operation is contraindicated. When the abdomen is much

distended, the temperature high, the pulse rapid and of high tension, the patient's expression most anxious and indicative of very serious intra-abdominal infection, the bowels constipated and unable to cause the expulsion of flatus, and when vomiting is continuous and tenderness is diffused over the entire abdomen, immediate operation will in most cases be more likely to kill than to cure. The miserable resistance offered by the patient to the infection is evident by the absence of leukocytosis. It is useless to subject such patients to additional pain and the discomfort of operation without being able to offer even a remote chance of recovery by means of the operation.

Absolute rest must be enjoined, the abdomen covered with ice-bags, all food by mouth withheld and rectal alimentation substituted; enemata of saline solution and hypodermic stimulation should be employed. If vomiting persists the stomach should be washed out and a fly blister applied to the epigastrium. If, under such a course of treatment, which promises more than immediate operation, the symptoms begin to abate, it will usually be found that one or more localized abscesses can be detected. When localization of the pus occurs operation is indicated and the abscess must be opened, the appendix removed, if possible, and the cavity drained; even though subsequent operations may be required for fæcal fistula or a ventral hernia.

The appendix should be removed at the primary operation in all but exceptional cases. If the constitutional condition of the patient be extremely precarious it is undoubtedly the part of wisdom to complete the operation as simply and as speedily as possible; especially does this hold good in children. In such cases it is quite sufficient to open and drain the abscess, and to leave the appendix alone. Certain local conditions may influence us in deciding for or against the removal of the appendix at the primary operation. The appendix may not be found, or if found it may not be accessible by reason of extensive exudate which forms the wall of the abscess and in which the appendix is

buried. I fully realize the importance of thorough knowledge of the surgical anatomy and technique in finding and removing the appendix in such cases; and the occasional or inexperienced operator will do well not to prolong the operation too much, nor to destroy limiting adhesions in his efforts to remove an appendix. The removal of the appendix is also unwise in those cases in which it has formed dense adhesions with soft friable intestines, or when such intestines have formed adhesions among themselves—the slightest manipulation in some of these cases being sufficient to cause their rupture. In children, apart from the precarious constitutional condition often present, which has already been referred to, it is good surgery in some exceptional pus cases, to permit the appendix to remain for excision at a secondary operation, because the position that the appendix holds in children is higher in the abdomen than it is in adults; because the small size of the abdominal cavity in children renders the walling off by gauze of the unaffected portion of the peritoneum extremely difficult, or even impossible; because children do not stand prolonged anæsthesia well; and because such tedious operations reduce their resistance to subsequent sepsis. As Dr. Murphy has well said: “Where the patient is apparently overwhelmed with the intoxication from a circumscribed or diffuse peritonitis or inflammatory process, I content myself with making a simple incision in the abdomen and relieving the pus tension by the insertion of a large drainage tube without irrigation, without sponging, and without manipulation of the tissues. On the other hand, in the ascending stage of the disease, when the intoxication is not severe, even when the quantity of pus is large, circumscribed or not circumscribed, the appendix is removed. In other words, the extent of operation is governed by the constitutional symptoms of the sepsis rather than by the extent or character of the pathological changes.”

If the surgeon is familiar with the anatomy of the right iliac fossa in the normal condition, and has seen a sufficient number of

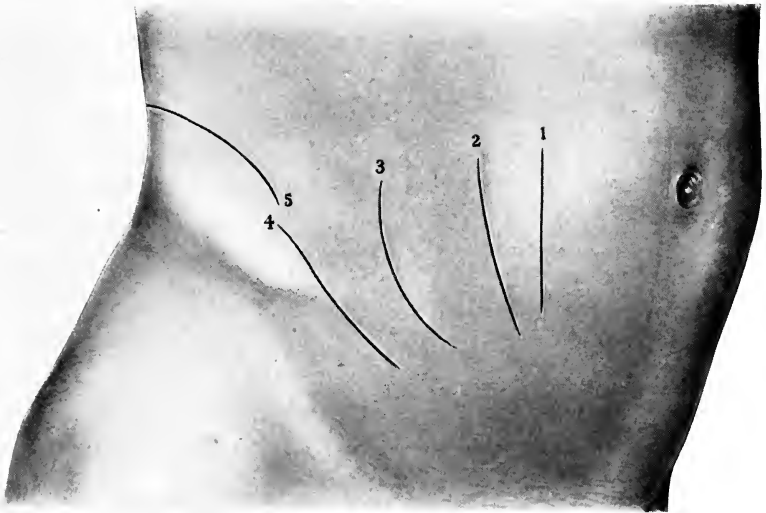
cases to make him acquainted with the conditions generally found in diseased states, he should be able to find the appendix in all cases. The search, however, is sometimes tedious and attended by difficulty. An appendix that is embedded in a wall of lymph, whether it form a portion of the abscess wall or not, can be removed with comparative safety, providing the operator has had sufficient experience and is dextrous in the treatment of this class of cases. The proper disposition of gauze and careful attention to other technique, in experienced hands, renders the dangers that attend the removal of the appendix much less than those that threaten the patient if the diseased organ be permitted to remain. A practice that is rather common is that of evacuating the abscess, and, after affording drainage, partly closing the wound, without attempting the removal of the appendix unless it lies in plain view. As a working rule it may be stated that no effort to remove the appendix should be attempted if risk to the patient is entailed.

TECHNIQUE OF OPERATION.

Under this heading it is convenient to consider: (1) The preparation of the patient; (2) the details of the operation itself; and (3) the after-treatment. The treatment of the various complications and sequels of appendicitis is discussed at considerable length in the final chapter.

Preparation of the Patient.—In acute cases of any severity the patient is usually in bed when first seen; but as already recommended, in no case should he be allowed to stay out of bed. In chronic cases the patient should be confined to bed for one or two days preceding the time set for operation, and his diet, as in acute cases, should be light and easily digested. The urine should be examined carefully at least once, and oftener if time permit, and what is most important the amount passed in the twenty-four hours carefully noted. These measures should never be neglected. An estimation of the hæmoglobin and a count of the white blood cells may also be made, both as a matter of record, and as a confirmation of the diagnosis as to the presence of pus. In brief, the same measures spoken of under the heading of Medical Treatment should be inaugurated, and continued until the time of operation. If the case is chronic, the patient's bowels should be evacuated by a laxative on the day preceding the operation, and in every case an enema should be given the morning of the day of the operation.

Where time and the constitutional condition of the patient permit, all demands of what may be called ordinary cleanliness should be met. That is to say the patient should receive a hot soap bath and be rinsed clean of epidermal scales. An entire change of the personal clothing of the patient and of the bed linen should be made. The entire abdomen and especially the pubic region should be gently scrubbed with tincture of green soap and all hair removed from these localities by shaving, after which a further and thorough scrubbing (using a piece of gauze or a soft brush) with



SKIN INCISIONS FOR APPENDICITIS.

1. The Simple incision through right rectus muscle. 2. Incision of Battle, Kammerer and Jalaguier. 3. McBurney's incision. 4. Hancock's incision. 5. Oblique lumbar incision.

soap and water should be made. The epithelial and fatty débris are then removed with alcohol, turpentine or ether, preferably the former, the abdomen rinsed with a 1 to 1000 bichloride solution, and a sterile towel or piece of gauze, which has been soaked in the latter solution and wrung dry, placed upon the abdomen. This towel is retained upon the abdomen by a circular or a Scultetus bandage until the surgeon is ready to commence the operation. When the dirt is ground in, as is sometimes the case with the lower class of ward patients, the local preparation described should be undertaken on the afternoon or evening of the day preceding the operation, and a wet dressing of corrosive sublimate (1 to 1000) should be left on the abdomen over night, and the cleansing process should then be repeated in the morning. If an abscess is present great care should be exercised not to rupture it by careless manipulation. In acute and very ill patients I think it is usually well to postpone this local preparation until the patients are on the operating table, and the administration of the anæsthetic has been begun. This plan materially shortens the time before operation is commenced.

When placed upon the operating table the bandage should be cut and removed and the patient covered with sterile sheets and towels, so as to expose the abdominal region; the gauze covering the abdomen should then be removed, and the field of operation be again washed with alcohol. The operation may then be proceeded with. Of course, it is not always possible to carry out this detailed preparation in all cases. It not infrequently happens that the operation has to be done at once or under other unfavourable conditions.

The Operation.—There are in use several *incisions* through the abdominal wall, each of which has its advantages in certain cases. In any case, the incision should be in the right iliac region, and should aim to secure the readiest access to the appendix, the greatest facilities for drainage (when this is required), and the least probability of subsequent hernia. The median incision for appendicitis cannot be too strongly condemned: it is not founded on

good anatomical grounds, and is therefore irrational and dangerous, particularly if pus complicates the case.

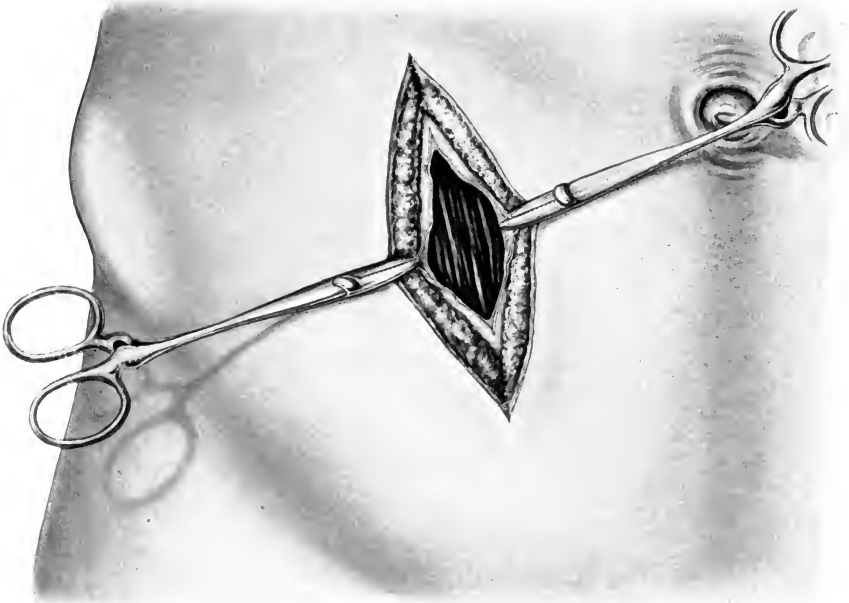
Abdominal incisions may be classed as *simple* and *combined*. In the former variety all the layers of the abdominal wall are divided in the same plane; and in the latter these layers are divided in different planes, the lines of the incisions crossing, as in the McBurney incision, or being parallel but not coincident, as in the incision practised by Battle, Kammerer, and Jalaguier.

That incision which I usually employ, and prefer for all but exceptional cases, is the *simple incision* passing through the outer half of the *right rectus muscle* (Plate xxx, 1). This incision is easy and rapid of execution, can be enlarged at will or made of insignificant size, affords ample drainage facilities, and is, I think, not more likely to result in hernia formation than any other incision. In most cases an incision of less than two inches is sufficient. I frequently remove the appendix in clean cases through an incision in the peritoneum only long enough to admit the index finger. The line of the deep epigastric vessels should be borne in mind, and the incision be placed above it. They run in an approximately straight course from their origin from the external iliac vessels just above Poupart's ligament to the umbilicus. Hence the lower end of an incision of about two inches in length need not divide them. After dividing the skin and superficial fascia, the anterior sheath of the rectus is exposed (Plate xxxi). This consists of two layers of fascia, the aponeurosis of the external oblique being readily separated from the sheath proper along the outer fourth of the muscle. By dividing these the fibres of the rectus muscle are exposed (Plate xxxii). These are then separated longitudinally with the handle of the scalpel (Plate xxxiii), and the posterior sheath of the rectus, the transversalis fascia and the preperitoneal fat are exposed. Below the semilunar fold of Douglas the posterior sheath of the rectus is deficient—usually below a line from one-third to one-half the distance from the umbilicus to the symphysis pubis. Each layer of the abdominal wall should be divided to



SIMPLE INCISION—SHEATH OF THE RECTUS EXPOSED.

Note that the lower end of the incision does not cross the line of the deep epigastric artery

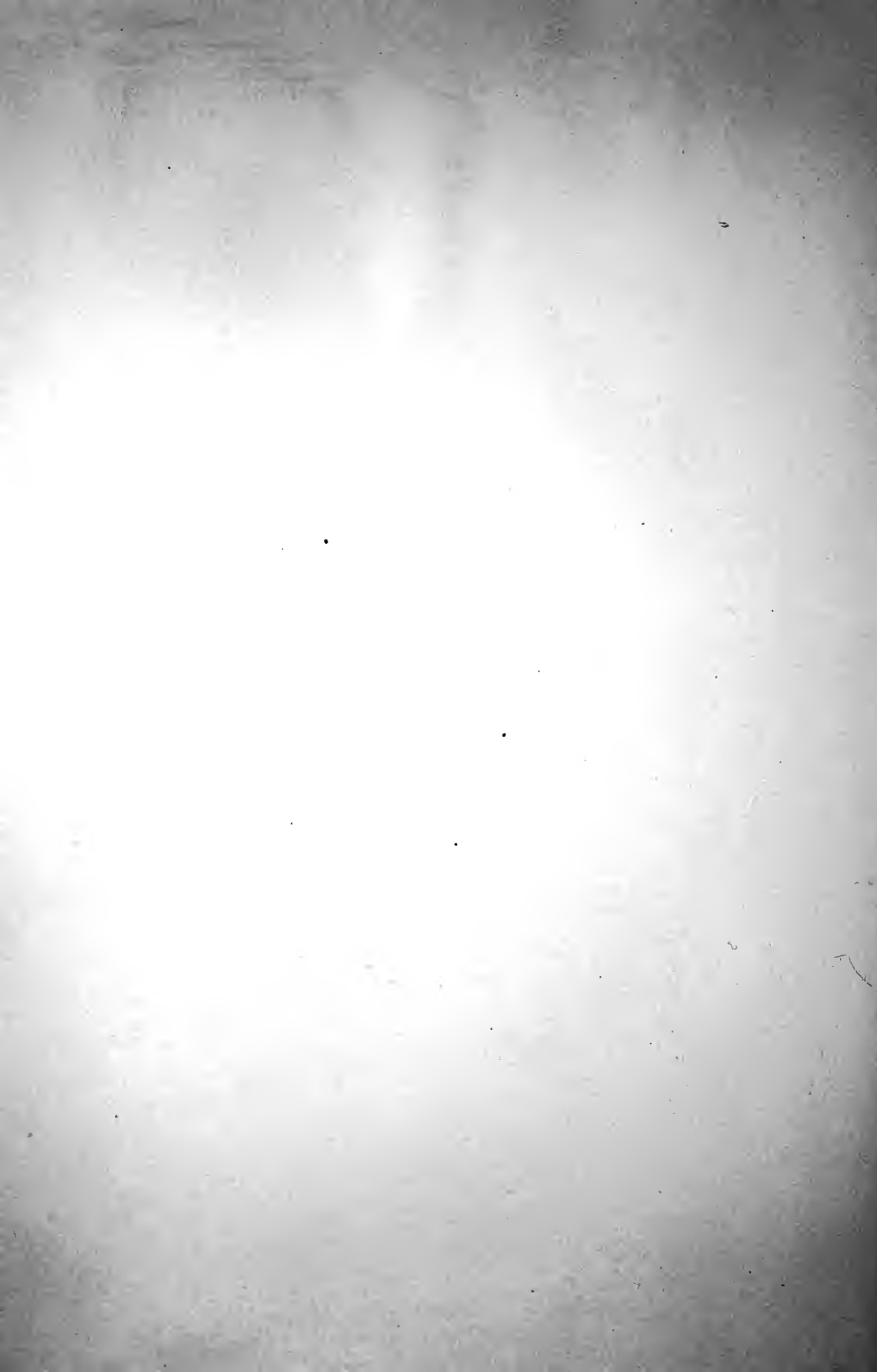


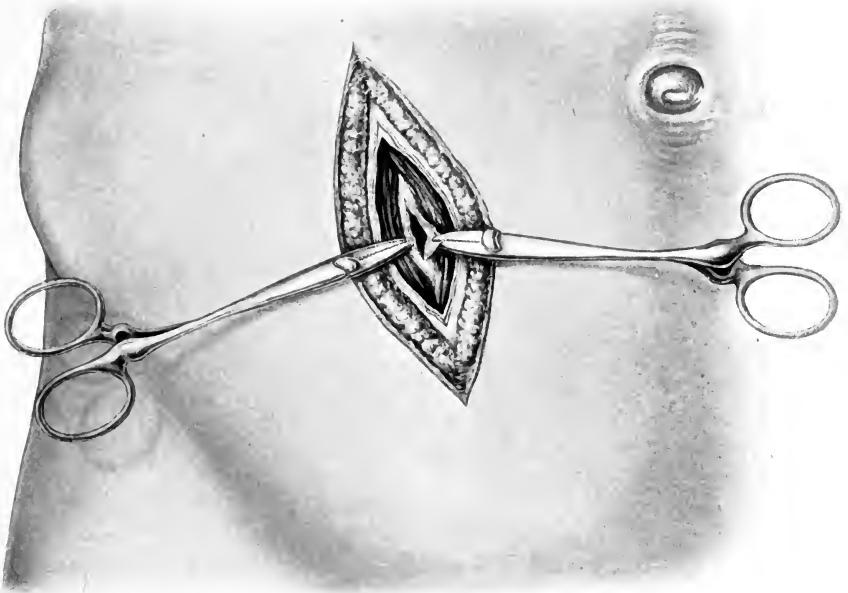
SIMPLE INCISION: FIBRES OF THE RECTUS MUSCLE EXPOSED, THE TWO LAYERS OF ITS SHEATH BEING RETRACTED WITH HÆMOSTATIC FORCEPS.



SIMPLE INCISION: THE FIBRES OF THE RECTUS MUSCLE ARE BEING SEPARATED LONGITUDINALLY WITH THE HANDLE OF THE SCALPEL.

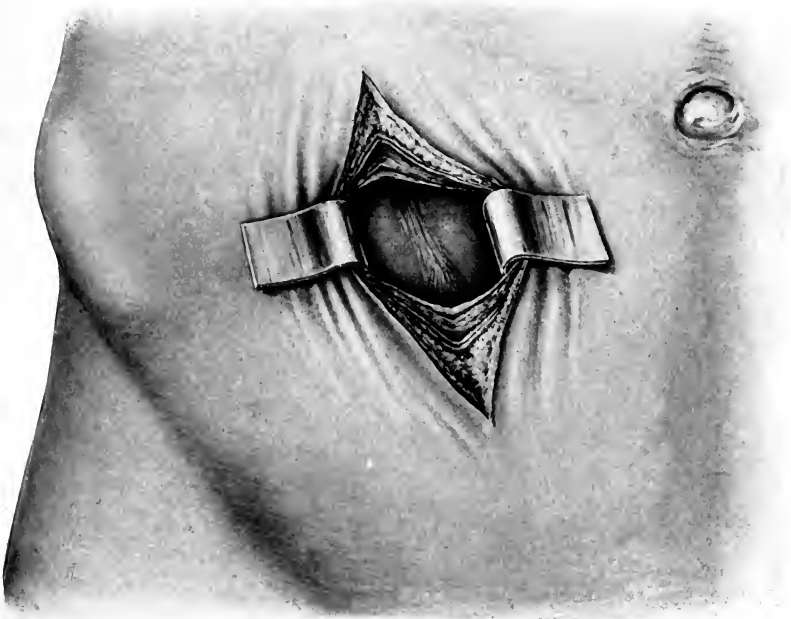
The posterior sheath of the muscle and the transversalis fascia are thus exposed.





SIMPLE INCISION: THE PERITONEAL CAVITY HAS BEEN OPENED BY A SMALL INCISION MADE WITH THE SCALPEL, WHILE THE FORCEPS HOLD THE ABDOMINAL WALL AWAY FROM THE INTESTINES.

The incision is to be enlarged with scissors.



SIMPLE INCISION: THE PERITONEAL WOUND HAS BEEN ENLARGED WITH SCISSORS EXPOSING THE CÆCUM, WITH ONE OF ITS LONGITUDINAL BANDS.



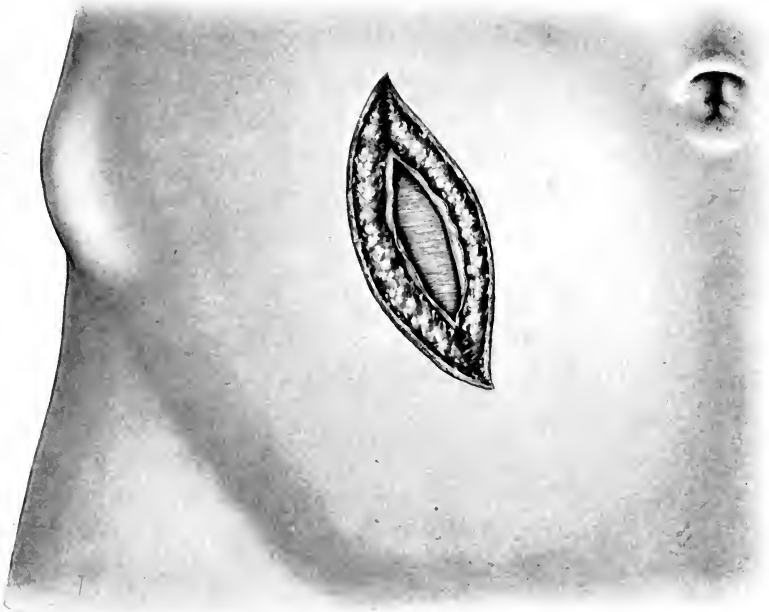
BATTLE'S INCISION: THE APONEUROSIS OF THE EXTERNAL OBLIQUE EXPOSED TO THE MEDIAN SIDE OF THE SEMILUNAR LINE.
The line of the deep epigastric vessels is not crossed.

the same extent as the skin incision, thus avoiding the formation of a funnel-shaped wound, which is more difficult to work through. When the structures lying beneath the rectus muscle are exposed, they should be caught in hæmostatic forceps at each side of the wound, and the surgeon should cautiously cut through them into the peritoneal cavity, with the flat surface, not the point, of the scalpel. As this is done traction should be made upon the two pairs of forceps, so as to raise the tissue away from the underlying intestine, and care should be exercised to cut only during the process of expiration, since during inspiration the intestines are forced against the parietal peritoneum. When the peritoneal cavity has been opened (Plate xxxiv), the scalpel is to be laid aside and the peritoneal wound enlarged with blunt-pointed scissors, the index finger of the left hand being used as a guide. By now retracting the margins of the wound the cæcum may be seen, but it is usually not visible on account of the great omentum and terminal coils of small intestine. When the cæcum is seen it is recognized by its longitudinal bands, its size and freedom from attachment to the omentum, and by the absence of epiploic appendages (Plate xxxv). In advanced cases, however, the peritonitis may have obscured all such landmarks. It has been objected to this operation that it divides the abdominal nerves, and hence by relaxing the rectus muscle predisposes to the formation of a hernia. I cannot say, however, that I have ever observed any such paralyzing effect, and think it could only occur where a very long incision had been made.

Another somewhat similar incision is that proposed nearly simultaneously by *Battle*, by *Jalaguier* and by *Kammerer* (Plate xxx, 2). The anterior sheath of the rectus is exposed and opened, as in the previous incision, but a little closer to the semilunar line (Plate xxxvi). Here its two layers are quite distinct (Plate xxxvii). The rectus muscle is then separated from the outer portion of its sheath (Plate xxxviii) and is drawn toward the median line, its fibres not being separated as in the incision first described,

but the surgeon working around its external border. Its posterior sheath, the transversalis fascia, preperitoneal fat, and peritoneum are then opened well toward the median line of the muscle—midway between the linea semilunaris and the linea alba. By this means the incisions through the different layers of the abdominal wall are not superposed one directly on the other, and the incision approaches the combined type. This incision is not adapted for pus cases, because of its valve-like formation, but when completely sutured offers a very sure protection against hernia formation.

The *McBurney, muscle-splitting* or *grid-iron* incision is placed entirely external to the semilunar line, dividing the oblique and transverse abdominal muscles in the line of their fibres. The skin incision may be made in any desired direction, preferably in the line of the fibres of the external oblique (Plate xxx, 3). The aponeurosis of this muscle is then exposed (Plate xli) and divided in the line of its fibres, exposing beneath its delicate overlying fascia the fibres of the internal oblique which in this situation runs nearly transversely (Plate xlii). This muscle and the transversalis (with its delicate overlying fascia) are then likewise separated in the direction of their respective fibres, exposing the transversalis fascia, preperitoneal fat and peritoneum (Plate xliii). These structures are then divided, with the usual precautions, in the line of the external oblique fibres (Plate xliv). A wound thus made does not divide any of the abdominal nerves, which fact is evidently a strong recommendation in favour of such an operation; but the great difficulty is to select the proper case. Although it is understood that this operation is particularly intended for the interval cases, yet many of these are quite complicated, and may require enlargement of the incision. This was formerly done by making a second cut upward along the semilunar line from the inner angle of the *McBurney* incision; but the method of dividing transversely the sheath of the rectus, and drawing this muscle toward the median line, introduced by Dr. Weir, is in every way superior.



BATTLE'S INCISION: THE APONEUROSIS OF THE EXTERNAL OBLIQUE HAS BEEN DIVIDED, EXPOSING THE TRANSVERSE FIBRES OF THE SHEATH OF THE RECTUS MUSCLE.



BATTLE'S INCISION: THE SHEATH OF THE RECTUS MUSCLE HAS BEEN OPENED, EXPOSING THE MUSCULAR FIBRES; THESE ARE DETACHED FROM THE POSTERIOR SHEATH AND TRANSVERSALIS FASCIA, AND ARE DRAWN TOWARD THE MEDIAN LINE OF THE ABDOMEN.

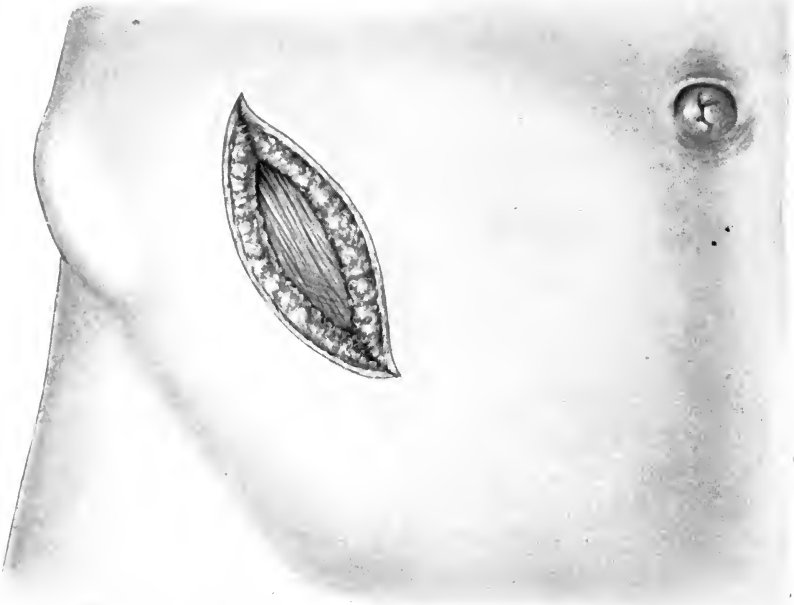




BATTLE'S INCISION: THE RECTUS MUSCLE HAS BEEN DRAWN TO THE MEDIAN SIDE OF THE WOUND, AND ITS POSTERIOR SHEATH IS DIVIDED.



BATTLE'S INCISION: THE PERITONEAL CAVITY OPENED.



MCBURNEY'S INCISION: THE APONEUROSIS OF THE EXTERNAL OBLIQUE MUSCLE IS EXPOSED TO THE OUTER SIDE OF THE SEMILUNAR LINE.

An incision similar to that originally employed by *Hancock*, is a good one in abscess cases, where the mass is close to the anterior superior iliac spine or where the appendix can be distinctly located in this position. This incision (Plate xxx, 4) is in the line of the fibres of the external oblique, about half an inch above the outer extremity of Poupart's ligament. There are divided, the skin, superficial fascia, aponeurosis of the external oblique (Plate XLV) a thin layer of fascia covering the internal oblique, the internal oblique (Plate XLVI), branches of the deep circumflex iliac vessels, a second thin layer of fascia overlying the transversalis muscle, and the transversalis muscle (Plate XLVII); the cut edges of the muscle on the inner side of the wound are then well retracted, and the transversalis fascia (Plate XLVIII) preperitoneal fat (Plate XLIX) and peritoneum (Plate L) are divided well down to the outer side of the cæcum. This incision is particularly adapted to those cases of appendiceal abscess where the patient is in no fit condition to withstand a complete operation, and where drainage of the abscess is all that is desired. In such cases it is frequently impossible to recognize the various layers of the abdominal wall as they are divided, since they are frequently infiltrated and matted together. Where the appendix, however, is found well toward the crest of the ilium it can be readily removed through this incision, with little danger of infecting the peritoneal cavity, as the limiting adhesions constituting the inner wall of the abscess cavity, are not broken down. The transverse division of the fibres of the internal oblique and transversalis muscles which is necessitated by this incision, renders the subsequent formation of a ventral hernia more likely when drainage is employed, but this is a small matter compared with the recovery of the patient, which is much more apt to follow the use of an incision allowing of rapid completion of the operation and direct drainage. Where drainage is not required and accurate suturing of the various layers of tissue is possible, a hernia is not to be feared.

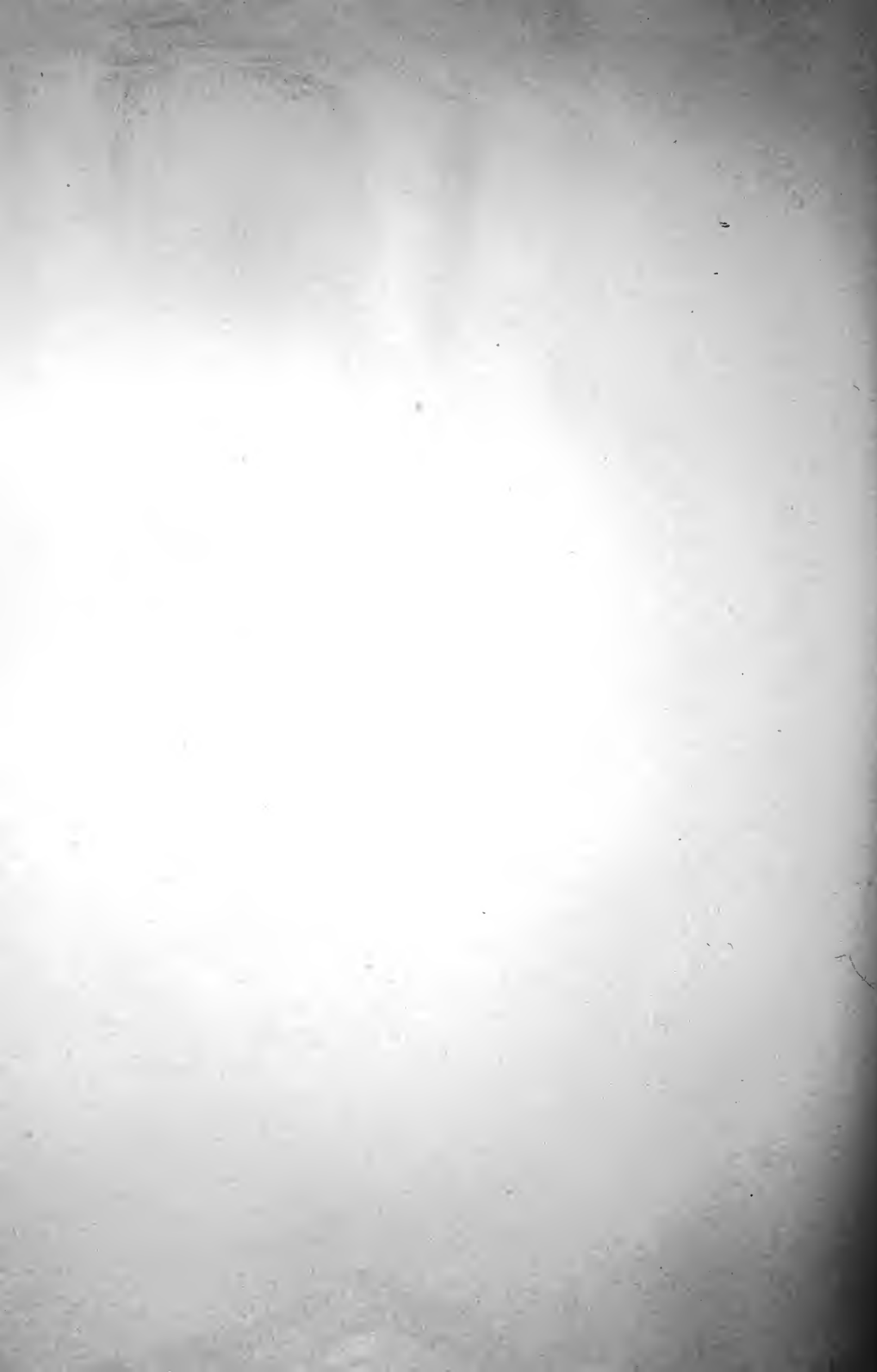
Still another incision is occasionally useful. This is an *oblique incision* passing from above the iliac spine back into the loin space, in the direction of the fibres of the external oblique. (Plate xxx, 5). It is particularly adapted to suppurative cases in which the appendix lies to the outer side of the cæcum and colon, running northwest; by this incision better access is gained to the site of the infected appendix, and there is less likelihood of infecting the general peritoneum. The great difficulty, however, in all these cases, is to determine, before the abdomen is opened, just where the appendix lies; and unless there is pretty good evidence of its running northwest in the right lumbar region it will not be advisable to employ this incision, although Hancock's incision, just described, may often be extended upward into this oblique incision with the utmost advantage. After any such large incision the developement of ventral hernia is to be anticipated, and a secondary operation will frequently be required for its cure.

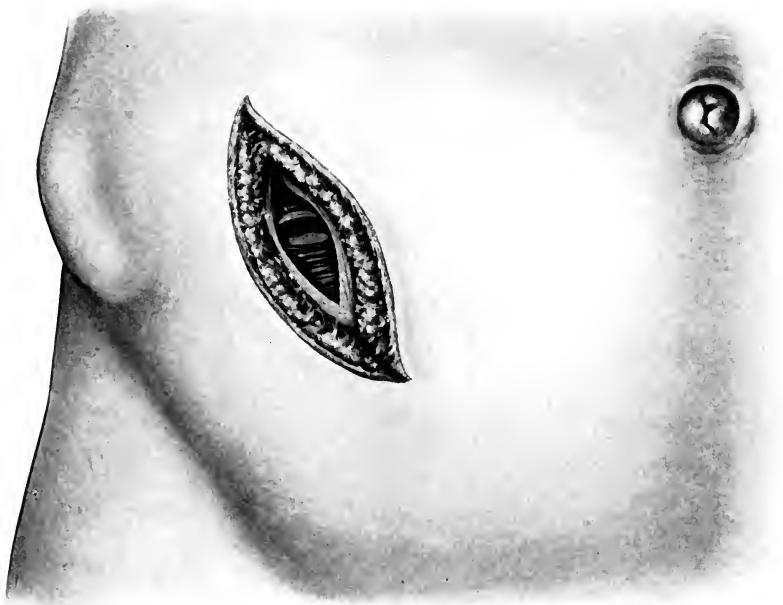
In making any of these incisions, hæmorrhage should be checked before the peritoneum is opened. Unless some vessel large enough to have a name—such as the deep epigastric or circumflex iliac—be divided, it is at times sufficient to clamp the bleeding point for a few minutes, when the bleeding will be found to have been arrested. It is always safer, however, to ligate every bleeding point. If a vessel of any size is divided it should without doubt be immediately ligated, being cut between two ligatures if necessary, since were a hæmostat left in place on such a vessel it might become detached and cause renewed bleeding at a period of the operation when any such delay would be perilous.

When the *peritoneum has been opened*, antiseptics, if used up to this time, should be discarded, and sterile water and saline solution should now be used for cleansing the surgeons hands and sponging the intestines, etc. Antiseptics are said to induce minute areas of necrosis, and although I do not know that I have ever seen any evil effects from their use, yet I do not think any good is



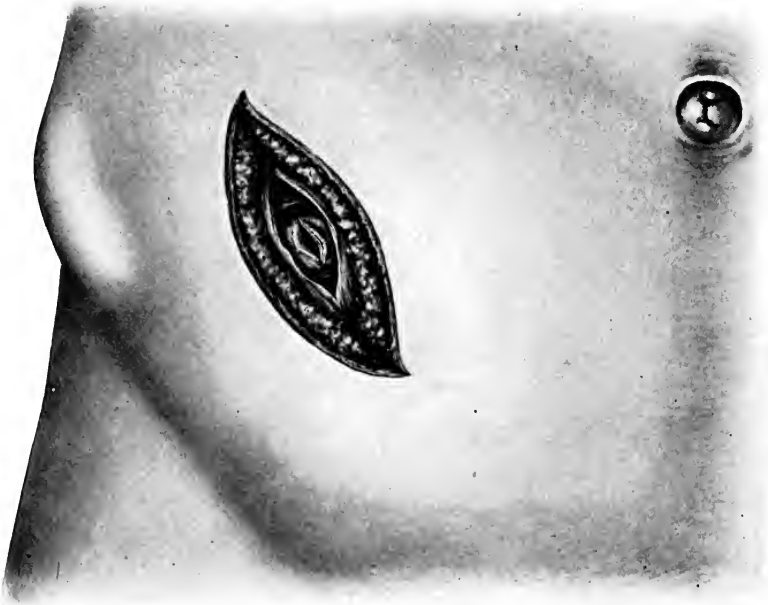
MCBURNEY'S INCISION: FIBRES OF THE INTERNAL OBLIQUE MUSCLE EXPOSED.





MCBURNNEY'S INCISION: THE INTERNAL OBLIQUE AND TRANSVERSALIS MUSCLES HAVE BEEN SEPARATED IN THE DIRECTION OF THEIR FIBRES, EXPOSING THE TRANSVERSALIS FASCIA.





McBURNEY'S INCISION: THE PERITONEAL CAVITY HAS BEEN OPENED.





HANCOCK'S INCISION: APONEUROSIS OF THE EXTERNAL OBLIQUE EXPOSED CLOSE TO THE ILIAC SPINE.



accomplished by employing them, except as especially described later.

It will be convenient first to describe the method to be employed in removing the appendix in cases where pus is known to be absent, and subsequently to describe the treatment of suppurative cases.

Technique in Clean Cases.—The surgeon may either pull forth the presenting bowel, which is usually the cæcum, through the wound, and trace one of its longitudinal bands down to the base of the appendix, whose position is thus determined; or, if his skill and tactile sense be sufficient for the purpose, he may introduce one or two fingers into the wound, isolate the appendix between them, and withdraw it from the abdomen at once, without first locating the cæcum. The latter makes a very brilliant operation, but the former plan is less apt to miscarry in the hands of less experienced operators. In trying to find the appendix by the sense of touch, the best manœuvre is to locate the external iliac artery, which is readily found by its pulsation, and then to run the finger up along its course until it is arrested by the lower end of the mesentery and the cæcum, in which neighbourhood the appendix may usually be found; by hooking the finger around it, it may then be delivered from the abdomen. My own practice in clean cases is not to retract the margins of the wound when the peritoneal cavity has been opened, but to introduce the index finger and locate the cæcum by the sense of touch, when, with a pair of dissecting forceps which are passed along the finger to the cæcum, it is grasped carefully and drawn into the wound. It is then grasped with the finger and thumb, and delivered through the abdominal wound until the base of the appendix is seen. If the wound is small and the cæcum large, care should be taken not to deliver too much of the cæcum at one time, but to replace some before delivering more. If this matter is not attended to at the proper time, the surgeon may be mortified to find, after removing

the appendix, that he must enlarge the abdominal wound to enable him to reduce the cæcum, which soon becomes congested when constricted by a small wound. I have seen one case in which efforts to reduce the cæcum through too small a wound caused the separation of the ligature from the meso-appendix, with the result that the patient nearly lost his life from intra-peritoneal hæmorrhage before the accident was discovered by the constitutional symptoms of concealed hæmorrhage. Where the great omentum or terminal coils of small intestine interfere with the free delivery of the cæcum and appendix it is my practice to introduce one or more gauze pads and in this manner make the manipulation easier and less likely in the presence of infection to damage the surrounding healthy peritoneum. If the cæcum and appendix do not lift out easily, in other words, are bound down by adhesions, I at once enlarge the wound as it is not safe to make traction to any degree, for fear that adhesions may be torn and infection liberated. There is also risk of tearing a subcæcal vein by too much traction upon the cæcum, an accident that has occurred once in my own practice and which necessitated a secondary operation for the resulting hæmorrhage.

As soon as the *appendix is delivered* the surgeon should ligate its mesentery. To accomplish this expeditiously the tip of the appendix may be held by an assistant in his fingers or with a pair of tissue forceps. The meso-appendix is then perforated close to the appendix by a hæmostat carrying a fine silk suture, and the ligature is tied around the meso-appendix (Plate LI), when the hæmostat is removed. The meso-appendix is then divided with blunt-pointed scissors between the ligature and the appendix and as close to the latter as possible (Plate LII); this is especially important where the meso-appendix is short, as then any deviation from the appendix might puncture the cæcum. When the meso-appendix is especially large and fat it is safer to ligate it in sections. When the appendix is thus freed of its mesentery, the surgeon carefully grasps the cæcum between the thumb and



HANCOCK'S INCISION: THE APONEUROSIS OF THE EXTERNAL OBLIQUE HAS BEEN DIVIDED, EXPOSING THE INTERNAL OBLIQUE MUSCLE.



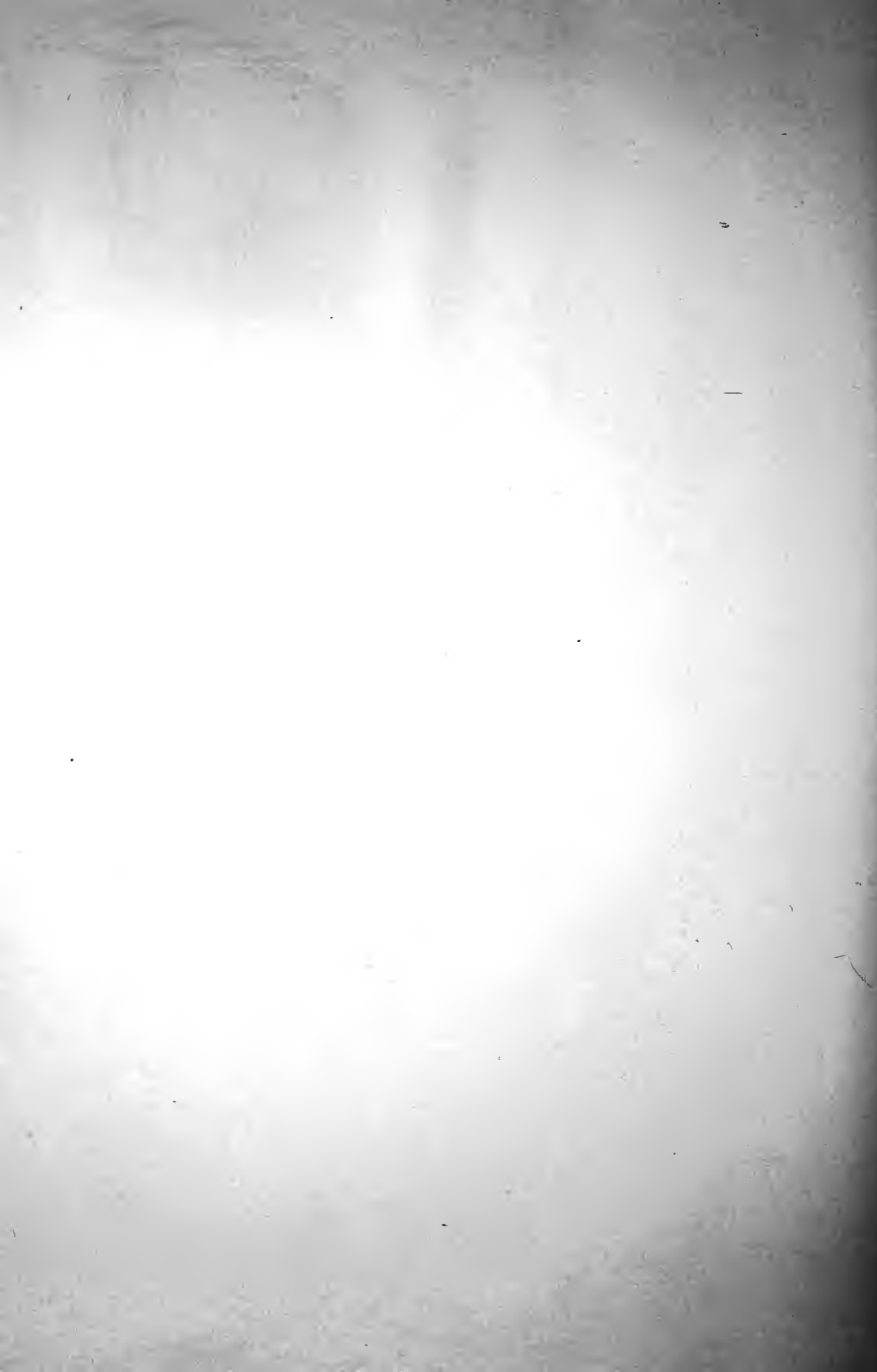
HANCOCK'S INCISION: THE INTERNAL OBLIQUE HAS BEEN DIVIDED, EXPOSING THE TRANSVERSALIS MUSCLE.



HANCOCK'S INCISION: THE TRANSVERSALIS MUSCLE HAS BEEN DIVIDED, EXPOSING THE TRANSVERSALIS FASCIA.



HANCOCK'S INCISION: THE TRANSVERSALIS FASCIA HAS BEEN DIVIDED, EXPOSING THE PREPERITONEAL FAT AND THE PERITONEUM.

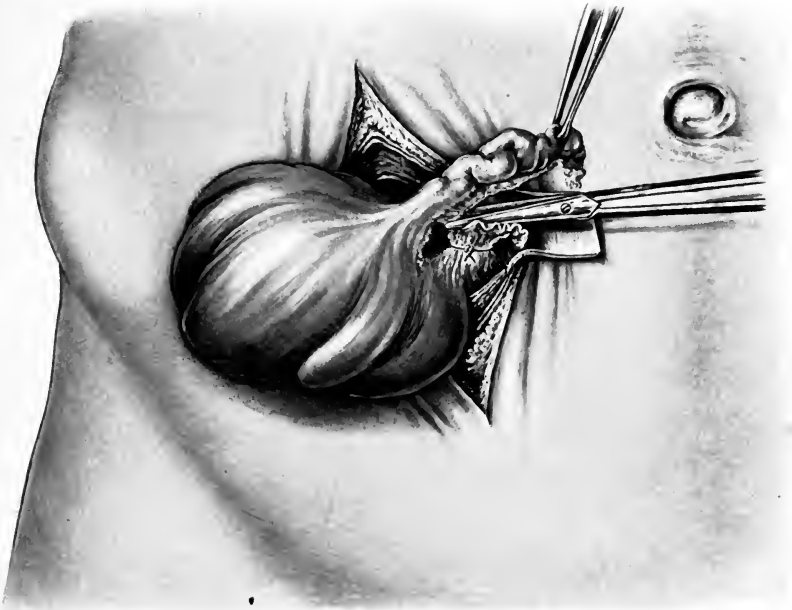




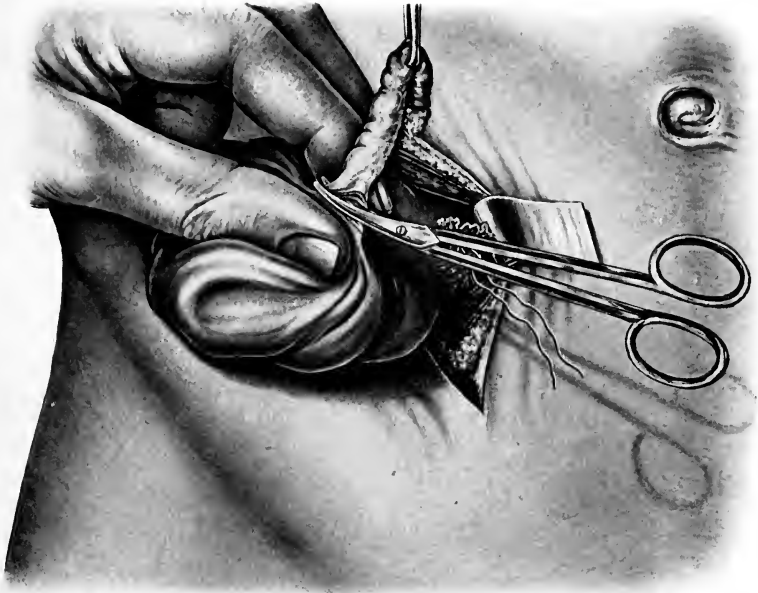
HANCOCK'S INCISION: THE PREPERITONEAL FAT AND PERITONEUM HAVE BEEN DIVIDED, OPENING THE PERITONEAL CAVITY.



LIGATION OF THE MESO-APPENDIX CLOSE TO THE CÆCUM.



DIVISION OF THE MESO-APPENDIX CLOSE TO THE APPENDIX.

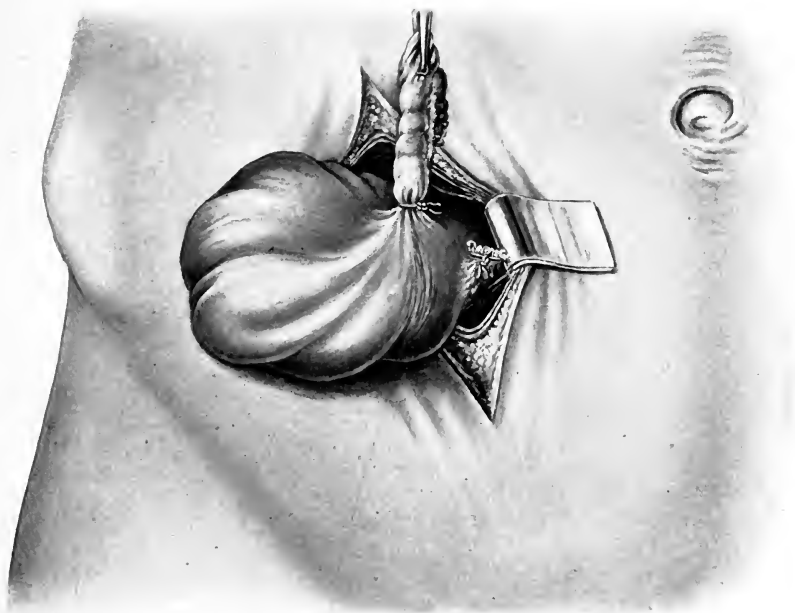


THE CÆCUM IS SECURELY HELD BETWEEN THE THUMB AND FINGER, WHILE THE APPENDIX IS CUT OFF FLUSH WITH THE CÆCUM.

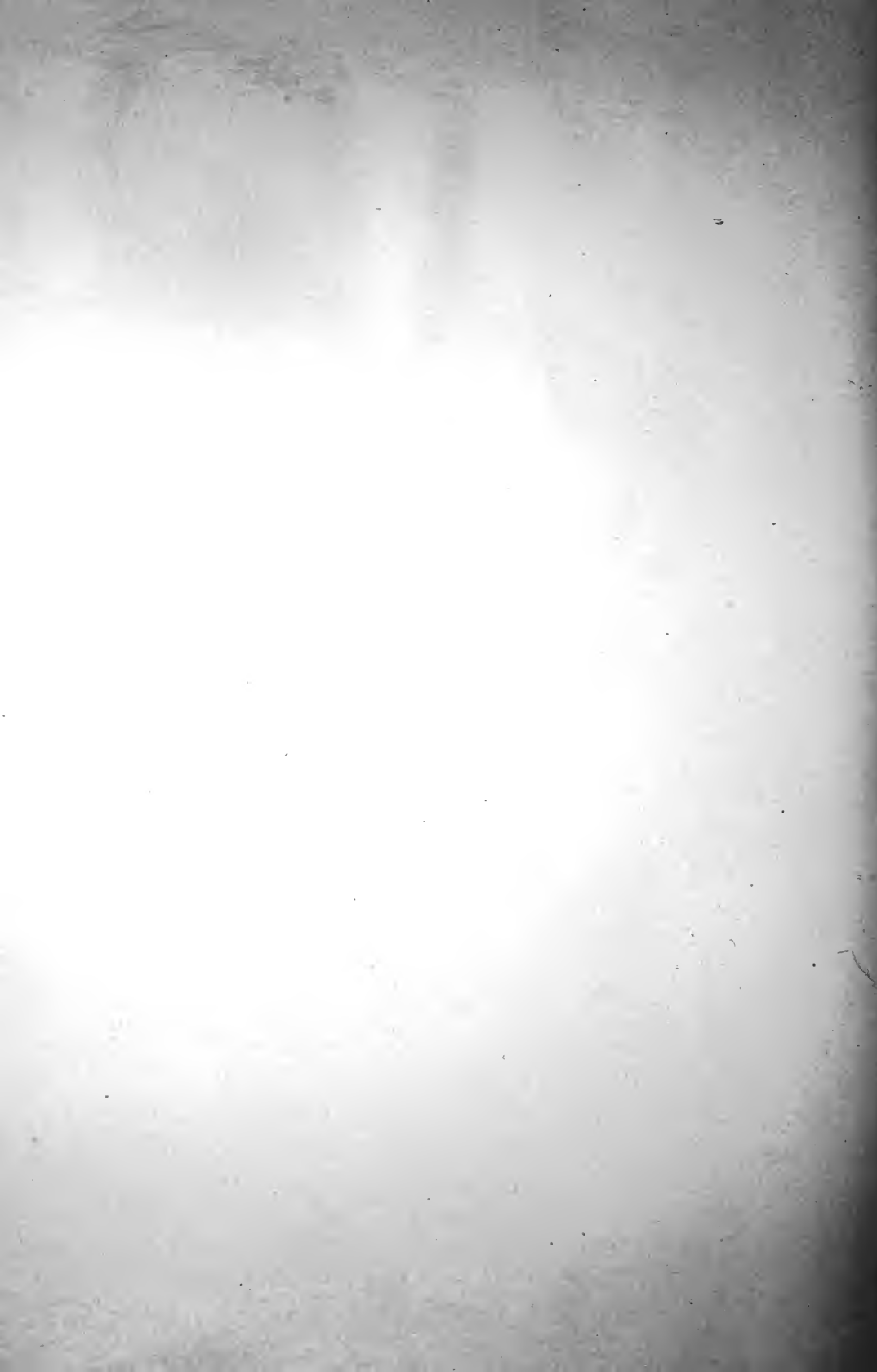


THE WOUND IN THE CÆCUM HAS BEEN SUTURED.



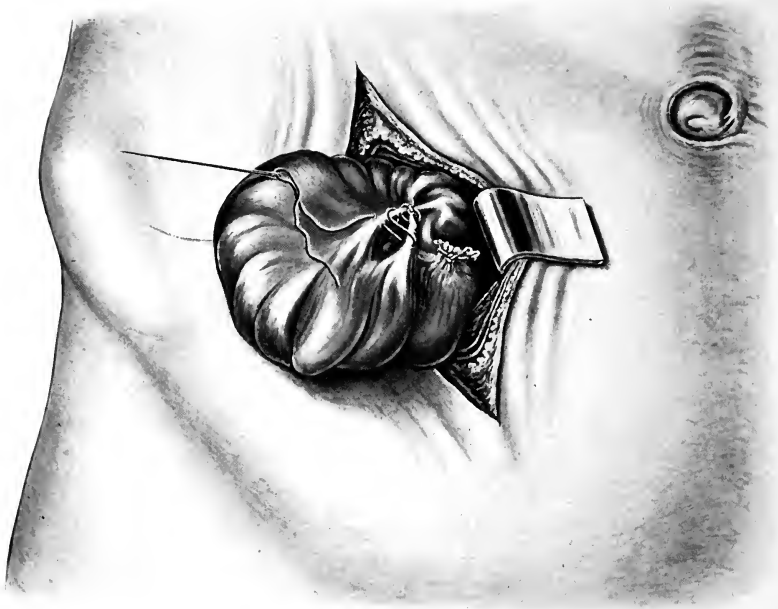


THE BASE OF THE APPENDIX HAS BEEN LIGATED.





THE APPENDIX HAS BEEN CUT OFF DISTAL TO THE LIGATURE.



THE LIGATED STUMP OF THE APPENDIX IS BEING INVAGINATED BY A CONTINUOUS LEMBERT SUTURE.

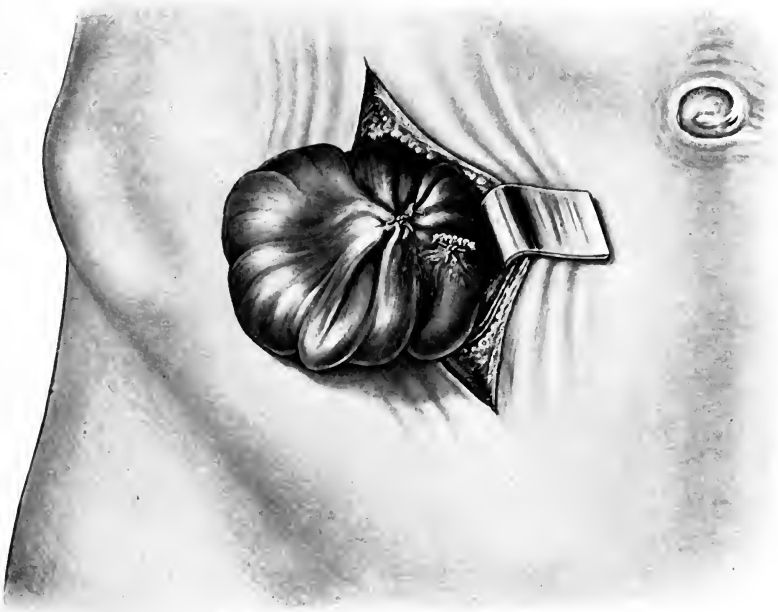
index finger of his left hand, close to the base of the appendix, and cuts the appendix off flush with the cæcum (Plate LIII). The *wound in the cæcum is then at once sutured* with a continuous silk suture, applied with a round, straight or curved needle. The first row of sutures should include the serous, muscular and submucous coats of the cæcum, and the second row should be of the Lembert variety invaginating the first row into the cæcum (Plate LIV).

This method of treating the stump of the appendix is, I think, a good one, but it should not be employed by the occasional operator, nor in any case where the cæcum is not easily and without tension brought out through the abdominal wound. Unless the surgeon has a very secure and steady hold on the cæcum, so that it is sure not to slip, it is far safer to ligate the appendix first, or to invaginate it by means of Dawbarn's purse-string suture, as will be presently described. If any such accident—slipping of the cæcum—should occur, either from relaxation of the surgeon's hold, or from an unexpected motion on the patient's part, the cæcum might slip back within the wound, and fæcal extravasation into the free peritoneal cavity occur with fatal result.

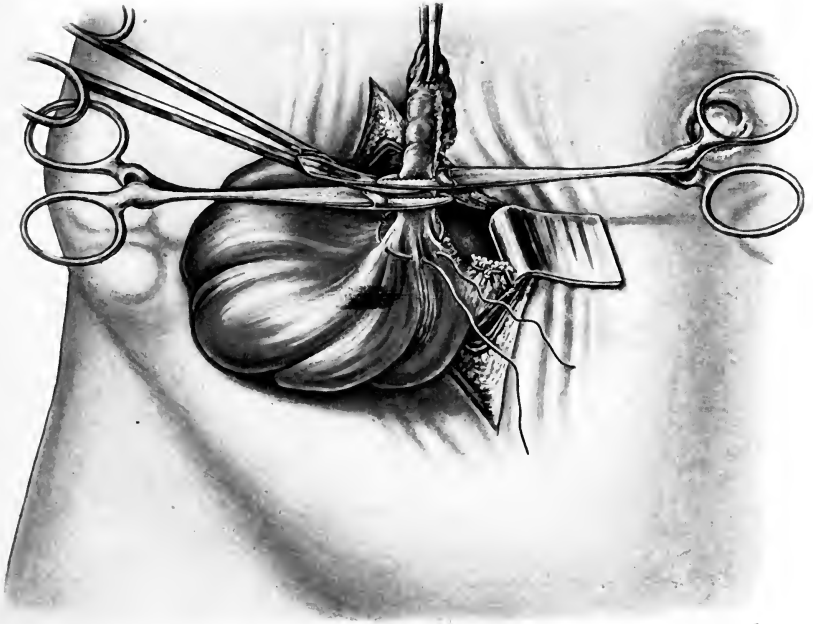
If for these or any other reasons, such treatment of the stump is not desirable, *the base of the appendix may be ligated*, with silk in clean cases, or catgut in infected cases, as an artery is ligated (Plate LV), the appendix being then cut off distal to the ligature (Plate LVI) and the stump thus left invaginated with a continuous Lembert suture (Plate LVII). The puckering of the cæcum is in this case more pronounced (Plate LVIII) than where the first method is employed; and there is the objection that a small mucous surface in the stump of the appendix is merely covered over by peritoneum, and is not invaginated into the cæcum, as is the case with the first method; and if this portion of the appendix is infected, drainage from its surface is not provided for, and abscess formation with the development of a fæcal fistula may occur. I do not know, however, that these

objections are other than theoretical. In many cases, as where it is impossible to bring the base of the appendix within sight, it is sufficient to ligate the appendix as an artery, and to leave the stump exposed, without attempting its inversion into the cæcum. In many infected cases this is also the preferable method, as will be mentioned subsequently.

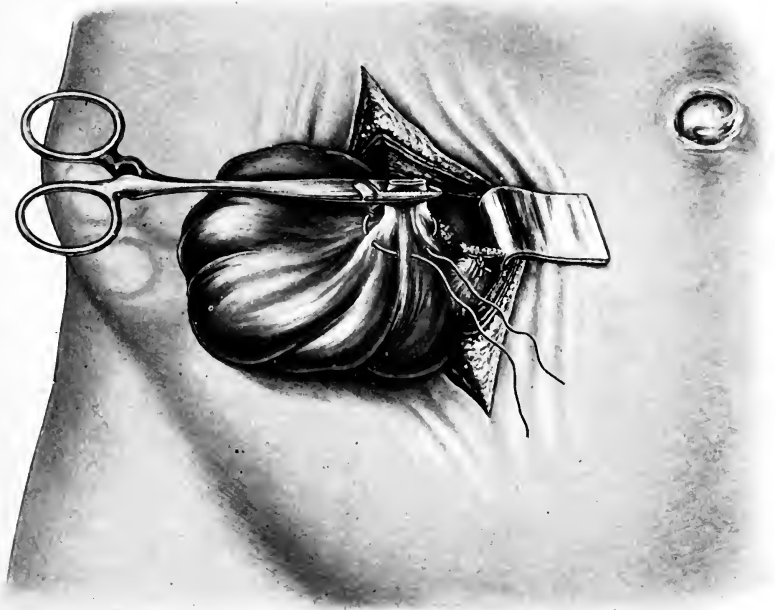
Dawbarn's method (Plate LIX) consists in the application of a *purse-string suture* in the walls of the cæcum, close to the base of the appendix, before this latter structure is cut away from the cæcum. It is a method of closing the cæcum particularly adapted to cases in which it is impossible to deliver the cæcum through the abdominal wound, or in which the base of the appendix or even the surface of the cæcum immediately surrounding the base of the appendix is involved in the inflammatory process and the appendix must be cut off flush with the cæcum, or some of the wall of the cæcum itself must be excised. It is frequently well to clamp the appendix with hæmostatic forceps in two places, and then to divide it with scissors between the hæmostats and flush with the lower one; by this plan contamination of the surrounding tissues, through leakage from either end of the appendix, is avoided. The appendix being thus removed (Plate LX) the remaining hæmostat occludes the lumen by pressure and another hæmostat is then applied below the occluding hæmostat and the latter removed. This leaves a stump which the assistant can grasp with tissue forceps. The last hæmostat is then taken off, and the stump of the appendix is invaginated by the assistant into the cæcum (steadying the latter with tissue forceps) (Plate LXI), as the purse-string suture is tightened (Plate LXII). This primary suture may be reinforced, if desired, with a continuous or an interrupted suture, or with a mattress suture, any such stitch being, of course, of the Lembert variety. It is not necessary, however, to reinforce the purse-string suture if this has been applied in healthy tissue, as the closure of the cæcum effected by it is perfectly sufficient to prevent leakage (Plate LXIII).



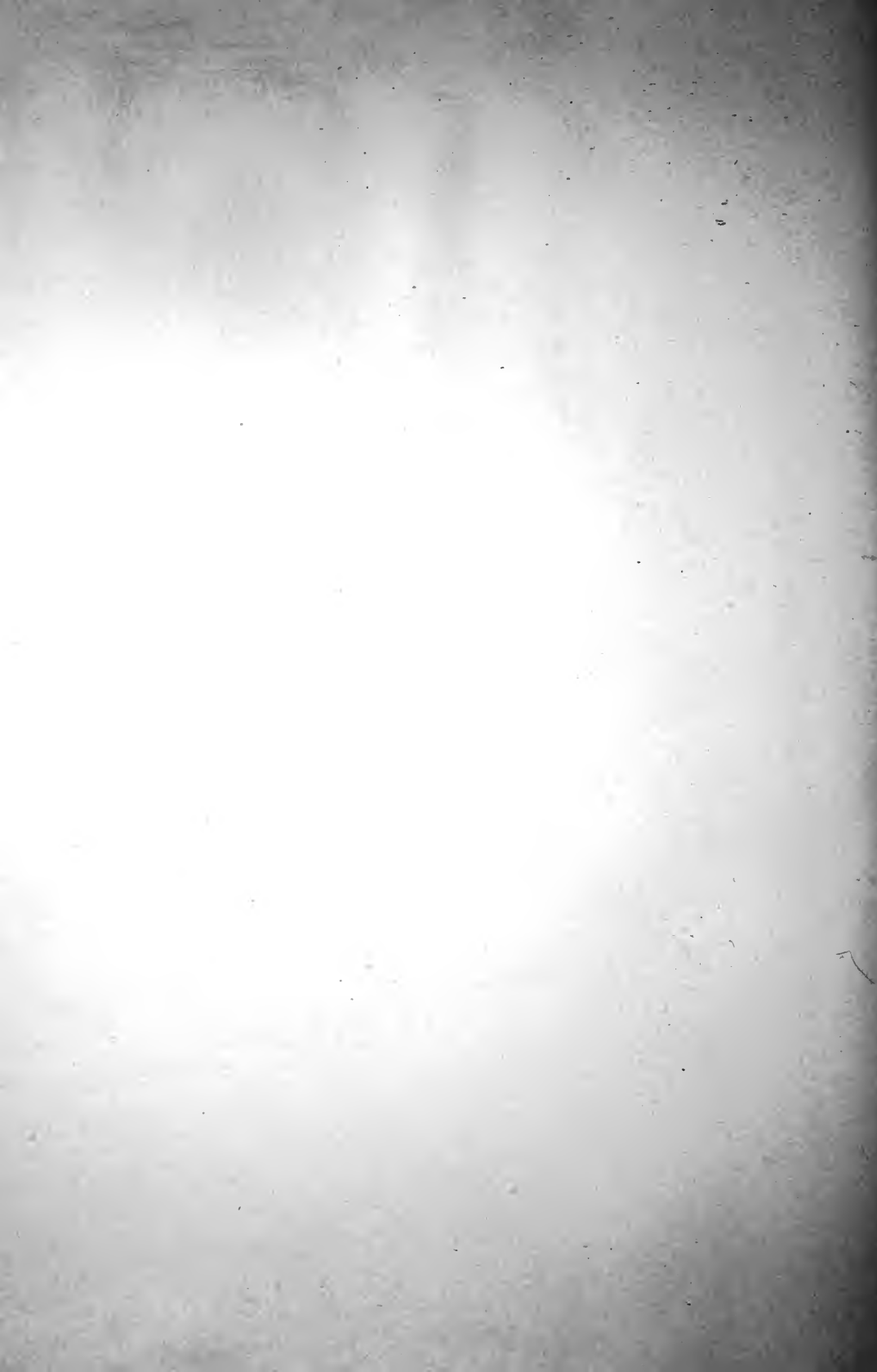
THE STUMP OF THE APPENDIX COMPLETELY INVAGINATED.

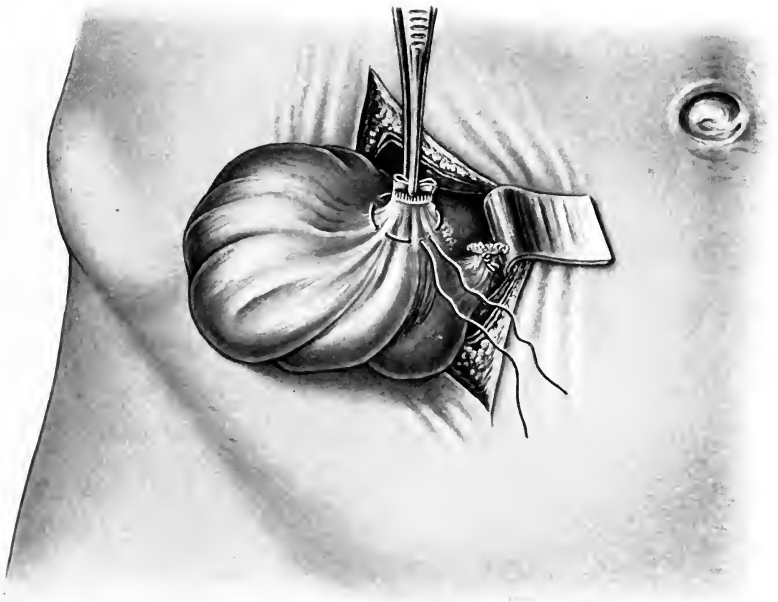


DAWBARN'S METHOD: THE BASE OF THE APPENDIX IS SURROUNDED BY A PURSE-STRING SUTURE.

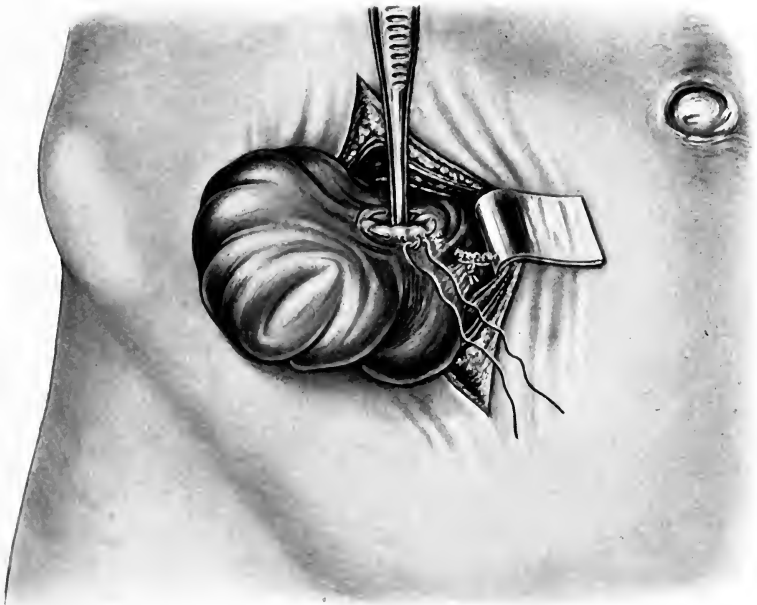


DAWBARN'S METHOD: THE APPENDIX HAS BEEN CUT OFF CLOSE TO THE LOWER HEMOSTAT, WHICH OBLITERATES THE LUMEN OF THE STUMP.

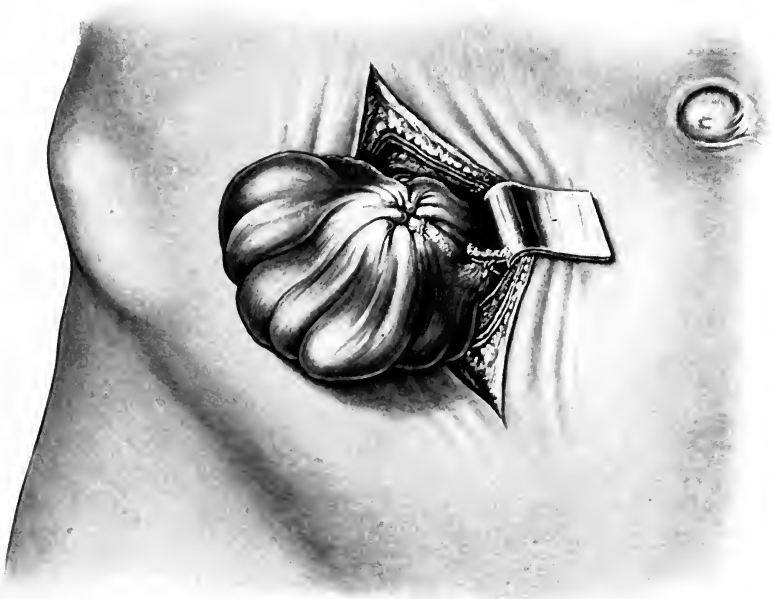




DAWBARN'S METHOD: THE OBLITERATED STUMP OF THE APPENDIX IS GRASPED IN TISSUE FORCEPS, PREPARATORY TO ITS INVAGINATION INTO THE CÆCUM.



DAWBARN'S METHOD: THE STUMP OF THE APPENDIX IS INVAGINATED INTO THE CÆCUM AS THE PURSE-STRING SUTURE IS TIGHTENED.



DAWBARN'S METHOD: THE PURSE-STRING SUTURE HAS BEEN TIED, COMPLETELY BURYING THE STUMP OF THE APPENDIX.

Technique in Suppurative Cases.—Since the success of the operative treatment of appendicitis complicated by pus formation depends largely upon a knowledge of the anatomical varieties of peri-appendicular abscess, as well as upon a complete comprehension of the safest method of evacuating the pus and removing the appendix without infecting the general peritoneal cavity, a brief description of the operative technique to be practised in each instance may be given.

Depending upon the location of the pus, peri-appendicular abscess is met with as one of five varieties: First, and in my experience the most common, is that in which the collection lies below or to the outer side of the cæcum beneath the anterior parietal peritoneum, being confined by the cæcum, coils of small intestine, the omentum, the parietal peritoneum, and inflammatory exudate; second, that in which the collection of pus is located behind the cæcum, to the outer side of or behind the cæcum and ascending colon, or between the layers of the ascending mesocolon, in the retro-peritoneal cellular tissue; third, that in which the abscess lies in the pelvis, being usually entirely shut off from the general peritoneal cavity; fourth, that in which the collection of pus is located near the median line of the abdomen and to the median side of the cæcum; fifth, that in which the pus is free in the general peritoneal cavity.

In dealing with any variety of circumscribed peri-appendicular suppuration, it is extremely important to protect the general peritoneal cavity from infection. As a rule it is only when the abscess is of the first variety described above, that it can be reached and evacuated without first traversing the free peritoneal cavity. Hence it becomes necessary in almost all suppurative cases to work through a coffer-dam of gauze. The correct disposition of this gauze requires the utmost skill. It may be laid down as a rule that in endeavouring to exclude the intestines from the field of operation the disposition of the gauze must be commenced from the extremities of the wound, and proceed to the

centre; by placing a gauze pack first in the centre of the wound, the intestines will prolapse around both sides of it, and it will be very difficult to again exclude them from the operative area. Another good rule is never to proceed with an operation in which adhesions are discovered until gauze has been so disposed as to protect the general peritoneal cavity from the rupture of an abscess which may be concealed by adhesions.

In dealing with any variety of peri-appendicular suppuration which must be treated transperitoneally, as soon as the peritoneum is incised the general peritoneal cavity should be protected from infection by the proper disposition of gauze pads. The first pad to be introduced should pass from the right iliac fossa into the pelvis, and will hold the small bowel away from the lower angle of the wound. Then as many more pads as may be required are to be placed from below upward until the entire median side of the wound, as well as its lower extremity, is lined with gauze. Finally, the upper limit of the field of operation must be protected by gauze. The abscess should then be opened by breaking through the layer of exudate that forms its outer wall, or, if the abscess be of the second variety, through the outer layer of the ascending meso-colon. The abscess cavity should be wiped out with dry gauze. The appendix should then be located and removed. Before invaginating its stump into the cæcum it is well, in all suppurative and gangrenous cases, to curette the remaining mucous membrane, and to swab it off with strong corrosive sublimate solution (1 to 500) or with commercial carbolic acid. It is better not to invaginate an infected stump into the cæcum, but rather to simply ligate the appendix with chromicized catgut. The catgut is less liable to form a dead ligature than silk or other nonabsorbable material. Drainage consisting either of narrow strips of iodoform or plain gauze, or a rubber drainage-tube, or both, should then be introduced to the bottom of the abscess cavity, and the abdominal wound should be closed with the exception of the site of the drain.

The intestines should be protected from the gauze by rubber tissue, thus preventing the formation of excessive granulations upon their surface. Some operators prefer a "cigarette" drain, and where all pyogenic matter has been removed at the time of the operation, and it is desired only to obliterate a dead space, a plug of gauze will answer the purpose very well, and will absorb all the serum which is always exuded from the surface of a wound, no matter how thoroughly aseptic it has been kept. But under any other circumstances I consider tube drainage the only rational form to employ. If the abscess has been opened extra-peritoneally, that is to say, without invading the general peritoneal cavity, it is usually sufficient to drain it by means of a tube alone; but if it must be drained across the general peritoneal cavity, or if the abscess cavity is deep and tortuous, it is almost invariably proper to employ gauze as well as a tube. The gauze forms a coffer-dam, keeping the tract from the bottom of the abscess cavity out to the abdominal wound open, while in the centre of this coffer-dam runs the tube, through the lumen of which the matters to be drained find ready escape. The rubber tube should be sutured to the skin by catgut to prevent slipping.

The drain should emerge, as a rule, through that part of the wound nearest the abscess cavity; usually this will be through the lower extremity of the abdominal opening. In some cases the wound should be left entirely open. If an oblique incision, passing into the flank, has been employed the drainage should emerge from its outer or posterior extremity. After the lapse of four or five days, or even longer, the drainage may be removed, only enough gauze being replaced to prevent reaccumulation of pus, and the abdominal wound being allowed to heal gradually by granulation. A fuller discussion of the subsequent management of these cases will be found under the heading of After-treatment.

In the treatment of the *first variety of peri-appendicular abscess*, the collection of pus is often opened immediately upon carrying the incision through the parietal peritoneum. It is for

these cases that I prefer the incision close to the iliac crest and Poupart's ligament, since the abscess usually points in this situation. The pus cavity should be evacuated and wiped out with antiseptics without irrigation. Irrigation in this variety of abscess is attended by danger on account of the delicacy of the confining wall, which renders dissemination of infectious material a matter very easy of accomplishment. Evacuation of the abscess is ordinarily effected without risk of infecting the peritoneum, since the incision that corresponds to the most prominent part of the swelling, or, if no swelling be present, to the point over the involved region most tender to pressure, comes directly down upon the purulent collection. This variety of abscess can usually be said to be present when the abdominal muscles along the line of the incision are found to be the seat of inflammatory œdema and infiltration. If the muscles are not thus affected, the infiltrate will be found in the transversalis fascia and the preperitoneal fat. Unless the case is of several days standing, the amount of pus in this variety of abscess is small as compared with that generally encountered in the second variety of peri-appendicular abscess. It is, therefore, readily disposed of by mopping with pieces of gauze. If the appendix can be located and removed without trespassing upon the unopened peritoneal cavity it should be dissected free, and as it is loosened from its bed small pieces of iodoform gauze should be introduced so that, when the appendix is entirely free, its former site is occupied by the gauze. The appendix can then be excised, and the abscess cavity and abdominal wound should be treated as in the first instance.

In this first variety of abscess it frequently happens that the collection of pus is not confined at its lower end, but is in communication with the pelvis. I make it a rule, therefore, to pass a glass drainage tube down to the floor of the pelvis, to determine definitely the presence or absence of pus. On many occasions when operating upon this variety of peri-appendicular suppuration, I have evacuated no more than a drachm or two of

pus upon opening the peritoneum; but upon passing a drainage tube into the pelvis, as much as half a pint of pus has escaped.

As already remarked, in treating the *second variety of peri-appendicular abscess*, an incision through the loin would be preferable, opening directly into the abscess cavity. This method is the preferable one in all abscess cases, avoiding as it does the risk of infecting the general peritoneal cavity. I am well aware that so distinguished an authority on abdominal surgery as Dr. Murphy has recently condemned this technique, stating that he invariably opens such abscesses transperitoneally, through a coffer-dam of gauze; but experience, who is a severe task master, has convinced me that such a procedure is not always so innocuous as it appears on paper. But in this second variety of abscess, as in other varieties, it is frequently impossible to know beforehand the exact location of the purulent collection; under such circumstances I think it a perfectly legitimate procedure, after having made the anterior incision and seeing that the collection of pus is post-cæcal, to then close the anterior incision and proceed to evacuate the abscess through the loin. It is true, as I have said in former editions of this work, that this would subject the patient to additional traumatism and shock, and that it would probably necessitate the postponement of the removal of the appendix to a secondary operation; but the additional traumatism and shock would be immaterial, since the anterior wound, for the purpose of exploration only, would be of insignificant size; and even if the patient were to be drained and to have his appendix removed through the anterior wound, a secondary operation would even under these circumstances be nearly unavoidable, inasmuch as the formation of a hernia would be a foregone conclusion. Yet in exceptional cases of post-cæcal collections of pus, where the extent of necrotic tissue is great, and where drainage established through the anterior wound appears insufficient, through and through drainage is indicated. Here it is best to use both gauze and tubing, the gauze keeping the intestines out of the drainage

tract, and a large-sized perforated rubber tube passing from the anterior abdominal wound out through a counter opening made at the outer margin of the erector spinæ muscle. This is a method which I employ less and less as the years go on.

In operating upon the *third variety of peri-appendicular abscess* the abdomen is usually opened by an incision in the right rectus, the inner margin of the wound raised by retractors and the general peritoneal cavity well walled off from the pelvic cavity with gauze before an attempt is made to treat the appendix or the abscess. The gauze is most readily disposed of by carrying one or more pads across the intestines toward the left side and then successively packing gauze from this across the median line and then above the cæcum on the right side. In this way the wall of pads isolates the general peritoneal cavity from the pelvis and not only gives additional room to work in but prevents the extension of pus when the abscess is opened. After the proper disposition of gauze the finger should be carried over the brim of the true pelvis down into the collection of pus, and, with the finger as a guide, a glass drainage tube should be introduced. The abscess may be irrigated—but rarely do I do it—the glass tube removed, and the appendix should be ligated and excised. This “limited irrigation,” as I call it, is free from the objection made to general irrigation—that of spreading infectious material. Here the site of operation is already isolated by the gauze packs, and the irrigation is not continued sufficiently long to saturate the wall of gauze. After the removal of the diseased organ the glass drainage tube should be re-inserted, and, in addition, gauze drainage should be provided. The gauze should be permitted to remain until adhesions that will close off the abscess cavity have formed—usually from four to six days. In some cases, if the patient be convalescing favourably, the gauze may be permitted to remain eight or ten days. The glass drainage tube may remain in place from one to four days, depending upon circumstances. The upper portion of the

abdominal wound should be closed; the lower, through which protrude the glass tube and the gauze, is to be allowed to remain open, and subsequently to heal by granulation.

The evacuation of this pelvic variety of peri-appendicular suppuration through the vagina or rectum I regard as opposed to the dictates of sound surgical practice, and as attended by more risks to the patient than the operation through the abdominal wall. By the latter means the true condition of affairs is definitely determined, nothing is taken for granted, and the operative procedures are directly under the control of our various senses. In particular, the appendix can be removed at the time of the primary operation—a procedure which I regard as extremely important. Of all varieties of appendicitis attended by suppuration, these cases of pelvic suppuration due to appendicitis have been, in my hands, among those most successfully treated by operation. The reason for this success is that the general peritoneal cavity can be so thoroughly protected by gauze packs, and that in consequence the appendix can be safely removed at the primary operation. If it were not possible to so thoroughly exclude the area of operation, it would no doubt be safer to evacuate the abscess through the vagina or the rectum, the case then being analogous to the treatment recommended for the second variety of peri-appendicular suppuration, by evacuation through the loin; with the important exception, however, that in the latter the appendix can frequently be successfully removed through the lumbar incision at the first operation, whereas in the case of pelvic abscess the appendix could not possibly be removed through the vagina or rectum.

In the *fourth variety of peri-appendicular abscess* the collection of pus lies to the inner side of the cæcum, and the confining wall is made up of the cæcum, appendix, small intestine, mesentery, omentum, and possibly the sigmoid flexure. At times, also, the purulent collection is found in the retro-mesenteric tissues. In operating upon these cases, which are among the

most fatal of all varieties of circumscribed peri-appendicular suppuration, the surgeon is indeed fortunate if he can open into the abscess cavity without first traversing the peritoneal cavity. If, however, on making his incision in the usual place, he finds adhesions to the parietal peritoneum and evidence of inflammation in a region which makes it probable that this form of abscess is present, it may be necessary for him to make a second incision toward the median line of the abdomen, to insure the proper disposition of gauze for the protection of the general peritoneal cavity. The further operative procedures are similar to those already detailed.

In the treatment of the *fifth variety of suppuration, or diffuse purulent peritonitis*, the least traumatism possible should be inflicted upon the already diseased peritoneum. The appendix should be removed, and drainage should be established, with as little manipulation of the intestines as possible. I no longer irrigate these cases, and have had many more recoveries from simple drainage, than I had when an attempt was made to remove the pus and other inflammatory products at the time of operation. Where adhesions are absent, I introduce a glass drainage tube into the pelvis, and place the patient in a semi-sitting posture in bed. As fast as any fluid collects in the pelvis it is sucked out through the tube. This plan of omitting irrigation considerably shortens the time of operation, and I have observed that the patients who have not been irrigated do not have a rise of several degrees in temperature within a few hours after the operation, nor do their abdomens become markedly distended and tympanitic; both of these features were usually prominent in the patients whose abdomens I irrigated. If we could be even fairly certain that the peritonitis was general, *i. e.*, that the entire peritoneal cavity was filled with a sero-purulent exudate, then irrigation would be the rational treatment because of the impossibility of adequate drainage. It is quite rare, however, for such to be the case, the infection being widely diffused but not general, and just as in

burns of the surface of the body a known degree determines the recovery or death of the patient, so in the peritoneal cavity every portion of surface which can be kept free from infection increases the chances of recovery. Irrigation may disseminate the infection and convert a large but circumscribed area of peritonitis into one which is general.

But as there are many surgeons who still employ irrigation, and who claim to afford their patients much benefit by so doing, I do not consider it out of place for me to describe the proper method of irrigation, even although I do not recommend it myself.

It is usually best to remove the appendix before irrigating the peritoneal cavity, in accordance with the surgical principle of removing the source of infection before making the toilet of the peritoneum; but in the case of appendicitis this rule is not so inflexible as in the case of perforation or rupture of the intestines or the bladder, since even if the appendix be perforated, the escape of fæces through the perforation is quite exceptional. Irrigation of the peritoneal cavity is most thoroughly as well as expeditiously accomplished by the use of a funnel attached to a tube with many perforations; by passing the end of the tube into the various depressions and pockets of the peritoneum as the hot irrigating fluid is constantly poured into the funnel, a large amount of peritoneal exudate can be evacuated in a surprisingly short time. Some surgeons, as Blake, of New York, have employed an irrigating tube with central inlet and lateral outlets, which, by syphonage, is claimed to cleanse the abdomen in a short time, as well as to aid in the removal of flakes of fibrin and other products of inflammation, by causing them to adhere to the outer surface of the tube by suction. In using any form of irrigating apparatus the surgeon should proceed upon a definite plan of action, and not blindly thrust the tube here and there without regard to the anatomy of the abdomen. As a rule, the pelvis is to be first cleansed and when the fluid returns fairly clear from it, the irrigating tube may be passed into the left flank, to the outer side of the descend-

ing meso-colon. Then the right flank outside the ascending meso-colon should be similarly treated, and finally the tube should be passed both above and below the mesentery, the fingers of the surgeon's left hand separating the coils of small bowel as his right hand conducts the tube among them. Before concluding the irrigation it is well to again visit the pelvis, in which by this time a considerable amount of turbid fluid may have collected. If time does not press, the process of irrigation may be repeated, but as a rule the irrigating fluid will return clear in about five or ten minutes' time at the outside, and I can see no object in prolonging this feature of the operation up to forty-five minutes or an hour, as has been done at the Johns Hopkins Hospital in some cases of diffuse peritonitis. The irrigating fluid should as a rule, be either the deci-normal solution of sodium chloride (sodium chloride $\mathfrak{z}\text{jss}$, sodium bicarbonate gr. xv, distilled water Oij) or sterile water. Price claims that the saline solution favours the subsequent formation of flakes of lymph, and always uses sterile water; but for my own part I think the saline solution is to be preferred. If the pus is thick and clings to the peritoneum, some surgeons use equal parts of saline solution and peroxide of hydrogen as the irrigating fluid, and have on more than one occasion attributed the favourable outcome of such cases to its employment. I have not used hydrogen peroxide within the peritoneum for some years, and cannot recommend it.

If the case of diffuse peritonitis be of sufficiently long standing to have permitted of the formation of extensive adhesions throughout the general peritoneal cavity, irrigation alone will not be sufficient to cause the removal of infectious material from the numerous recesses of the peritoneal cavity. It may become necessary, therefore, in some cases, to disembowel, cleanse, etc. In children such an undertaking, as a rule, entails too great shock, and even in adults, it is a precarious thing to scrub the intestines free of adherent lymph, and to separate all adhesions. It is a

well-known fact that toxic absorption occurs very much more rapidly from the abdominal cavity when the peritoneum has been denuded of its endothelium, and every effort of the surgeon should be directed to preserving it intact. Peroxide of hydrogen, as already mentioned, is considered by some a great aid in removing these products of inflammation; but usually it will be wiser to limit our efforts to the evacuation of every abscess that can be found, draining each suppurative focus with a separate tube and strips of gauze. This gauze should then be allowed to remain until sufficient time has elapsed for the separation of the sloughs, when the sinuses may be encouraged to close by granulation. In some instances these adhesions are met with very early after the onset of the first manifestations of the attack; I have encountered them at the end of twelve hours. These cases are very virulent from the onset and the prognosis is extremely unfavourable.

In some cases in which there has been no attempt upon the part of nature to wall off the pus, it will also be necessary to insert a series of pieces of gauze in such a manner that they will drain the general peritoneal cavity. This should be accomplished in a systematic manner, and for a surgeon who is well acquainted with the anatomy of the parts this is not difficult. The pelvis and each flank must be drained, as it is in these portions of the abdomen that fluid is prone to accumulate; moreover, where the purulent exudation is general, one strip of gauze must be placed above the mesentery, and another below. Besides these it is usually requisite to pack the intestines away from the wound by several more strips of gauze, their number depending upon the size of the wound. But this drainage by gauze is by no means so important when adhesions are absent, as it is when they are extensive. In the latter class of cases the adhesions are prone to re-form, and residual abscesses will almost surely develop, unless every suppurating focus is separately drained.

In dividing adhesions and dissecting the intestines free from

each other, from the omentum, the pelvic organs, or the parietal peritoneum, all damage should be repaired as soon as it is inflicted. Areas denuded of their serous covering should be inverted by Lembert sutures of fine silk, or be covered by a graft of omentum, stitched in place; hæmorrhage should be checked by ligature, by suture, or even by packing, this last method being only applicable to bleeding from a bed of adhesions where pressure is possible. Irrigations with hot solutions will also aid in checking the hæmorrhage. If large peritoneal defects are found a flap of parietal peritoneum may be transplanted, as advised by Senn; or Cargile membrane may be used. I have employed this last-named material a number of times and have yet to see any evil effects from its use. Omentum or parietal peritoneum, however, are to be preferred.

In **closing the abdominal wound** one of several methods may be employed: (1) Interrupted sutures including all the layers of the abdominal wall; (2) buried sutures uniting the different layers of the abdominal wall individually; and (3) a combination of both methods, or a modification of either. The method of election depends upon whether or not drainage is employed, on the length and character of the incision, and on the development of the abdominal walls.

In *clean cases* where the incision can be sutured in its entirety, I prefer to use a buried continuous suture of eight or ten-day catgut for the peritoneum, introducing it like a mattress suture, so as to slightly evert the peritoneum into the wound, thus bringing serous surfaces into contact, and making the suture practically extra-peritoneal. With this method I regard as very remote the probability of any adhesions forming between the abdominal viscera and the scar. Then interrupted sutures of silkworm gut are introduced through all the thickness of the abdominal wall down to, but not including the peritoneum; these sutures are left untied until the aponeurotic layers of the abdominal wall have been approximated with a running

suture of chromicized catgut, and are then finally tied, making a very firm splint for the support of the buried sutures. The skin is then neatly approximated by a few interrupted sutures of fine silk or lightweight silkworm gut or catgut, as may be required. When the incision is only an inch or less in length splint sutures are unnecessary, as the strain upon the wound is slight; but in other cases these sutures are of the utmost value in supporting the gut stitches, and in obliterating dead spaces between the different layers of the abdominal wall.

In clean cases, with a small wound, I sometimes use a single suture of chromicized catgut for both the peritoneum and the sheath of the rectus, stitching the peritoneum from the lower angle of the wound upward, then transfixing the rectus and its anterior sheath on one side of the wound without tying the suture, and finally stitching the rectal sheath downward to the starting point at the lower angle of the wound, where the two ends of the suture are tied together. I find that this form of suture not only obliterates all dead spaces, but tends to decrease the length of the wound to a very considerable degree.

I am careful in all cases, but especially in those where there is much subcutaneous fat present, not to suture the skin surface of the wound too closely, but to leave a half inch or an inch between the sutures. In every wound there is normally a certain amount of serum exuded from the opposed wound surfaces, and if no exit for it is allowed between the sutures it will accumulate beneath the skin, and materially delay the healing of the wound. For the same reason I have almost entirely abandoned the subcuticular suture, which has, in my hands, only too often caused the formation of a subcutaneous collection of serum, necessitating the too early removal of the suture, with consequent gaping of the skin wound, and the production of a more conspicuous scar than follows the use of the customary interrupted or Glover's suture. I may add that I have seen similar unsuccessful results from the subcuticular suture in the hands of other

surgeons, so that I do not think they can justly be attributed to faults in technique.

When *drainage is employed*, the buried sutures are used as above described, but they are made interrupted, not continuous, thus avoiding the unpleasant experience of infection of one such suture causing gaping of the whole corresponding layer of the abdominal wound. In infected cases I always prefer catgut to silk. Splint sutures of silkworm gut are also employed, those inserted where the drains emerge being left long at the ends, and looped, or clamped at their tips by a shot, so as to aid by being subsequently tied, when drainage is dispensed with, in the repair of the wound. The buried sutures, of course, extend only as far as the point of emergence of the drains. In many cases it is inadvisable to employ buried sutures of any kind, since rapid completion of the operation is imperative. Under such circumstances the silkworm sutures must include all the layers of the abdominal wall, even the peritoneum; but if after all these through-and-through sutures have been introduced any prolongation of the operation seems justifiable, it will be well to apply a few buried interrupted sutures of chromicized catgut to the aponeurotic layer, as without such sutures the approximation of this layer, on the accuracy of which depends to a very great extent the subsequent freedom from hernia, is at most very imperfect.

In cases in which there is much putrid and sloughing matter in the abdominal cavity, which cannot be removed at the time of the operation, gauze as well as tube drainage will have to be employed and the wound must be left widely open. Yet it is well to introduce a few interrupted sutures of silkworm gut, even if they are passed only through the skin margins, as without some such barrier above the gauze the bowels will prolapse into the wound. Such sutures must be drawn tight enough only to act as a barrier, and not so tight as to bring the lips of the wound into contact.

In the introduction of the buried sutures I use a round needle for the peritoneum, straight if the wound is large and the walls relaxed, so that it can be conveniently held in the fingers; but a curved round needle in other cases, using as a needle holder a pair of hæmostatic forceps. For the fascial stitch the ordinary triangular pointed, curved surgical needle is used, it being very difficult to force a round needle through such thick tissues. In introducing the silkworm-gut sutures I prefer the ordinary straight surgical needle; I use the Reverdin needle only in a limited number of cases where rigidity or thickness of the abdominal walls makes it very difficult to introduce these splint sutures with a straight needle; such cases are exceptional.

An accident sometimes met with in closing the simple abdominal incision is a puncture with the needle of one of the deep epigastric veins. I am aware of a case in which such an occurrence led to the death of the patient from hæmorrhage. If this accident occurs, the surgeon is not justified in closing the wound until the vein has been ligated. The deep epigastric veins can be exposed, after they have left the rectus muscle, by lifting this muscle upward and drawing it backward, thus separating it from the transversalis fascia, between which and the muscle the veins course. Remembering this fact it is a simple matter to find and ligate the injured vessel. Some surgeons prefer to use a straight round needle for piercing the abdominal wall, thinking it less likely to cut the vessels just mentioned. Personally, however, I prefer the straight spear-pointed needle, or the Reverdin needle, as they are easier to manipulate, and I do not believe their use is attended by any increased danger of puncturing the vessels.

The **dressings of the abdominal wound** is a matter that usually receives too little attention. Many operators are content to lay on a quantity of sterile gauze in any manner, or in no particular manner, and to dismiss the patient without further thought. If the wound is a sterile one, we can be content with a

sterile dressing, and even in many suppurative cases a sterile dressing will suffice; but the method of its application is not a matter of no consequence.

If the *wound is completely closed*, it is usually well to apply some form of protective to its surface, to prevent the gauze from becoming agglutinated by the slight discharge from between the stitches which is unavoidable in most cases. A piece of rubber-dam is an excellent protective; dusting the wound with iodoform answers the purpose; or a few layers of silver foil may be applied over the incision; any such plan renders the first subsequent dressing more agreeable to the patient than if the gauze sticks to the wound. With very small wounds a collodion scab makes an efficient protective. The odour of iodoform is objectionable to many patients and it, as well as bi-chloride, may give rise to a dermatitis.

If *drainage is employed* an antiseptic dressing may be used, but usually sterile gauze, if it is carefully applied, suffices. The sutured portion of the wound may be dusted with iodoform, or coated with silver foil as above described. When gauze drainage only has been employed, the ends of the gauze drains should be surrounded by a sort of bird's nest of crumpled gauze, and over the whole more crumpled gauze and many layers of flat gauze are to be applied. A similar method is advisable when tube drainage is employed, but the end of the tube, if of glass, must be long enough to protrude beyond all the gauze dressings, which are to be perforated and slipped over the tube. The end of the glass tube is then slipped through a small perforation in a piece of rubber-dam, and the four corners of the rubber-dam, which should be about six inches square, are folded up over the projecting end of the tube, and securely fastened together with a safety pin. It is well to have a slender strip of iodoform gauze extending to the pelvis, left in the interior of the glass tube at the conclusion of the operation; and immediately over the end of the tube, and inside the rubber-dam a piece of crumpled gauze

should be placed, to collect any discharge which may accumulate.

The dressings of the abdominal wound are to be held in place by two or three strips of adhesive plaster, the lowest passing from the femoral trochanters across the pubic region, and the others from the crests of the ilia and from the flanks. An abdominal binder is finally applied, being made simply of gauze; or a formal bandage of Scultetus may be used. The binder should be fastened fairly tight about the abdomen, but if tympanites develops should be loosened. In fastening the many tails of the bandage of Scultetus those lowest down, at the pubes, should be crossed first, and the interlacing of the tails should proceed upward until the last pair is reached; these should be turned down somewhat obliquely across the abdomen, so as to make the upper margins of the bandage lie snugly in contact with the patient's waist.

THE AFTER-TREATMENT.

The *after-treatment* of a patient' operated upon for appendicitis is of the utmost importance, and his welfare depends upon close attention to details. The **general after-treatment**, applicable to all cases, is the following: The patient should be isolated and should be under the care of a competent trained nurse. The temperature, the pulse-rate, and the respiration rate should be recorded at least twice a day. They may be recorded oftener if the necessary procedures do not annoy the patient, or if there arise special indications that render it advisable. The patient should be kept warm by the proper amount of bed-clothing, and by hot-water bottles, hot-water bags, hot bricks, or, if these cannot be procured, by small bags of heated salt. It is often wise to protect the abdominal wall against pressure of the bed-clothes by a bed-cradle, which is readily constructed in emergencies by tying together two half hoops of a barrel. If great pain be referred to the back, as is sometimes the case, much comfort may be afforded by a hot-water bag, a cold-water bag, or by the pressure of the nurse's hands against the painful region, or by the placing of a hard pillow under the small of the back. While it is preferable for these patients to lie quietly in the supine position, I frequently allow those whose wounds are small and securely sutured to be cautiously turned on their right side after the lapse of twelve or twenty-four hours, if the dorsal position seems insupportable longer; but care should be exercised that the patient is not allowed to turn himself, but is rolled passively over by the surgeon and nurse, and that his back is well supported by pillows.

The *after-effects of ether*, such as vomiting and tossing about in bed, should be carefully guarded against, and strict attention on the part of the nurse must be enjoined. If great restlessness develops, it may be necessary to fasten the knees of the patient together and to administer an enema of the bromide of sodium

or potassium (1 drachm) and chloral (from 20 to 30 grains). These are preferably given in about two ounces of milk. If these measures are unsuccessful, or if the pain is severe (which it rarely is) a hypodermic injection of morphine may be given— $\frac{1}{2}$ or $\frac{1}{3}$ of a grain will usually suffice.

The *urine* should be drawn by a catheter if necessary. This, however, is rarely called for, if the patient is given the opportunity to evacuate his own bladder within eight hours after the operation. Catheterization is to be avoided whenever possible, not only because it may be a painful procedure, but also because of the danger of producing cystitis. A catheter-cystitis is capable of giving rise to very much more discomfort than is the operation for appendicitis itself under ordinary circumstances.

If *stimulation* should be necessary, hypodermic injections consisting of strychnine (from $\frac{1}{40}$ to $\frac{1}{30}$ of a grain), atropine ($\frac{1}{240}$ of a grain), and whiskey (one hypodermic syringeful) may be employed. They should be repeated as frequently as the circumstances of the case may indicate. In cases operated upon promptly, and in chronic cases, no medication at all is usually required. Absolutely nothing should be given by the mouth until after the ether vomiting and nausea have ceased. Afterwards, rarely sooner than eighteen to twenty-four hours after the operation, small pieces of ice may be allowed at intervals of ten or fifteen minutes, and the mouth and lips should be kept cool by moistening with a wet cloth. Hot water, not merely luke-warm, in teaspoonful doses, may be more agreeable to some patients than cracked ice. An ice-bag to the head will often be found very grateful to the patient; but the nurse must be careful that the patient does not abstract the ice and produce renewed vomiting by swallowing it in large quantities.

No *nourishment* should be given by mouth until the lapse of at least twenty-four hours after the operation. If at the expiration of this time the stomach has for some hours showed no evidence of irritability, albumen water, one of the commercial

preparations of beef, or a meat broth prepared by the nurse, or milk, peptonized by the cold process, and the peptonization not carried so far as to render the milk bitter, in doses of a teaspoonful (or less) may be given if the stomach remains tolerant. Milk with lime-water may be used in place of the peptonized milk, and may be cautiously given every hour or two. A drachm or so of whiskey may also be given if required. If the stomach continues retentive, larger quantities of milk may soon be given—one to two ounces every two hours—and the quantity increased or decreased according to circumstances, and the intervals lengthened as convalescence progresses. In addition to milk, chicken broth, bouillon, liquid beef peptonoids, beef peptones, dry champagne, etc., may be administered. If vomiting should return, absolute abstinence from food and liquids, for a time at least, will again become necessary.

In almost all cases the primary thirst may be much relieved by the use of enemata of normal saline solution; a pint is readily absorbed by the bowel in a short time, and should be given through a high rectal tube, the fluid entering from a funnel by the force of gravity. If the saline solution is forced into the rectum by a Davidson syringe it may reflexly excite vomiting. If gastric irritability persists, nourishment also may be administered by the bowel, in quantities of from three to six ounces every four or six hours, as described under the heading of Medical Treatment, at page 358.

If abdominal distention and inability to pass flatus should occur, asafœtida suppositories or enemata of milk of asafœtida should be administered. If these are not followed by the desired result the nozzle of a Davidson syringe should be introduced into the anus and allowed to remain for a short time; this failing, a rectal tube should be introduced for twelve or fourteen inches, and left in place for a half hour or longer if it produces no discomfort. These failing, two or more ice bags should be applied to the abdomen; these often serve to stimulate peristalsis, and thus favour

the expulsion of flatus. Eserine (physostigmine sulphate) in doses of from $\frac{1}{80}$ to $\frac{1}{40}$ of a grain, hypodermically or by mouth, is much relied upon by some surgeons for this purpose; and I have myself seen good results follow its use, but it has frequently failed to bring any relief. It should not be repeated more than two or three times, at intervals of one to two hours.

The use of combined enemata (magnesium sulphate, glycerine and turpentine, alum), and the use of the actual cautery over the abdomen, applied short of burning, are only mentioned to be condemned.

In clean cases, of which we are speaking, continued or marked distention is an indication of a peritonitis due to faulty technique, and is a reflection upon the surgeon.

If the patient does well, the *bowels* need not be disturbed until the third or fourth day after operation; and are then best opened by enema. If this should fail to procure a good movement, a dose of Hunyadi water, Rochelle or Epsom salts, sodium phosphate, or citrate of magnesium may be employed, according to the preference of the patient. In some cases, especially where the tongue is coated, it will be found advantageous to administer calomel in doses of from $\frac{1}{20}$ to $\frac{1}{10}$ of a grain every hour or two until the bowels move or until not more than two grains have been taken. If the constipation is due to obstruction of the intestines, purgatives are to be condemned.

Persistent vomiting—which may develop in any case—is most successfully treated by lavage of the stomach; the accumulating bile and mucus are removed by the tepid water, and nausea ceases. A cantharidal blister (one and one-half inches square) over the epigastrium may aid the action of the lavage. Sometimes benefit is derived from the administration of cocaine in doses of from $\frac{1}{8}$ to $\frac{1}{6}$ of a grain every hour or two, its local anæsthetic action tending to allay the irritability of the stomach. Teaspoonful doses of hot, strong, black coffee every half hour may have the same effect. Spirits of chloroform, 30 drops on cracked

ice, and in some cases iced champagne may be found of service. But such remedies are rarely successful, except in occasional instances, and the judicious use of the stomach tube offers the most certain remedy for the vomiting. During the persistence of the vomiting no food whatever should be given by mouth; if necessary to maintain the patient's strength, resort must be had to nutrient enemas.

With regard to the **special after-treatment** of cases operated upon, they may, for convenience, be classified as follows: (1) Simple, uncomplicated cases in which the abdominal wound is completely closed at the time of operation; (2) cases of local suppuration in which rubber-tube drainage has been employed, the tube being usually surrounded with gauze; (3) cases of general peritonitis, where either a single glass tube remains in the pelvis, or where besides such drainage, numerous gauze wicks have been introduced into the peritoneal cavity.

1. In *simple, uncomplicated cases*, if the temperature and general condition of the patient show no abnormalities, the wound does not require dressing for a week or ten days, when it should be changed, the skin gently cleansed with alcohol, of the dried blood or serum and a sterile dressing reapplied; the sutures may be permitted to remain undisturbed for two or more days longer, if there is no evidence of stitch irritation. When the sutures are of silk or silkworm gut they can be removed on the tenth or eleventh day; if catgut is employed no removal is necessary. A sterile dressing of gauze should still cover the wound until every vestige of scab is removed, and the scar is firmly healed. A sudden rise of temperature or a decided increase in the local pain, necessitates immediate changing of the dressings and a careful search for the source of irritation. Stitch abscesses usually develop early and should be opened and treated on general principles. If pus should form within the abdomen, the case alters its aspect and becomes one of the following classes.

The patient may be allowed to leave his bed, in simple cases,

at the end of twelve days or two weeks, or even in some cases as early as the eighth day, where the incision has been a small one. For the first week or ten days after the patient begins to move about, his abdominal wall should continue to be supported by an ordinary circular bandage or a bandage of Scultetus. I have stated elsewhere that I do not consider abdominal supporters of much value, except perhaps, when the incision has been unusually large.

2. Cases with *local suppuration* and drainage by tube, gauze or both, may require stimulation to a greater or less degree. This should consist of strychnine or digitalis, with whiskey, brandy or champagne. If the patient is greatly depressed as a consequence of prolonged suppuration, the judicious use of normal salt solution will often be found of the greatest utility, and will materially accelerate the patient's improvement. This saline solution is most advantageously administered by enteroclysis, the fluid being allowed to gradually seep in through the rectal tube which is kept constantly in place; or in less severe cases being administered periodically by enema. In case of sudden collapse the intravenous infusion produces a more rapid effect; the temperature of the solution for this purpose should be 110° F. to 120° F. For rectal or subcutaneous administration a temperature from 100° F. to 105° F. is sufficient. Hypodermoclysis is not nearly so effective as enteroclysis, and for emergencies cannot compare with the intravenous administration. It is slow, painful and cumbersome, with the possible danger of infection. In some of these cases it will be found necessary to continue the use of stimulants, tonics, and especially nutritious diet, for a considerable time.

The dressings, in cases of local suppuration, need not be disturbed until the third or fourth day after the operation, unless the outer dressings have become soiled by the discharges from the wound, or unless some unfavourable symptom makes inspection of the wound advisable sooner. In case the outer dressing does become soiled, it should be changed immediately, and in some

cases it may be necessary to do this once or twice daily; as long as the outer dressings are dry and are not saturated by the discharging wound, bacteria from the air or bed clothing do not find sufficient nutriment, and perish. When the dressings remain saturated with blood or serum or even with purulent exudate, such bacteria may rapidly infect by continuity. As a rule at the end of the third or fourth day these outer dressings must be removed and the skin surrounding the wound gently cleansed of inspissated pus or blood clots. Only in exceptional cases should any of the gauze packing be removed this early. The too early removal of gauze packing frequently produces disastrous results by opening avenues by which infection may extend into the surrounding coils of bowel, causing a peritonitis or secondary pus collection. In addition, fully formed granulations are crowded with leukocytes preventing absorption, and if the bowel surface is injured too early by the removal of gauze such protection is not afforded. If the case be one where an appendiceal abscess was opened extra-peritoneally, little or no gauze will have been used around the tube; in such cases it may be well to remove this gauze at the first dressing, and, having cleansed the tube, to replace it with less gauze, allowing the abscess cavity to gradually close by the pressure of the neighbouring coils of bowel. But where a coffer-dam of gauze has been used, the adhesions between the surrounding loops of bowel will not be sufficiently firm at the end of three or four days to ensure the general peritoneal cavity from infection if the protecting gauze is removed; and besides this consideration the too early removal of the gauze is very painful to the patient, and is apt to cause bleeding from the adherent bowels. After seven, eight or ten days, however, it will be found that the granulations on the peritoneal surfaces in contact with the gauze have reached such a stage of development that usually the gauze may be removed with little pain and considerably greater facility than at an earlier date. Before attempting the removal of the gauze, each piece in

turn should be thoroughly saturated with warm normal saline solution, sterile water, or boracic acid solution; and in their removal neither haste nor force should have any place. Unless their removal proceeds with the utmost gentleness, the protective adhesions may be torn, or the bowel or omentum may be dragged into the wound. Even when the greatest care is exercised this sometimes occurs. If it does, the bowel or omentum should be replaced and held in position by pieces of sterile gauze until the remaining gauze has been removed. It is sometimes wise not to attempt the removal of all the gauze at the first sitting, but, after thoroughly saturating the most firmly fixed pieces, to again attempt their removal after the lapse of eight or twelve hours. My experience has been that the longer the gauze remains in the wound the easier has been its removal. After the removal of each gauze drain, it should be immediately replaced by another, smaller; at most not more than two or three should be out of the wound at once, since the correct disposition of the new pieces would thus be made very much more arduous. It is not usually necessary to irrigate the abscess cavity, since if the gauze is sufficiently moistened the abscess cavity will be satisfactorily cleaned during the process of renewing the gauze. The tube should be replaced if there is anything further to be drained; but as a rule all that is required after the first week or ten days is to keep the wound open and allow it to heal by granulation from the bottom.

In those rare cases where a cigarette drain has been employed, without a tube, and where there was practically nothing to drain, it is usually well to remove this gauze plug on the third or fourth day; if no bad odour is present, and the gauze is practically unsoiled, it may then be proper to draw the wound together in its entirety by the sutures which were left untied at the time of operation. The subsequent management of such cases is the same as that of those where the wound was completely closed at the time of operation; but extra attention should be paid the case on account of the possibility of suppuration progressing beneath the wound.

Appendicitis.

3. In cases where at the time of operation there was *diffuse peritonitis and exudate* was present, drainage will have been employed either by a glass tube extending to the pelvis, by multiple wicks of gauze, or by both. In such cases as these vigorous stimulation is required. It is my practice to place the patients in bed in a semisitting posture, thus encouraging the gravitation of all fluids into the pelvis, whence they are least readily absorbed and most expeditiously removed by the drainage employed. Especially valuable in these cases is enteroclysis, which serves more or less to replace the bodily fluids lost by the process of suppuration, and to dilute the toxins which are constantly being absorbed. All nourishment by the mouth must be withheld for the time being, and benefit is often obtained by packing the abdomen in ice bags. Nutritious enemata must be continued for a longer time than is ordinarily required.

If a glass tube has been employed, its extremity should project beyond the other dressings, and should be covered with sterile rubber tissue containing a gauze sponge to absorb any fluids that may be drained out by the capillary action of the iodoform gauze wick placed in the interior of the tube. In addition, the nurse in attendance should be provided with a long-nozzled syringe (a rubber tube attached to the nozzle of an ordinary syringe will answer the purpose) to suck up from the pelvis through the glass drainage tube any purulent matter that accumulates. During the first eight to twelve hours the glass drainage tube should be exhausted every fifteen, thirty, or forty-five minutes, according to the amount of fluid that accumulates; this should not be allowed to exceed a half ounce. During the intervals a strip of gauze should be reinserted through the drainage tube into the pelvis, and it will commonly be found that some, at least, of the extravasated matters are absorbed in this manner into the gauze covering the outer extremity of the glass tube. The most painstaking care should be taken not to further contaminate the peritoneal cavity. To this end the suction apparatus should be repeatedly sterilized, and the

nurse's hands should be surgically cleansed each time the tube has to be exhausted. During the first twelve or twenty-four hours the amount of fluid which collects in the pelvis will be found to gradually diminish, until on the second day it will usually be necessary to exhaust the drainage tube only every three or four hours, and subsequently at even greater intervals. On the second day and thereafter the tube should be given a half turn to loosen any adhesions which the omentum or bowel may have formed to the fenestrations of the tube. When the amount of fluid becomes insignificant and of a straw colour—usually on the third or fourth day, if the patient has not sooner succumbed to the widespread peritonitis—the glass tube may be removed, and a rubber tube of smaller calibre substituted in its place, introducing the rubber tube through the glass tube before the latter is removed. The periodical exhaustion of the tube may then be discontinued. A rubber tube is generally much less irksome to the patient than one of glass and after the peritoneal discharge has nearly ceased, drains equally well. The rubber tube is to be replaced in its turn by a strip of gauze, and the wound allowed to close by granulation. In cases that progress favourably no rubber tube need be introduced, the tract being allowed to heal by granulation. I usually dust some iodoform over the orifice of the tract.

If gauze drainage, either in conjunction with a glass tube or without one, has been employed in these cases, it should not be disturbed for a week or ten days, unless the purulent discharge forces the gauze into the wound. In these cases, even more than where the suppuration is localized, are skill and dexterity requisite to safely dress the wound, and to prevent the prolapse of the bowel or omentum. Great care must be exercised in replacing the gauze, on the one hand not to leave any suppurating pockets undrained, nor on the other to produce intestinal obstruction by packing the abscess cavity too tightly. The management of the pelvic tube is the same in these cases as in those when no gauze has been employed.

COMPLICATIONS AND SEQUELS.

The complications and sequels of appendicitis are many and varied. Some of them—as circumscribed peritonitis, for example—are in many respects rather a part of the disease than one of its complications; others, as diffuse peritonitis, gangrene of the bowel, abscess of the liver, etc., are of much more serious moment, and greatly interfere with the prompt recovery of the patient, or cause a fatal issue; others, which may or may not pertain to either of the foregoing classes are of importance only as they render more or less difficult the proper surgical treatment of the affection.

It is thus convenient to divide a consideration of the complications and sequels into: (1) The complications due to the disease itself. (2) The complications of operation. (3) The sequels of the operation.

Such a division must occasionally be somewhat arbitrary, as, for example, the occurrence of intestinal obstruction which, following operation, is nearly always due to the peritonitis produced by the escape of infection from the appendix; or fæcal fistula, which may occasionally occur where no operation has been performed and which is almost always caused by local necrosis of a cæcum infected by a diseased appendix.

COMPLICATIONS OF APPENDICITIS.

Of the complications that pertain to the disease itself **peritonitis** is the most frequent, and in some respects the most important. In every case of acute appendicitis the peritoneum reacts to the irritant and secretes a serous effusion, the quantity of which depends upon the amount and virulence of the bacteria or their

toxines, or both. Nature then offers two measures by which the toxines may be rendered harmless and the patient recover. The first and most common is by the formation of protecting and encircling adhesions which, for a time at least, confine the infection to a localized area and thereby limit the amount of absorption. But sooner or later the purulent products extend in the direction of least resistance, thus obtaining a much wider field for absorption. Nature does her best in the beginning, but the aseptic scalpel of the surgeon must complete the cure by providing an external opening for the pus. The other method I referred to consists in the peritoneum reacting to the irritant by effusing from its entire surface an amount of fluid proportionate to the irritation, diluting the toxines and furnishing an antitoxine which endeavours to check bacterial invasion after perforation of the appendix (Moszkowicz). The antitoxic action of this effusion explains the rapid recovery of the peritoneum from infection after removal of the appendix, if operation is performed early.

If operation is delayed, the swollen belly, filled with thin serous fluid, so often encountered at the operating table, shows that there is no tendency to form adhesions, and that large amounts of virulent bacteria or their toxines are invading the abdominal cavity. The five most frequent locations of **local suppuration** have already been described in the chapter on Treatment, and the procedures proper to be employed in each case have there been discussed in considerable detail; so that it is unnecessary to do more here than urge the importance of evacuating all such abscesses at the earliest possible moment, so as to prevent sepsis, and secondary perforation of the intestinal tract. **Diffuse supplicative peritonitis** is a much more fatal complication. It occurs under two chief forms, as already described in the chapter on Pathology. In the first many adhesions are formed, and small abscesses arise here and there between the intestinal coils; in the second, few if any adhesions are present, and the intestines float free in a bath of pus. Septic peritonitis or preferably **toxic**

peritonitis, in which condition the system is overwhelmed by a rapid production and absorption of virulent toxins, has been sufficiently discussed in previous chapters.

In certain of the suppurative and gangrenous cases of appendicitis, and particularly when the abscess or the appendix lies behind or to the outer side of the cæcum or colon, the surrounding tissues will be found semi-gangrenous. This retro-peritoneal form of sepsis is an infection by continuity, and not by way of the lymphatics; since, as is well known, the lymphatics of the appendix do not empty into the retro-peritoneal tissues in this situation, but pass to lymph glands lying in the angle between the ileum and the colon. In cases where the disease presents this type, the wound must be treated as an open one, as has been fully described when discussing the operative technique for appendicitis.

Bowel necrosis is a very serious complication of appendicitis. The appendix may perforate directly into the cæcum or another portion of the intestinal tract to which it has become adherent; or an abscess, formed around the appendix, may rupture into some portion of the intestinal canal; or, where diffuse suppurative peritonitis exists, with multiple abscesses among the intestines, any one of these, or several of them, may ulcerate into the neighbouring intestine, and a fæcal fistula will thus be formed even before an operation is undertaken. Instances of perforation into the duodenum, ileum, cæcum, colon, sigmoid flexure and rectum have been reported.

A diseased appendix or a collection of pus about an appendix may be in relation with, and give rise to **necrosis of the iliac blood-vessels**. The vein is more likely to become involved in the inflammatory process than is the artery, probably for the two reasons that its coat is thinner, and the blood within it circulates less rapidly. Whichever vessel be involved, perforation of the vessel with fatal hæmorrhage may ensue. Pevvel has recorded a case of perforation of the external iliac artery. It is more common, however, for an **arteritis** or a **phlebitis** to occur. This results in

thrombo-arteritis or thrombo-phlebitis, which may be mechanical or infective, and may give rise to infective or noninfective embolic processes. Scheibenzuber has reported an unusual case of embolism of the left anterior tibial artery with consequent gangrene of the leg, and Bérard a case of obliteration of the right crural artery, the result of arteritis. Of the venous involvements may be mentioned inflammation of the right iliac vein, of the right femoral vein, of the left femoral vein, of the mesenteric veins, and of the portal vein. Inflammation of the veins of the extremities is not so rare from other causes as to require illustration in this connection. Mesenteric thrombosis has already been discussed in the chapter on Differential Diagnosis.

Inflammation of the portal vein, however, with a consequent suppurative hepatitis, is not very infrequently seen. These inflammations are generally infectious, and give rise to infectious embolic processes, which are met with under the forms of **hepatic abscess** and **suppurative pylephlebitis**. Occasionally these conditions co-exist, as in the following case:

A. T., a white male, aged twenty-two years and a bartender by occupation, had a negative family history. His previous personal history was also negative—he had had only the ordinary diseases of childhood. During the eighteen months prior to first observation he had had three or four attacks of colic, attended by vomiting. There was no recollection of localized pain. These attacks usually subsided within a few days and he was able to return to his work.

On March 1, 1885, he developed a sore throat, which was accompanied by stiffness of all his extremities and was followed by excruciating griping pains in the epigastrium, which were increased by deep inspiration. He had chills, fever, and sweats at irregular intervals; headache and backache; his appetite was fair and his bowels were loose. When seen by his attending physician on March 15th, he presented the following symptoms: Temperature, 103.4° F.; pulse-rate 96; hectic flush on the cheeks; extreme pain and tenderness and slight tympany in the epigastrium. His tongue was thickly coated; his heart and lungs were normal. His urine contained a trace of albumin and a few granular casts. Blood examination revealed the normal number of erythrocytes and leukocytes, and the normal percentage of hæmo-

globin. Microscopically, a few intracellular organisms, resembling the hæmatozoa of malaria, were found. During the succeeding night he had a severe chill and profuse sweating. The following morning at 5-A. M. his temperature was 98° F. and his pulse-rate was 80. A serous diarrhœa, then set in. Quinine was administered without relief, and no change in his symptoms was noted until March 19th, when, with a morning temperature of 96.6° F., his pulse-rate was 104. His pulse was irregular, there was general abdominal distention, accompanied by marked tenderness and tympany, and a general peritonitis had evidently supervened. The diarrhœa continued, the pulse was rapid and irregular, and the patient grew weaker, and died April 4th. At necropsy, performed eight hours after death, there was detected a general peritonitis due to a ruptured abscess of the liver. The appendix was perforated and was embedded in a mass of necrotic adhesions. There was purulent inflammation of the portal vein extending into the liver substance. In the upper part of the right lobe of the liver there were numerous embolic abscesses, one of which, situated near the surface, had ruptured beneath the diaphragm.

This case, which came under my observation at necropsy only, is reported: (1) To demonstrate the importance of excluding primary appendicular inflammation in the diagnosis of all intra-abdominal affections, particularly when pain and tenderness are not referred to the right iliac fossa; and (2) to emphasize the value that should be attached to a history of previous attacks of colic with gastric irritation, as indicating early involvement of the appendix—from which as an infectious focus other organs may subsequently become involved.

Unfortunately fatal suppurative hepatitis may occasionally follow even comparatively early removal of the appendix, if time has elapsed sufficient for perforation of the walls of the appendix by the infecting bacteria.

C. L., coloured, age twenty-eight years. Family and personal history good. Present trouble started thirteen days before admission to German Hospital November 30th, 1904, with acute paroxysmal pain over right abdomen, radiating to pit of stomach. Paroxysms every ten to fifteen minutes for eighteen hours, pain then became localized to right iliac fossa and gall-bladder region. Bowels opened by oil and enema. Patient vomited five or six times. Three days later he began to become jaundiced, gradually increasing to a deep yellow colour. Stools clay colour; tongue coated.

Examination showed rigidity of entire right abdomen, tenderness over appendix and gall-bladder region; slight distention, liver dullness decreased, probably from gas. Had a slight cough and few râles over base of right lung.

Operation.—Incision well toward spine of ilium; peritoneum opened over a small abscess. Pus sponged out and fæcal concretion removed. Abscess cavity packed with iodoform gauze. The patient died in a few days.

Pathological Report. Special Observations.—Peritoneal cavity showed no free pus. Appendix was found somewhat anterior and pointing straight toward the pubis. It was gangrenous, about 6 cm. long and showed a large perforation at its middle. There was a small pus pocket, containing a few drops of pus, at this point. The colon at and above the ileo-cæcal valve showed beneath serosa small areas of purulent material up to almost the transverse colon. Upon opening it there was found a purulent and ulcerative colitis, extending up almost ten inches. Small intestine congested. The mesenteric glands were enlarged. Superior mesenteric veins in some places on section showed pus because of a phlebitis. Spleen slightly enlarged and much congested. Liver very much enlarged and a hand's-breadth below the costal margin. Weight 3600 grammes. A curious extension of the left lobe was noted as a very flat portion. The surface and interior of the liver showed multiple abscess formation, the abscesses being not yet well defined or broken down. The veins showed a phlebitis. Gall-bladder normal. Lungs: the lower lobe of the right lung was very pale with many anthracotic spots. Kidneys: right, normal, very pale; left, enlarged and pale.

The following case occurring in the service of Dr. H. C. Deaver at the Episcopal Hospital, is a good instance of suppurative pylephlebitis with the formation of hepatic abscess:

H. R., a white male, aged thirty-one years, a farmer by occupation, had his first attack of appendicitis in March, 1904. He was confined to his bed for two days, with pain in the right side of the abdomen, and vomiting. One month later he had a similar attack, but was again confined to bed for only two days. His third attack of appendicitis began on September 4th, 1904, with pain, general over the abdomen, finally becoming localized over the region of the appendix. Vomiting began about twenty hours after the commencement of the attack. Examination on admission, twenty-four hours after the beginning of the attack, showed the patient to look toxic; the right side of his abdomen was slightly rigid, and very tender. There was no pain or tenderness on the left side. The leukocytes numbered 15,000. His urine was acid, of 1032 specific gravity; albumin was marked, and great

Appendicitis.

quantities of hyaline and granular casts were present. Operation was done September 5th, 1904, thirty hours after the commencement of the attack. The appendix was gangrenous, and its interior was full of pus; it was not perforated, but was bound down by moderately firm adhesions. One piece of gauze drainage was inserted. September 8th.—The gauze drain was removed, a little pus following it. September 9th.—More pus was discharged. September 10th.—The whole wound was infected; all sutures were removed, and the margins of the wound separated. Had one chill to-day, temperature reaching 104° F. The wound is dressed twice daily, only a little pus being found. September 14th.—A large collection of pus found to outer side and back of cæcum. This was drained by a rubber tube. Another chill; temperature varies from 99° F. to 102° F.; pulse-rate from 88 to 100. September 16th.—Still having chills; temperature 105.6° F.; pulse-rate 100 to 120. September 20th.—Condition very bad; little hope of recovery. September 23d.—Temperature subnormal; pulse-rate 120 to 140. September 25th.—Died 2.30 A. M. Had had no chills since 17th. Urine, shortly before death: 1017; acid; marked trace of albumin; a great many hyaline, granular, and cellular casts.

Autopsy.—Septic pylephlebitis, and pus collections in abdomen around intestines, but all communicating with the external wound. The surface of the liver presents nothing abnormal, but its substance is full of small abscesses, all situated in branches of the portal vein. No abscess larger than a split pea is to be found.

The subjects of hepatic abscess and pylephlebitis have recently been studied by Pellegrini, by D. F. Jones and by A. K. Gerster. From various authorities quoted by these writers it appears that suppurative pylephlebitis or hepatic abscess occurs in from 1 to 2 per cent. of all cases of appendicitis, and that of all intestinal lesions inflammation of the appendix is the most frequent cause. If the whole portal vein becomes the seat of septic thrombosis the inflammatory process spreads to its minutest branches in the liver, forming a true suppurative pylephlebitis, as in the case just recorded. If, however, a single embolus lodges in the liver only one abscess is formed at first, though others may arise either by subsequent emboli becoming lodged, or by extension from the original focus of suppuration in the liver. Infection of the liver is probably always produced by way of the portal system, as the

retro-peritoneal lymphatics do not drain into the liver; this is well shown by the rarity of liver abscess as a complication of appendicitis where the appendix lies in the retro-cæcal cellular tissue, or even in contact with the liver; also in cases of perinephric abscess. Moreover the superficial lymphatics of the liver itself drain from its centre towards the periphery, and do not pursue a centripetal course, like the bile.

The *symptoms* most to be relied on in the diagnosis of suppurative hepatitis are the following: First and foremost, it is important to learn the history of the case, so as if possible to detect a preceding appendicitis, or any disease simulating its usual symptoms, since in very many cases pylephlebitis follows an attack of appendicitis which has passed entirely unnoticed. Rarely will any symptoms referable to the liver be detected earlier than the fifth or sixth day, and they may be delayed for several weeks. If, however, a patient known to have had appendicitis, presents, after a suitable interval of time, sudden epigastric or right hypochondriac pain, with a chill, and develops tenderness over the liver, with perhaps pain on deep respiration, and jaundice, hepatic complications should be suspected. Special attention is called by Gerster to the frequency with which this dreaded complication results from operations performed even after the acute attack has subsided, and thorough postmortem examinations are suggested in such cases in order that if possible undeserved blame should be removed from the operator who has had the misfortune to operate upon a patient with a septic thrombus which is ready to be detached and carried into the portal circulation on the slightest provocation. It may be difficult at times to exclude a right-sided pleurisy or pneumonia; an examination of the blood should be made to exclude malaria; while careful physical examination will usually render evident the absence of malignant endocarditis and miliary tuberculosis. All of these diseases are liable to present somewhat similar symptoms. Tenderness on deep pressure over the liver is the most valuable local sign; occasionally, if the hepatic

abscess contains gas, a tympanitic note may be obtained. Loison is said by Pellegrini to have detected a solitary hepatic abscess by means of the Röntgen rays. Puncture or aspiration of the liver for the purpose of detecting suppuration is a dangerous as well as an uncertain method of making a diagnosis. Even puncture of the exposed liver will frequently fail to reveal the presence of pus, although a good-sized abscess be present.

At a later stage the pain and tenderness are often diminished; diarrhoea may set in, jaundice may be detected, and there may be bile in the urine. If numerous chills occur it is extremely probable that the affection is a suppurative pylephlebitis, and not a single abscess of the liver, since each new infection almost invariably produces a rigor. The temperature is extremely irregular, varying from 100° F. to 104° F. In the later stages of the disease the fever is more constant and is remittent in type, while the chills disappear although profound sweats occur. If only one or two abscesses are present in the liver this organ may be noticeably enlarged. If relief is not soon afforded, sepsis progresses, the patient may become delirious, and finally death from exhaustion ensues.

The question of *operative treatment* is even more unsettled than is that of diagnosis. A correct diagnosis is said to be made in only one out of fifty cases. If we could be sure that one or at the most two or three discrete abscesses existed, the institution of drainage would, of course, be proper; but in cases where a general suppurative pylephlebitis exists nothing can be accomplished. According to Pellegrini's investigations the abscess is single in only about 30 per cent. of the cases, and even thus is accessible to surgical treatment in only 16 per cent. of the whole number of cases. If from the symptoms and physical examination it appears that the abscess is solitary, or that only a few solitary abscesses exist, operation should be undertaken before the patient becomes too exhausted. As a rule the transpleural thoracic route is to be preferred, since the abscess is almost invariably on or near

the convex surface of the liver, well back from its anterior edge. In some instances it is well to first do an exploratory laparotomy, and subsequently, if the condition cannot be successfully treated by this route, to resort to the transpleural operation. In this latter method it is extremely important to prevent the formation of pyo-pneumothorax; hence the two layers of the pleura must be sutured together after excising one or more ribs in the axillary line; or the diaphragm may be sutured to the intercostal muscles. After dividing the diaphragm, the peritoneal cavity should be protected by gauze packs, unless the liver is adherent to the diaphragm. After incising the capsule of the liver, the subsequent exploration for the abscess (which may at times be located with the aspirator after the liver has been exposed in the wound) should be conducted with the finger. If the purulent collection is found it is to be drained by one or more tubes, surrounded by gauze, this last being usually necessary to check the oozing of blood from the healthy liver substance traversed before entering the abscess cavity.

These hepatic complications of appendicitis are of the utmost importance and merit the careful attention of the physician. Indeed in some cases abscess of the liver, single or multiple, may so mask the symptoms of the primary appendicular disease that the necropsy alone reveals the purulent focus in the appendix. The more that attention is directed to these complications of appendicitis, the less rare they seem to become; and inasmuch as they constitute the most serious and almost necessarily fatal complications of appendicitis, and may be met with in cases unattended by local pus formation—in some cases of severe interstitial appendicitis, especially when follicular abscesses have formed, and in other cases with circumscribed ulceration or gangrene—it is evident how very alert the attending physician or surgeon must be to detect the early signs and institute active treatment at the proper stage. When we consider the freedom of the anastomosis of the veins of the mesentery, it is not strange

that abscess of the liver and other complications should occur. Such is the importance of these complications that they have been dignified by a special designation by Dieulafoy, who speaks of this condition as *la foie appendiculaire*.

At times a **peri-appendicular abscess** may burrow upward behind the liver, either through or posterior to the diaphragm, and may finally **rupture into the lung**, the pus being expectorated. The following is an illustrative case:

R. S., a male, aged nineteen years, was admitted to the German Hospital on August 25, 1895, and the following history was elicited: He had always enjoyed good health until three days prior to admission, when, after a hearty meal, he commenced to complain of pain in the epigastric region. This was attended by vomiting, which afforded no relief. The pain increased in severity and became localized in the right iliac fossa, which was markedly tender on pressure. The vomiting finally ceased, but nausea persisted. The patient considered himself afflicted with an ordinary attack of intestinal colic, and did not summon medical aid until the pain had become unbearable. He was sent immediately to the hospital, where, upon admission, his temperature was found to be 102° F.; his pulse-rate 94; his abdomen slightly distended and rigid, especially upon the right side, where tenderness was most marked. He complained of general abdominal pain.

A diagnosis of appendicular abscess was made.

Ice-bags were applied to the abdomen and saline purgatives were administered. Some abatement of the pain and tenderness resulted. Although operation was strongly advised, it was absolutely refused by the boy's parents. At this time his temperature ranged from 99° to 99.8° F.; his pulse-rate from 84 to 100. He was, however, fairly comfortable, despite occasional nausea and vomiting and the continuance of abdominal tenderness. He remained in this condition until the fourth day after admission (the seventh day of the attack), when he suddenly grew worse, his temperature rising to 104° F. and his pulse-rate to 120 a minute. He vomited continuously, became dyspnoëic, and expectorated large quantities of foetid, muco-purulent matter, tinged with blood. Examination of this revealed no tubercle bacilli. The patient became exhausted and died nine days after admission to the hospital.

At necropsy a perforated appendix, pointing north, and lying just below the diaphragm, was found. The abscess surrounding the appendix had perforated through the diaphragm into the lung, which revealed some gan-

grenous areas. The expectorated matter was evidently some of the contents of the peri-appendicular abscess.

In addition to this case I have encountered several other cases in which the pus from a peri-appendicular abscess was evacuated through the mouth. Similar cases have also been recorded by other surgeons.

At times there results a **purulent pleuritis**, which may or may not be accompanied by inflammation, abscess or gangrene of the lung. I have seen the case of a young man who suffered an attack of acute appendicitis, from which he apparently recovered without operation. Later his right chest filled with fluid, which aspiration indicated to be appendicular pus—probably the consequence of a subdiaphragmatic abscess. A rib was resected, and he improved. Still later the sigmoid flexure was perforated, and the pelvic abscess further evacuated itself through the rectum. A **subphrenic abscess** is not unfrequently an early process in such a chain of events, and may result from either intra-peritoneal or retro-peritoneal suppuration. If the latter is the preceding condition there first occurs a lumbar or perinephric abscess, of which a considerable number of cases have been observed. This is an inflammation by contiguity of structure, or direct extension. Suppuration of the kidney, of its pelvis, and of the ureter have also been encountered, and these conditions have been noted in addition to the usual renal manifestations of appendicitis, such as albuminuria, and casts or even blood in the urine. On the other hand, vesical complications may be prominent. Vesical irritability in connection with appendicitis has been referred to in another portion of this book, and may be reflex or due to actual contact of the diseased appendix or of its inflammatory products with the bladder. In addition to this there may arise a **purulent cystitis** as a consequence of the migration of the colon bacillus or other bacteria through the apparently intact bladder wall. Reference has also previously been made to the occurrence of rupture of a diseased appendix or of a peri-appendicular abscess

directly into the bladder. Two of the most interesting cases that have come under my observation were of this character. One was a vesico-intestinal fistula in a young man, from whom fæces passed through the urethra; the other was in the person of a young girl, with a similar condition, who passed flatus through the urethra.

Besides the infection of the lung, above referred to as occurring by direct extension through the diaphragm, **septic** or **croupous pneumonia** may arise as a consequence of pyæmia, septic emboli becoming lodged in branches of the pulmonary artery. In other cases of pyæmia there may occur an **acute nephritis** of severe type; while the development of **septic endocarditis** is by no means rare. Pyæmic abscesses of the spleen, brain, etc., have also been observed as a consequence of appendicitis. Inflammation of the **parotid gland** is another of these manifestations which is sometimes encountered. I have seen one case of bilateral suppurative parotitis in a case of extra-peritoneal appendiceal abscess.

D. F. Jones has recorded a remarkable case in which a girl of nineteen years developed double parotitis (nonsuppurative), three times as a complication of as many attacks of appendicitis. He quotes Stephen Paget, who found that of 101 cases of parotitis the records of which he examined, 18 only were due to disease or injury of the alimentary canal, 23 to that of the abdominal wall, 10 to that of the genito-urinary tract, and 50 to disease or temporary derangement of the generative organs. I have encountered several examples of parotitis occurring usually about three days after operation and subsiding without suppuration, but have considered them more in the light of accidental infections of the salivary glands independent of the abdominal lesion. I have also seen the parotid gland suppurate, necessitating incision. In one case the abscess evacuated itself spontaneously into the mouth.

The dryness of the mouth, the stagnation of the parotid secretion during anæsthesia and later by reason of the enforced liquid diet, together with possible injury to the exit of Steno's duct by the fingers of the anæsthetist, are all favouring factors

in the production of parotitis should a mouth infection ascend the duct. Battle and Corner state that Dyball has suggested that a nonsuppurative inflammation of the glands may arise from the action of toxins in the blood.

Abscess of the abdominal wall consequent upon an appendicitis may occur in rare instances. The following is an illustrative case:

A boy, aged thirteen years, with a history of three attacks of appendicitis, was referred to me by my friend Dr. P. F. Moylan. During his last attack the boy had been attended by Dr. Moylan, who said to me that at the time of his first visit there was a general peritonitis, which was attended by so much distention that he was unable to make out by examination the cause of the peritonitis. There was apparent recovery after this attack.

At operation, performed by making an incision through the right semi-lunar line, a cheesy mass situated beneath the transversalis muscle was disclosed. The peritoneum beneath this collection had been destroyed and the mass was limited posteriorly by the great omentum. The cheesy material was curetted away and the cavity was antiseptized. The diseased portion of the omentum was ligated from the remaining healthy portion and was excised. The cæcum contained two perforations, which were exposed after the removal of the diseased and adherent omentum. The appendix was post-cæcal and embedded in a mass of coagulated lymph, and was perforated at its base. The pelvis contained a collection of pus, which was limited by adherent coils of intestine.

The patient recovered.

Among the important complications of appendicitis are various lesions of the gastro-intestinal tract. **Obstruction of the intestine** consequent upon contraction of peritoneal adhesions is one of the most common. Intestinal obstruction is more frequently encountered after operations in pus cases, but may occur in chronic cases, and in some instances the first symptoms complained of may be those of intestinal obstruction, more or less complete. These peritoneal bands should be sought for, and, if detected, should be divided at every operation for appendicitis. Even when actual strangulation does not exist, the obstruction may be sufficient to cause the most distressing gastro-intestinal symptoms,

such as obstinate constipation, flatulency and colic. The obstruction may be due to generalized adhesions, or to a single band beneath which a knuckle of gut becomes constricted. In the former case there is not often strangulation of the bowel, but the gastro-intestinal symptoms above mentioned are almost invariably present. But if the appendix itself, or some distinct peritoneal band, extends from one portion of the abdomen to another, no symptoms of any consequence may arise until suddenly acute intestinal obstruction occurs from the strangulation of the bowel beneath this band. I have seen a case in which a peritoneal band the result of chronic appendicitis was stretched between the appendix and a Meckel's diverticulum. Obstruction resulted from a coil of intestine becoming engaged beneath this band. A case in which the appendix became adherent to the sigmoid flexure, forming a bi-mucous fistula, is referred to at page 23. I have seen intestinal obstruction follow the contraction of the walls of an appendiceal abscess in which the wall of the abscess cavity was made up largely of small intestine.

Among the most intractable accompaniments of appendicitis is **mucous** or **membranous colitis**. In some cases the obtruding symptoms are purely those of the colitis, and the diseased condition of the appendix may be for a long time unsuspected. At times there are also manifestations of indigestion, and at other times the most aggravated neurasthenia. Indeed, it is quite certain that a not inconsiderable percentage of neurasthenics suffer from chronic appendicitis; but as mentioned in the chapter on Chronic Appendicitis, it does not always happen, as in the following case, that removal of the appendix effects a cure of the neurasthenia as well as of the gastro-intestinal symptoms:

Miss P., aged forty-four years, was referred to me with the following history: For the past three years she had suffered from a mucous diarrhœa, which had been attributed by various physicians to enterocolitis, dysentery, etc., and had been treated by the most diverse methods, from bismuth by the mouth to quinine and nitrate of silver by the rectum.

Upon admission to the German Hospital she was markedly neurasthenic and much emaciated. Her bowel movements averaged from four to eight daily. They contained mucus, shreds of mucous membrane, and blood. Upon careful examination the appendix was found enlarged and was painful on pressure; there was no rigidity of the abdominal wall. She gladly consented to operation, in the hope of obtaining relief, and the appendix, when removed, was found to present typically the lesions of catarrhal inflammation. Recovery from the operation was uninterrupted. The bloody and mucous stools, the neurasthenia, and the emaciation, however, did not markedly improve for over three months after the operation, when her symptoms rapidly abated. She gained flesh, and within one year she considered herself entirely cured. The digestive functions were performed normally, the neurasthenia had disappeared, and she had increased in weight over twenty pounds.

The removal of the diseased appendix, which may or may not be the primary cause of a train of symptoms like those just narrated, is of utility only in that it removes a portion, even if it be considered the most important portion, of the cause of the symptoms. The other morbid conditions present will then require treatment, and it is often months or years before decided improvement is manifest. Indeed I have now seen so many cases where the removal of a chronically diseased appendix—one which has never produced acute symptoms—seemed to have absolutely no effect on the neurasthenic and gastro-intestinal symptoms, that I feel very doubtful whether such an appendix may not be considered as much the result as the cause of the disease.

Hernia of some form or variety may complicate an attack of appendicitis, and if the hernia be strangulated, or even if it be only irreducible or inflamed, or if strangulation be suspected, the symptoms of the appendicular inflammation may be entirely obscured, as is illustrated by the following case:

Mrs. X., aged forty-two years, was admitted to the German Hospital and the following history was elicited: Two days prior to admission she had been attacked with general abdominal pain, which was associated with vomiting and marked constipation. The attending physician detected a mass in the right inguinal canal which the patient stated was an old hernia. The mass

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was tender on pressure and was irreducible by taxis, even under anæsthesia. The patient steadily grew worse, and the following morning she was again etherized and another futile attempt was made to reduce the mass. She was then removed to the hospital, where I saw her. The mass was tender and was evidently inflamed; the abdomen was distended and the bowels were absolutely constipated; vomiting occurred frequently. Incision over the tumor showed that it was the sac of an old hernia which was not the seat of inflammation. By extending the original wound the peritoneal cavity was opened, and a general purulent peritonitis was disclosed. The appendix which was extensively diseased was removed. The peritoneal cavity was thoroughly irrigated, drainage was introduced, and the wound was closed. The patient did not rally, but died eighteen hours after the operation.

The original site of inflammation was undoubtedly the appendix, but the hernia and the mass to which it gave rise in the right inguinal canal had misled both the attending physician and myself.

Not only may appendicitis be mistaken for a strangulated hernia and *vice versa*, but the appendix may be found in the sac of the hernia, of either the inguinal or femoral variety. It has been observed in left-sided hernias as well as in those on the right, being probably carried into these abnormal positions by the ileum, which is the part of the intestinal tract most frequently found in hernial sacs. The appendix may remain in the sac for years, unattended by symptoms; it may be found, uninflamed, in the midst of strangulated bowel, at a herniotomy; it may become inflamed, and suppuration may occur, in the hernial sac, without there being any strangulation, yet producing symptoms nearly typical of strangulated hernia; or it may be detected only by accident at necropsy, or at operation for the radical cure of the hernia.

Tuberculosis, either latent or active, is a very grave complication of appendicitis. I have frequently been impressed by the fact that in many cases that do badly there is a tuberculous family history, even if no demonstrable tuberculous lesions exist in the patient. The underlying condition may thus be not only one of diminished power of resistance to the influence of

agents provocative of acute inflammation, but also, in some instances at least, a mixed infection, the consequence of dormant tubercle bacilli being roused into activity by infection with appendicular pus. Be this as it may, the fact is certain that protracted convalescence, the development of multiple abscesses, or of a fæcal fistula, and other debilitating results, are to be greatly feared in the tuberculous subject. Indeed it is questionable, I think, whether it is always wise to remove an appendix from an undoubtedly tuberculous subject, except for acute disease. Where the disease is chronic, or at most subacute, I think the surgeon will do well to palliate, as any operation on such subjects is liable to rouse into activity dormant tuberculous processes; and the exchange of a semiquiescent appendix for a persistent fæcal fistula will be most unsatisfactory to all concerned. I have seen a number of such results which were unavoidable, as operation was undertaken for the evacuation of appendiceal abscesses; but where an operation is not imperative, temporizing will as a rule be more to the interest of the patient. I have seen a case of this tubercular type, which has already been referred to, in which the patient, a young man, submitted to excision of a rib for empyema consequent upon an attack of appendicitis, from which he had apparently recovered without operation. Subsequently the sigmoid flexure was perforated and the pelvic abscess further evacuated itself through the rectum. This is a rare but fortunate result of allowing nature to care for these cases in her own way.

Finally, extremely important complications and sequels of appendicitis are certain **diseases of the female genitalia**. Appendicitis of every variety has been found associated with almost every pathological condition of the pelvic organs. The sequence of events varies in different cases: at times the lesions commence in the appendix and subsequently involve the genitalia; at other times the inflammatory phenomena are inaugurated in some portion of the genitalia and later implicate the appendix. From

Appendicitis.

rather extensive observation it has seemed to me that the former is not at all uncommon, (1) because widespread pelvic lesions are particularly likely to be encountered in young women and girls in whom no history or sign of external infection can be detected; (2) because of the excessive virulence of appendicular pus and the especial faculty it possesses of inaugurating purulent processes in other portions of the body; and (3) because the initial symptoms point rather to disease of the appendix than to disease of the genitalia. Although the diseased processes in individual cases may commence in the genitalia, the manifestations of appendicitis may be so prominent that the symptoms of uterine, tubal, or ovarian disease are obscured, and are revealed only by operation or necropsy.

When a peri-appendicular abscess occupies the pelvis it usually results from an ulcerative or gangrenous inflammation of an appendix that points due south or southeast. In these cases the distal extremity only of the organ may be affected, but it is usually in close relationship with one of the pelvic organs. The pain in these cases is usually left sided, and the abscess formed is of moderate size only. For these reasons there is great liability of confounding the conditions with disease of the pelvic organs, and errors in diagnosis are rendered still more likely because of the rapid formation of firm adhesions that limit the abscess to the immediate vicinity of the sigmoid flexure, the rectum or the bladder. The bladder and sigmoid flexure are often perforated. Two cases of this character have already been referred to.

Special emphasis must therefore be directed to the clinical importance of these pelvic lesions—conditions in which both the tubes and ovaries, together with the appendix, are involved in phlegmonous inflammation. Surgically they present difficulties that are often insurmountable. The various organs are covered by great masses of fibrinous or fibrino-purulent exudate in which one or more abscesses may be encountered. There are also found dense adhesions that have so devitalized the tissues

that the slightest traction is likely to lead to rupture of the bladder or the intestine.

These conditions not only possess a present danger, but also a most serious remote danger, in that they exhibit a most persistent tendency to recur, a tendency which it is sometimes beyond the power of human skill to overcome. As already mentioned, intestinal obstruction and strangulation may ensue. In addition, the omentum frequently becomes attached to the parietal peritoneum, and, by its efforts to free itself, as well as by certain of the patient's movements, such as coughing, sneezing, deep inspirations, etc., intense pain may be provoked. Indeed, in some cases even slight adhesions are sufficient to constitute a source of considerable trouble and complaint.

Pregnancy also may complicate appendicitis, and *vice versa*, and is always a cause of anxiety. If appendicitis occurs during the early stages of gestation, abortion frequently results. In any case a pregnant woman who is attacked by acute appendicitis should be operated upon as soon as practicable after the onset of the initial pain. The removal of a diseased appendix during pregnancy is attended by few if any risks to either mother or foetus, apart from those dangers that may attend any operation. The usual risks, on the other hand, that accompany the non-removal of an inflamed appendix, in every case, are much increased by the pregnant state, and the evil consequences of a subsequent attack of appendicitis, with perhaps perforation and gangrene, are correspondingly augmented. A recurrent attack with pus formation may occur at a later stage of the same pregnancy when the dangers of operation and miscarriage may be considerably greater than in the early stages. I have seen a number of cases of appendicitis in pregnant women in whom, as a consequence of delay in operation, the right uterine adnexa have become infected, and most serious conditions—in some instances death—have ensued. The earlier the operation, the less the likelihood of infection of the right tube and ovary, and the less

likely, therefore, the developement of serious complications. The wisdom of early operations is especially evident from the fact that I have never had a abortion to occur in pregnant women upon whom I have operated for acute appendicitis unless the right uterine appendages were involved in the disease and seldom then. Appendicitis also may complicate parturition and the puerperium, and in either condition is of serious moment. The establishment of a differential diagnosis between ante-partum or post-partum sepsis and appendicular sepsis will often tax the resources of the most erudite and experienced. The havoc which may result from suppurative pelvic appendicitis in a young girl is simply enormous.

COMPLICATIONS OF THE OPERATION.

The complications of the operation itself are usually unavoidable, but are occasionally due to faulty technique.

In the latter class of cases may be ranked those where, the diagnosis being uncertain, a **median incision** has been made, with the result that extreme difficulty arises in properly treating the appendicular condition. If these difficulties appear insurmountable, the surgeon should close the median wound, and make a separate incision in the right iliac region. In some such cases, however, the appendiceal condition, though important, is only secondary to some form of pelvic disease for which operation was undertaken; here the technique of the operation cannot be considered faulty, as the incision will have been made in accordance with the most imperative indications.

Among the unavoidable complications of the operation are certain **physical conditions** of the patient. At times a patient is found, who, either because he has inhaled ether a number of times before, or because of chronic alcoholism, or for other reason, *cannot be satisfactorily anesthetized*, no matter how much ether is inhaled. In such patients it is almost impossible to secure complete relaxation of the abdominal muscles; here

the intestines are likely to present in or protrude from the abdominal wound at most inopportune moments. The addition of a few drops of chloroform to the ether, however, will usually overcome this tendency, and effect complete muscular relaxation. Some patients are prone to excessive accumulations of mucus in the throat, greatly impeding their respiration, and accordingly interfering with the proper inhalation of the anæsthetic. By the slow but persistent dropping of ether on gauze laid over the mouth and nose, without at any time saturating the gauze, and by always keeping the jaw gently but firmly forward, the anæsthetizer will generally be able to prevent this excessive production of mucus; but where it occurs in spite of all precautions, it must be repeatedly but gently swabbed out with sponges in a suitable holder; and the head of the patient should be lowered, so as to favour the maintenance of an unobstructed larynx.

Vomiting during the operation likewise calls for lowering of the patient's head, to obviate the developement of a septic inhalation pneumonia. By careful attention the anæsthetizer can usually prevent vomiting, except in those desperate cases where reversed peristalsis is present before the operation is begun. In this type of case it is questionable whether operation should be undertaken; I question if the stomach tube would not be of more service than the scalpel of the surgeon. Unexpected vomiting may seriously complicate the operation not only by forcing the intestines out of the wound, but by rupturing ligatures and sutures, or by rendering impossible the reposition of the bowel already everted.

Hæmorrhage from the deep epigastric artery or its venæ comites is at times an annoying complication. These vessels are not apt to be divided except when the incision is extended downwards to facilitate the treatment of pelvic complications. The line of the artery is from its origin from the external iliac artery, just above Poupart's ligament, to the umbilicus; and when the incision approaches this line, or

crosses it, the surgeon should be prepared to ligate the artery. This should, if possible, be done before dividing it. The artery runs just superficial to the peritoneum, until it penetrates the substance of the rectus muscle, and is as a rule easily found. If the artery cannot be detected, the bleeding area may be caught in a buried catgut suture, and the hæmorrhage be thus satisfactorily controlled. It is not safe to trust to sutures of the abdominal wall to check the bleeding, since I am cognizant of a case, in the hands of another surgeon, where severe secondary hæmorrhage from a deep epigastric vein necessitated re-opening the wound several days after operation.

The **condition of the abdominal wall**, apart from mere muscular rigidity, is often a serious impediment to the dextrous removal of the appendix. If, on account of the excessive deposition of *fat* the abdominal wall is very thick, the difficulty of locating the cæcum and appendix, and of bringing them within the field of vision, may be considerable. In some very thick abdominal walls a very large incision is required, much increasing the chances of subsequent hernia. Moreover, in suppurative, perforative or gangrenous cases, a much greater extent of subcutaneous tissue is exposed to infection in these very fat abdominal walls, both during the operative manipulations and during the process of granulation. I can recall cases in which the abdominal wall was from four to five inches in thickness, and in which the cæcum and appendix were firmly united to the floor of the right iliac fossa by rather dense adhesions. In one of these cases the appendix, which was freed with difficulty on account of the thickness of the abdominal wall, was so friable that it was torn loose from its cæcal attachment in the endeavour to ligate its base. The remaining stump could not be brought within the limits of the abdominal wound because of the firm adhesions of the cæcum. The stump was then caught with a pair of hæmostatic forceps and a ligature was thrown about it below the forceps, and tightly tied. The stump was then invaginated into the cæcum, and by using a short curved needle

in a long hæmostatic forceps, it was possible to cover in the stump of the appendix by stitching the wall of the cæcum over it. It is in cases such as these that I have found Dawbarn's purse-string suture of the greatest advantage. In other cases, where the difficulty is even greater, I sometimes leave the hæmostatic forceps in place, and pack gauze around it; the forceps usually separates of its own accord in from four to six days, and no fæcal fistula results as a rule.

It is thus seen that the **condition of affairs within the abdomen** may very seriously complicate the operation. These circumstances may be due either to conditions existing before the appendix became inflamed, or to changes produced in the progress of the disease. Among those existing before the onset of the appendicitis, *unusual positions* of the appendix are the most important, often causing considerable difficulty in the removal of the organ. I have frequently encountered cases in which the anatomical conditions were such that at first sight the organ might be supposed absent. In these cases the appendix was usually found in intimate association with, and beneath the peritoneal covering of, the cæcum—the same layer of serous membrane being reflected over both (Plate VIII). Or the appendix may be partially or wholly intra-peritoneal, and yet escape detection because of its situation in the ileo-cæcal fossa, or in some other pocket of peritoneum around the caput coli. Again the appendix may have slipped into a hernial sac, and thus elude the surgeon. In all such cases the operator should first locate the cæcum, and then follow down one of its longitudinal bands, when these can be recognized, until the base of the appendix appears; it will then usually be possible to perceive the situation of the rest of the organ. Exceptionally neither the appendix nor cæcum can be found in the right iliac fossa; here it is probable that the cæcum retains its foetal position high in the abdominal cavity, or even in the right or left hypochondriac region.

Various circumstances due to the inflammatory changes them-

selves often combine to conceal the appendix. Chief among these is the presence of *adhesions*, which, in long standing cases, may acquire such bulk and vascularity that the unwary operator may congratulate himself on having discovered the appendix when in reality he is dealing with neighbouring bands of adhesions. If, in addition to the presence of bands of adhesions and perhaps pus, the appendix be subserous, the determination of the whereabouts of the organ is sometimes exceedingly difficult, and its removal is particularly arduous. Should such conditions exist it may be advisable to cut through the external layer of the ascending meso-colon in order to gain free access to the appendix. This procedure reduces to a minimum the danger of infection of the general peritoneal cavity.

The appendix is sometimes embedded in a great mass of fibrinous exudate. If this cannot be readily removed, its thickest and firmest portion, which usually corresponds to the seat of primary disease of the appendix, should be incised, whereupon the appendix will be readily detected. Again the appendix may be so rolled up in a fold of omentum that it is impossible to define its outline. In these cases it is proper to ligate and cut away the omentum along its attachment to the appendix, after which the appendix itself can usually be freed with facility. This method ensures control of hæmorrhage from the omentum and permits of ready manipulation of the appendix.

Sometimes, either because it is subserous, or because of adhesions, it is impossible to bring the tip of the appendix into the operative field. Under these circumstances it is often possible, after ligating and dividing the base of the appendix, to strip it out of its peritoneal coat as a finger is pulled out of a glove; by thus removing all but the serous covering the entire area of infection is taken away, and the serous envelope cannot cause a recurrence of the disease. It is often much easier to ligate and divide the base of the appendix first, and subsequently to ligate its mesentery and detach the remainder of the organ;

especially convenient is this procedure where the wound is deep and where the appendix runs in a northerly direction posterior to the cæcum. When once the base of the organ is divided, and the first section of the mesentery ligated and cut, it will be found that the direction and location of the remainder of the organ can be very much more readily detected, and its removal accomplished without difficulty.

A very *fat meso-appendix*, unless properly treated, often complicates the removal of the appendix, especially by giving rise to troublesome hæmorrhage. A fat meso-appendix is always friable and it is likely to be torn during the operative manipulations attending the removal of the appendix, especially when the application of the ligatures is undertaken. It is best to ligate a fat meso-appendix in sections, and to cut away each portion as the ligatures are tightened. This procedure minimizes the danger of laceration and consequent hæmorrhage.

At times there is *necrosis or gangrene of the apex of the cæcum*. If such be the case, it will often be found that it is impossible to secure any tissue sufficiently healthy to retain sutures introduced for the purpose of closing the opening. An attempt, however, should be made to close it by the introduction into the cæcum, wide of the necrotic area, of sutures so placed as to include as healthy tissue as is possible. Too much tension on the sutures must be avoided; and it will often be found that mattress sutures hold better than the ordinary Lembert stitches. When the perforated or gangrenous area approaches too closely the ileo-cæcal valve, great care must be exercised to avoid encroaching too much upon this orifice; ordinarily, however, no fear of producing stenosis need be entertained. When the cæcum cannot be closed securely, the great omentum may be carried down to the area affected, and a portion of it made to serve as a flap, by stitching it in place so as to reinforce the sutured area; or if a large meso-appendix be present it may be utilized for the same purpose. I have frequently done this with good results.

I have also employed Cargile membrane on numerous occasions, but much prefer an omental flap. In certain cases it will be found impossible to close the gangrenous area. All that can be done under such circumstances is to wall off the general peritoneal cavity by a coffer-dam of gauze and to leave the gangrenous area *in situ*, but exposed beneath the wound. In a few days the slough will be cast, with the formation of a fæcal fistula, which may be closed at a subsequent operation, if repair does not take place spontaneously. In many of these cases the surgeon's ingenuity is taxed to the utmost, and the greater his experience the more likely are his endeavours to be attended by a successful outcome. It is well to bear in mind that if the gangrenous area be invaginated, and the abdominal wound be immediately closed, the developement of a fatal peritonitis is a most likely event.

In a considerable number of cases the appendix is found *adherent* to one or another of the *abdominal* or *pelvic organs*. In these cases great care must be exercised in the removal of the organ because of the liability of the occurrence of hæmorrhage, or the subsequent developement of a fæcal fistula. Hæmorrhage is especially to be feared in those cases, fortunately rare, in which the appendix is discovered adherent to the iliac vessels. After detachment of the appendix the vessel itself must be carefully investigated, as in some cases it has been found to be the seat of necrosis or more or less gangrene. If such be the condition, and the weak point in the wall of the vein is not reinforced by peritoneal flaps, fatal secondary hæmorrhage may ensue. Where the appendix is adherent to the small intestine, the colon, or the sigmoid flexure, it is usually advisable to invert the point of its attachment to these structures with a few Lembert sutures: these serve to control any hæmorrhage from the point of contact, and lessen the likelihood of subsequent perforation.

SEQUELS OF THE OPERATION.

Unfavourable sequels of an operation for appendicitis are next to unknown when the operation has been performed within the first twenty-four or thirty-six hours of the disease. Almost every one of the serious and at times life threatening complications that follow an operation may be directly laid to procrastination in seeking the surgeon's knife.

When the peritonitis at the time of the operation was widespread, was spreading, or even when a localized suppuration only was present, there may develop within the first week or ten days following the operation, one or more **secondary** or **residual abscesses** which as a rule must in my opinion be charged to defects of drainage. At times, of course, ideal drainage is impossible. In the presence of numerous adhesions it will often be beyond the power of the surgeon to tell when he has reached the last encysted collection of pus, and the best he can do is to break up all the adhesions he can find, and drain from every place where adhesions were present. If a localized suppuration alone was present, secondary abscesses are liable to form only where the original abscess was merely evacuated, and where its limiting adhesions were not broken up, thus allowing the possible leakage of pus from the lower end of the abscess cavity into the pelvis or among the coils of small intestines. Dr. Murphy in a recent article states that he now invariably attacks an appendiceal abscess from its intra-peritoneal aspect, protecting the general cavity by gauze, as he fears that through simple evacuation of such an abscess by an incision made through the abdominal wall directly into its cavity, without breaking down its walls, subsequent unsuspected leakage backward into the general cavity of the peritoneum might occur, leading to the death of the patient. But while his contentions are right in theory, it seems to me that they are not always best in practice, since there will always remain patients in whom the abscess is practically pointing through the

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abdominal wall, yet who will not stand the shock of operation necessarily involved in the procedure recommended by Dr. Murphy, and which is, I acknowledge, the proper course to be pursued in the majority of cases of appendiceal abscess. I have recently had under my care at the German Hospital a case of suppurative appendicitis where the appendix was removed and drainage instituted by the transperitoneal route. The wound granulated satisfactorily, and the patient was discharged from the hospital, and returned to the dispensary to have the wound dressed. About two weeks subsequently a residual abscess formed, for which the patient was again admitted to the hospital. A large fluctuating abscess was pointing above the iliac spine. I opened this by direct incision, and evacuated a large quantity of offensive pus. For a couple of days the boy did well; but he then began to vomit, his fever became higher, his bowels were obstinately constipated, and it was evident that there was secondary peritoneal involvement. Recognizing that longer delay meant death, I opened his belly in the hypogastric region, turned out his intestines, which I found adherent in innumerable places, and separated all the adhesions. There were, I think, at least seven different abscesses among the intestinal coils, one abscess being beneath the transverse meso-colon in the epigastric region. After thorough irrigation of the bowels and the peritoneal cavity, the intestines were returned to the abdomen, drainage was instituted by means of a glass tube to the pelvis and multiple wicks of gauze throughout the abdomen, and the wound of operation was partly closed. The lad's fever subsided, his stomach became retentive, and although multiple fæcal fistulas developed, he is now, I am happy to say, well.

At times in cases of suppurative appendicitis there may be found an **abscess in the omentum**, apparently entirely unconnected with the original focus of infection. Such an abscess is as a rule best treated by excision of the entire area of omentum involved in the process. If adhesions render this course im-

practicable, care should be taken to secure adequate drainage from the abscess cavity after evacuating its contents.

In certain of the suppurative and gangrenous cases of appendicitis, and particularly when the abscess or the appendix lies behind or to the outer side of the cæcum or colon, the **surrounding tissues** will be found **semigangrenous**. In this type of the disease the wound must be treated as an open one, no attempt being made to close it. I have seen partial or nearly complete closure followed by an extension of the inflammation to the neighbouring bowels, resulting in paresis and distention, which, to the inexperienced, may simulate intestinal obstruction, and especially so if the patient is subject to paroxysmal pain due to gas. I frequently apply a large antiseptic flaxseed poultice over the wound, the flaxseed being mixed in a 1 to 500 bichloride solution.

When these wounds appear thoroughly healthy (filled with granulations) it is the practice of some to introduce sutures in the hope that the subsequent tendency to hernia will be less. I regard this as a perfectly useless procedure; not only does it do no good, but it may result in harm by confining septic material in the wound. To satisfy oneself that this procedure is useless it is simply necessary to repair a few hernias following such cases. Immediately after division of the abdominal wall, in any case, there is retraction of the different layers, particularly of the aponeurosis of the external oblique muscle on the outer side of the wound, where it is least restricted in its movements; and nothing short of apposing layer to layer and maintaining the apposition will surely guard against hernia. It can readily be seen that this is not done even when through and through sutures alone are used for primary repair of the wound; and hence it is even less useful in sewing up a granulating wound.

Acute intestinal obstruction is a sequel which is really more due to the appendicitis itself than to the operation, but is more conveniently considered in this place. In my experience this serious complication occurs in nearly 2 per cent. of cases—

in about one case in fifty or sixty. It may develop before any operation is performed, or its onset may be delayed for weeks, months, and in rare instances for years, after the acute affection. Its occurrence in connection with chronic appendicitis has already been discussed. (See pages 179, 427.)

It is, of course, most likely to occur where generalized adhesions were present, and especially when the small bowel is involved. The cæcum, the colon, and the sigmoid flexure are relatively so immovable that obstruction of these parts of the intestinal tract is comparatively rare. It also seems that the presence of a fæcal fistula, in cases where many adhesions were present at operation, renders the subsequent development of intestinal obstruction less liable to occur. Perhaps this is so because the drainage of the intestinal tract present in such cases keeps the small bowel fairly quiet, and by thus lessening peristalsis enables the inflamed bowels to recover with as few kinks and adhesions as possible. On the other hand the existence of obstruction below the seat of a fæcal fistula necessarily keeps this from healing. Certainly the practice of giving to patients, who have had numerous adhesions broken up, repeated and active purgatives in the hope of preventing the recurrence of these adhesions, is founded on no reasonable therapeutic or pathological grounds.

One of the most important sequels of appendicitis, whether associated with suppuration or not, is **fæcal fistula**. This is of comparative frequency after operations, and there is no question that the likelihood of its occurrence is much increased by delay in the performance of the operation.

Appendicular fistulas occur as one of two varieties—the internal and the external. In the *internal* variety the channel of communication, or the fistula, is in direct communication with some hollow abdominal viscus, and is entirely within the abdominal cavity. Any of the viscera in close proximity to the appendix may be involved—the intestinal tract, the bladder, the dilated

portion of the ureter, etc. In the *external* variety the fistula is in communication with the exterior through the abdominal wall. There may be only a single sinus, or there may be a number of fistulous tracts with a common or two or more external openings. The extent of the lesions and the organ or organs implicated cannot as a rule be determined until the viscera have been exposed by operation.

Of the **external fistulas** there are two varieties—the simple and the fæcal. *Simple fistula* may also be divided into: (1) Those that are the result of an unhealed abscess cavity, and follow the use of drainage. They are merely suppurating tracts that discharge pus, and have a tendency to heal spontaneously. Frequently an infected suture or ligature at the bottom of such a tract, or a fæcal calculus (rarely a piece of gauze) is the cause of the delayed healing. They are more properly sinuses. (2) Those in which the fistula is in communication with the lumen of an appendix and from which there has never been discharged anything but mucus. This type of fistula is encountered in cases in which the lumen of the appendix has become entirely occluded or obliterated at some point, or in which there has occurred spontaneous separation of the appendix in its continuity. This form of fistula is quite rare and is only observed when some portion of the mucous membrane of the appendix is left *in situ*. In one case which I observed there was a small external opening, not large enough to permit the passage of a small probe, which intermittently discharged mucus only. At the time of the original operation it had been noted that the appendix had been separated from the cæcum. Shortly after the operation there developed this fistula, which was treated expectantly, in the hope that it would heal spontaneously. This, however, did not occur. At the secondary operation the remnant of the appendix was found directly attached to the abdominal wall and draining itself through the fistula. A prompt recovery followed its removal. A somewhat similar case, recorded by Jopson, is referred to at page 119.

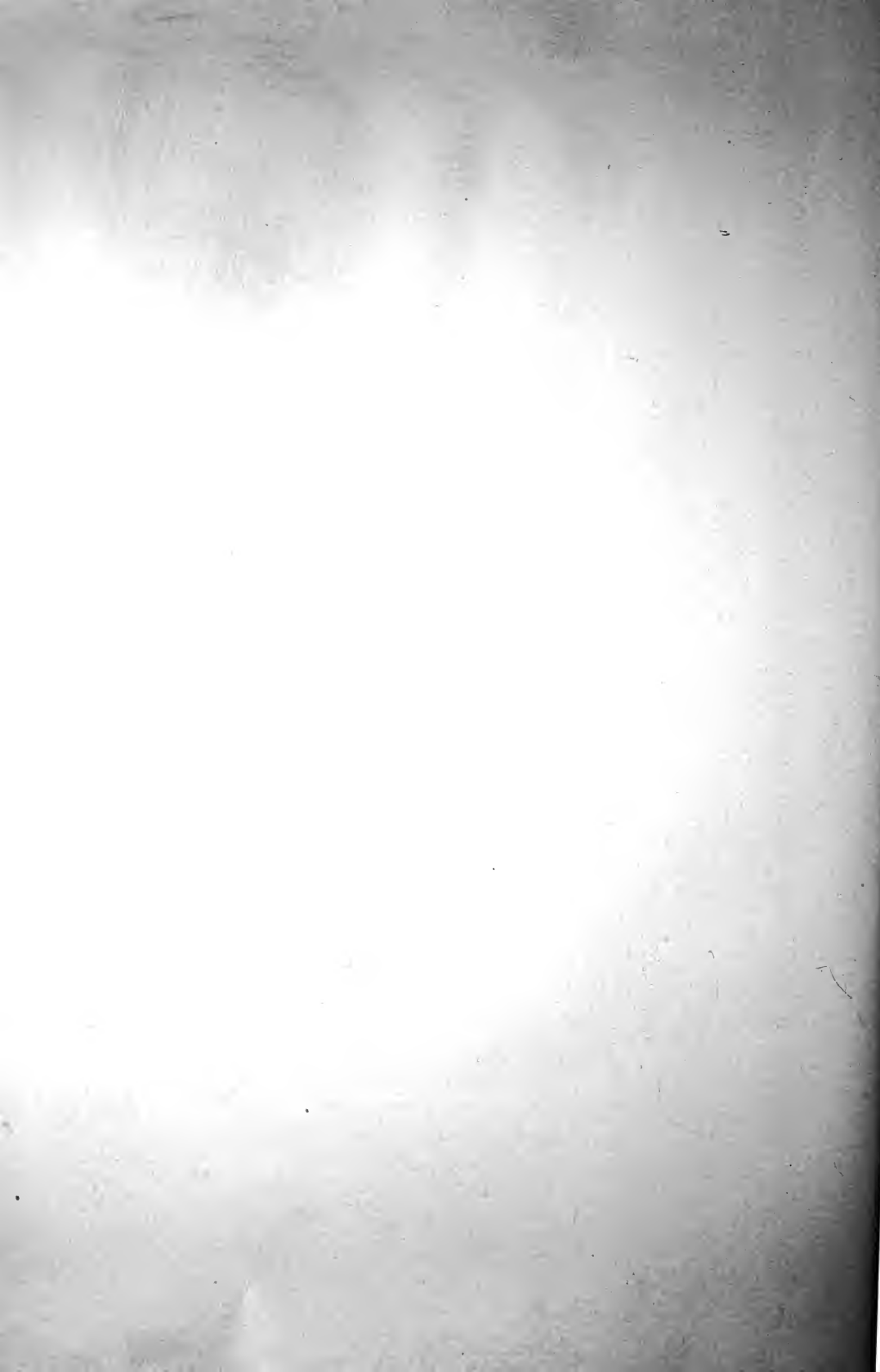
Fæcal fistula following appendicitis occurs in the two following varieties: (1) Those cases in which the fistula discharges through the lumen of a perforated appendix and from which as a rule at first fæcal matter, and later chiefly mucus is discharged. (2) Those in which the fistula is either caused by pressure necrosis upon, or necrotic inflammation of the cæcum, the ascending colon, the small intestine, or both the small and large intestines. In this variety the fistula may be so extensive as practically to constitute an artificial anus.

The exciting causes of fæcal fistulas are those which are active in the production of appendicitis, the destructive activity of pathogenic micro-organisms. As a result of inflammation in and about the appendix, necrosis and softening of adjacent or contiguous bowel may occur and the wall of such bowel break down, particularly if pus be present. While there are some cases in which pressure necrosis produced by inflammatory lymph results in the formation of a fæcal fistula, although pus either is not found or is present in such small quantity as to be scarcely discernible, yet abscess formation is undoubtedly the precipitating cause of fæcal fistula in the great majority of cases. In many cases there will be found a large perforation into the bowel, or it will be found that the appendix has separated in its continuity, and that the contents of the bowel are escaping from its proximal end. If at operation it be found necessary to insert stitches into an inflamed bowel, especial care must be exercised not to introduce them too closely nor to tie them too tight, as inattention to either of these points may result in the formation of a fæcal fistula.

In many cases of fæcal fistula persistence in the use of a drainage tube is one of the most active factors in preventing spontaneous healing. I have seen a number of cases in which removal of a drainage tube that had been worn for weeks was speedily followed by spontaneous healing of the fistulous tract. In particular I recall the case of a young man, whom I saw in consultation and who had recently been operated on twice for



FÆCAL FISTULA FOLLOWING APPENDICITIS.



appendicitis, and then presented two fistulas. One on the right side discharged bile and fæces, and another, on the left side, discharged pus. In the fistulous tract on the right side there was, and had been for some weeks, a large-sized rubber drainage tube, which extended to the bottom of the pelvis. Removal of the drainage tube was followed by spontaneous healing of the fistula within a short time.

It is not at all unusual for an appendicular fistula to make its appearance a week or ten days after an operation for acute appendicitis, and one should not dismiss from the mind the possibility of such a sequel occurring until the abscess cavity has been in great part obliterated, or even until the wound has healed.

The following is an interesting case in which I operated for the cure of fistula, the result of an attack of appendicitis which was not recognized until an abscess had formed:

The patient was a young woman. The operation was not a complete one, in that the appendix was not removed at the time of the evacuation of the abscess. On account of the softened condition of the intestine forming the wall of the abscess cavity, and because the appendix was not readily accessible, it was deemed advisable not to attempt its removal, but to leave it for excision at a subsequent operation. The abscess cavity was treated by packing. Ten days after the operation the dressings were found to be soiled, chiefly with bile. The fistula not only refused to heal spontaneously, but in addition there developed a most painful eczema of the skin surrounding the external orifice of the fistula. All the well-known topical applications proved of no avail. Operation became imperative, but the patient's condition was exceedingly bad. Because of the painfully irritated condition of the skin, all nourishment by the mouth had to be suspended, and nutritious enemata alone were given. The latter provoked irritation of the rectum. The operation was attended by considerable difficulty. There were widespread adhesions that bound the cæcum to the small intestines and to the region of the gall-bladder, and these necessitated extensive dissection. The fistula was found to involve the jejunum high up, and called for resection. The former abscess cavity was still present; its interior was lined with a grayish, unhealthy looking, granulating surface, which was stimulated, and the cavity was again packed with iodoform gauze. The abdominal wound was closed, except for a short distance, an opening being left to permit of

subsequent removal of the gauze. Two weeks after the operation the patient complained of pain. On removal of the dressings it was found that the fistula had recurred; in fact, that it was worse than it had been before the operation. The matter discharged from the fistula was fluid; and if milk, for instance, were swallowed, it was discharged from the wound a few moments after it was received into the stomach. Bile also escaped through the fistula. Owing to the nature of the fistula and the return of the eczema, another operation was determined upon. The opening in the small intestine was found some distance removed from the previous lesion, and the line of suture of the former operation was still intact. There was found in the jejunum a large opening, through which the contents of the bowel escaped. The entire duodenum was ballooned and very much attenuated. The jejunum was excised to the extent of five inches. The bowel was closed by end-to-end anastomosis, and the thinned portion was reinforced by peritoneal flaps. The abscess cavity was again packed with gauze, and the abdominal wound was closed except at the lower angle, which was left open to afford drainage. This operation was a success. The former abscess cavity soon granulated to the surface, and cicatrization was complete in a short time.

In the external variety of appendiceal fistula the character of the discharge varies greatly. Although profuse at first, the fæcal character of the discharge usually ceases in a short time, and the discharge becomes mucous or muco-purulent, and may continue indefinitely of such character.

It has been my experience that if the appendix be not removed at the time of the evacuation of the abscess, in the majority of cases it will be found to be the source of the fistula.

In a case already referred to (p. 308), the patient was supposed to be suffering from a perinephric abscess, which was evacuated and drained. Three or four weeks after the wound had healed the patient began to complain of pain in the region of the loin, and also of pain in the region of the appendix. He was then admitted to the German Hospital. While being placed upon the operating table, under the influence of the anæsthetic, there was detected a distinctly fæcal odour, as though the patient had had an evacuation of his bowels. On examining the site of the former operation there was found a free discharge of fæcal matter through

an opening in the cicatrix. This region was carefully protected, and the patient placed in the dorsal position and an incision made over the region of the appendix, which, when exposed, was found to be post-cæcal and post-colic and to be in communication with the fæcal fistula in the loin. The appendix was much dilated, and permitted of the passage through it to the fistula of the contents of the cæcum. The appendix was removed, the abdominal wound closed, and drainage introduced into the former fistulous tract. Complete recovery ensued.

The **internal variety of fistula**, the result of the evacuation of an appendicular abscess into a hollow viscus, is believed by some to be a fortunate termination of such a case. It has been my lot to see many cases in which the result has been most disastrous. In one case there was a fistulous communication with the bladder, which eventually cost the patient his life; in another case the fistulous tract emptied into the dilated portion of the ureter, and fæcal matter was discharged into the ureter, and escaped externally through the urethra; in another the fistulous tract communicated with the air passages; and so on. The least unfortunate variety of internal fistula is that in which the communication is with the cæcum or ascending colon. I have operated for recurrent appendicitis in which, during the previous attack, the abscess had evacuated itself spontaneously through the colon, resulting in the formation of this variety of fistula.

When the fistula is in communication with another portion of the intestinal tract, it has in many instances been the direct cause of an intestinal obstruction. The fistulous communication between the cæcum and an adjacent loop of small bowel has acted as a band, beneath which another loop of intestine has become engaged, and later strangulated.

The **constitutional manifestations of fæcal fistula** are evidenced by gradual loss of strength. If the fistula involves the upper portion of the small intestine, there occurs rapid

loss of strength and weight, on account of the loss through the fistula of the contents of the bowel containing the necessary elements of nutrition. In such cases the patient may be constantly hungry. As a rule, the skin surrounding the fistulous opening is most irritated when the fistula is high in the intestinal tract, thus allowing the discharge of unaltered bile and pancreatic secretion through the wound; whereas if the fistula is in the lower ileum, cæcum or colon, the surrounding skin remains in fairly good condition.

The **treatment of appendicular fistulas of the external variety** varies with the individual case. It is always well to permit nature to attempt a cure and such treatment as is adopted should be directed to maintaining thorough cleanliness, and to regulating the diet. The wound should be dressed as frequently as the amount of discharge requires, usually from four to six times daily. The surrounding skin should be protected from irritation and for this purpose I think nothing is so satisfactory as oxide of zinc ointment applied thickly for a distance of several inches around the margins of the wound. It is the only ointment I know which is not at once dissolved and washed away in the discharge. Occasionally benefit will be derived from painting the surrounding skin with collodion; but this should not be applied if the skin is already sore, as it is then extremely painful to the patient.

The adoption of solid food in the patient's diet, avoidance of laxatives of any kind by the mouth and the daily evacuation of the bowels by an enema are essentials in the proper management of a fistula, which in many instances will heal spontaneously without further interference. It is not wise to use a syringe frequently to irrigate the fistulous tract, such a course being as a rule rather apt to delay healing; but the tract must be wiped dry with small pledgets of absorbent cotton in the jaws of dressing forceps. If the fistula persists after the lapse of a reasonable time, operation offers the only hope of cure.

The **operative treatment of simple fistula** should consist in exploring the tract to ascertain if an infected suture, ligature or other foreign body be the cause. If this be so, it should be removed, and the tract should be curetted and packed with gauze. This usually suffices to insure a cure; but I have known a simple converted into a fæcal fistula by such a procedure, so that it is well to give a rather cautious prognosis.

When the fistula or sinus communicates with an unhealed abscess cavity, the mouth of the fistula should be enlarged sufficiently to permit of thorough cleansing and packing. When possible without opening the peritoneal cavity, the mouth of the fistula should be enlarged to a degree to equal the transverse diameter of the abscess cavity at its widest part. This should be followed by thorough cleansing and packing.

The **operative treatment of fæcal fistula** necessitates opening the peritoneal cavity, removing the appendix or its remaining portion, as the case may be, and thoroughly breaking up all peritoneal adhesions. When the fistula is in communication with one or more openings in the intestine, closure, preferably by suture, is to be attempted. In addition, transplantation of omental or peritoneal flaps is to be advised in suitable cases. It may be necessary to resect a greater or less portion of the bowel, and to do an end-to-end anastomosis (circular enterorrhaphy) or lateral implantation or anastomosis. In performing such operations it is my custom to employ no mechanical devices, but to rely solely upon the needle and thread. After closing the fistula in the best way possible under the circumstances, the sutured area should be isolated by gauze, and the wound treated as an open one, unless the fæcal fistula was very superficial, and it has been possible to excise all the infected wall of the fistula between the skin and its mucous orifice. Of course, where the wound must be treated by the open method, a hernia is to be expected, and this will require another operation for its cure. Occasionally the opening of a fæcal fistula involving the cæcum is so situated and its margin so

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infiltrated that in the attempt at closure the securing of sufficient healthy tissue to hold the sutures will transgress upon the ileo-cæcal valve. In two such cases I have had occasion to perform the operation of ileo-colostomy for the purpose of relieving the tension to which the walls of the cæcum were necessarily subjected in the passage of the gas and fæcal contents from the ileum into the colon. An uninterrupted repair was thus made more likely and the patient relieved of danger in the event that the ileo-cæcal junction should be so embarrassed as to cause obstruction to the passage of the contents of the small bowel into the large bowel.

The **abdominal wall may be infected** by the removal of a gangrenous or suppurative appendix. Care should be taken, therefore, to let as little infective material as possible come into contact with the abdominal wound either during the operation or while the wound is healing. This complication may as a rule be prevented by the judicious disposition of gauze. It is occasionally found, however, that suppuration occurs between the lips of the wound after it has been sutured; or, on removal of the sutures on the ninth or tenth day, that no union of the opposed surfaces has occurred, owing to an unsuspected infection. In either case the whole wound must be allowed to heal by granulation, and any hernia which forms must be repaired at a subsequent operation.

Stitch abscesses are occasionally a source of much discomfort to the patient, and may materially hinder healing of the wound. They must be laid freely open, swabbed out with corrosive sublimate, silver nitrate, or other antiseptic, and allowed to heal by granulation.

Hernia following operation for appendicitis is by no means uncommon. That hernia is most likely to develop when drainage has been employed is readily understood, and the frequency of hernia after operation in cases of purulent appendicitis constitutes one of the strongest arguments in favour of early operation in acute cases. That the occurrence of hernia in the absence of pus is in-

fluenced by the length of the incision will be generally admitted. In the very early operation and in the interval operation I am frequently able to remove the appendix through an incision merely large enough to allow the introduction of the index finger. I have never seen a hernia after so small an incision, and as a consequence I do not advise such patients to wear an abdominal support. The practice of wearing them after operation is a general one; but personally I have little faith in the efficacy of abdominal supporters and I cannot see that they do any good except from the general pressure they afford. Where the belts have to be rigged up with perineal bands it is my opinion that the discomfort occasioned far outweighs the good they accomplish. So far as preventing a hernia is concerned I regard them as absolutely useless.

Even where the operative wound is large, if the case be a clean one, proper suturing of the abdominal wound should in the vast majority of cases prevent the subsequent development of a hernia. Most important for this purpose is the accurate approximation of the peritoneum and of the aponeurotic layers of the abdominal wall—in the incision I habitually employ, the anterior sheath of the rectus muscle. The peritoneum is best sutured with a continuous mattress suture, placed so as to bring fairly broad areas of serous tissue into contact, and thus leaving no intra-peritoneal protrusions which may give rise to adhesions. The aponeurotic layer should be united by buried sutures, a continuous stitch being more satisfactory in clean cases, since it holds the aponeurosis in more uniform and accurate apposition. Special attention should be paid to the external portion of the rectal sheath, on the side of the wound towards the patient's right, as this is apt to retract to a considerable distance—much further than the median half of the sheath. Splint sutures, of silkworm gut including all thicknesses of the abdominal wall down to the peritoneum, should have been introduced before the fascial stitch, but are not to be tied until after this is in place.

Superficial sutures, to neatly approximate the skin between the splint sutures, will complete the closure of the abdominal wound.

A wound of even large size, if painstakingly sutured in the above manner, will be very unlikely to give rise to hernia at a later date. In some cases, however, hernia does occur; it may then often be justly attributed to the condition of the abdominal wall itself, either excessively fat, or weak and flabby.

In the event of the development of hernia from any cause, be the hernia ever so small, I strongly advise radical operation for its relief. The pernicious influence upon digestion exerted by hernias, especially small hernias, is well known; and the smaller the hernia, the greater the danger of strangulation passing unnoticed, should it occur.

The **operation for the repair of a ventral hernia** occurring after an abdominal operation should consist in the excision of the cicatrix and the careful denudation of the different layers of the abdominal wall forming the sides of the wound. The peritoneum should always be opened, any existing adhesions, either between the underlying viscera and the parietal peritoneum, or among the viscera themselves, should be disposed of, and the hernial sac cut off flush with its neck. The peritoneum and the different layers of the abdominal wall should then be sutured in the manner just described for the closure of a clean laparotomy wound. The buried sutures are preferably of kangaroo tendon or chromicized catgut; and the splint sutures are best made with silkworm gut. Superficial sutures of lighter silkworm gut or of fine silk may be employed. I do not use a subcuticular stitch, as it is apt to leave a dead space in the subcutaneous tissues, where fluids may accumulate and delay healing of the wound. The great advantage of the splint sutures is that they prevent any dead spaces by embracing the whole thickness of the abdominal wall, except the peritoneum; and that when they are tightened they, to a great extent, relieve the aponeurotic sutures of all strain. In very fat abdominal walls it is occasionally well to apply a

buried continuous suture of catgut in the subcutaneous cellular tissues, thus ensuring still more accurate approximation of the lips of the wound. It is now my practice in patients with fat abdominal walls to unite the skin with interrupted catgut or silk sutures, introducing them one inch apart, thus providing for drainage.

ABDOMINAL PAIN PERSISTING AFTER OPERATION.

Pain which persists even after the removal of a diseased appendix is a sequel seen sufficiently often to render a short discussion of its prevention and treatment of some interest.

If the operation has been performed before the formation of many adhesions, that is, while the disease is still confined to the appendix, it is very unusual for any subsequent discomfort to be experienced. When done at a later date, however, when adhesions have already formed, it is the rule for some adhesions to re-form, and for a few to persist throughout the patient's subsequent life. In patients who have had very many or dense adhesions at the time of operation, intestinal obstruction, as already mentioned, will occasionally occur. More often there is merely aggravated constipation, or rather obstipation, with flatulency, consequent either upon some nonstrangulating adhesions, or, as Macewen has suggested, upon the interference with digestion occasioned from removal of the appendicular secretion, and from impairment of the efficiency of that of the cæcum. In any case which has been drained it is almost certain that the omentum or perhaps some of the intestinal coils have become adherent to the under surface of the abdominal cicatrix; and in a large majority of such cases an omental hernia or even an enterocele will form in the wound. The dangers of this last condition, and the possibility of the strangulation of a small hernia being overlooked, have already been alluded to. Where adhesions to the abdominal cicatrix exist, the patient may complain of a more

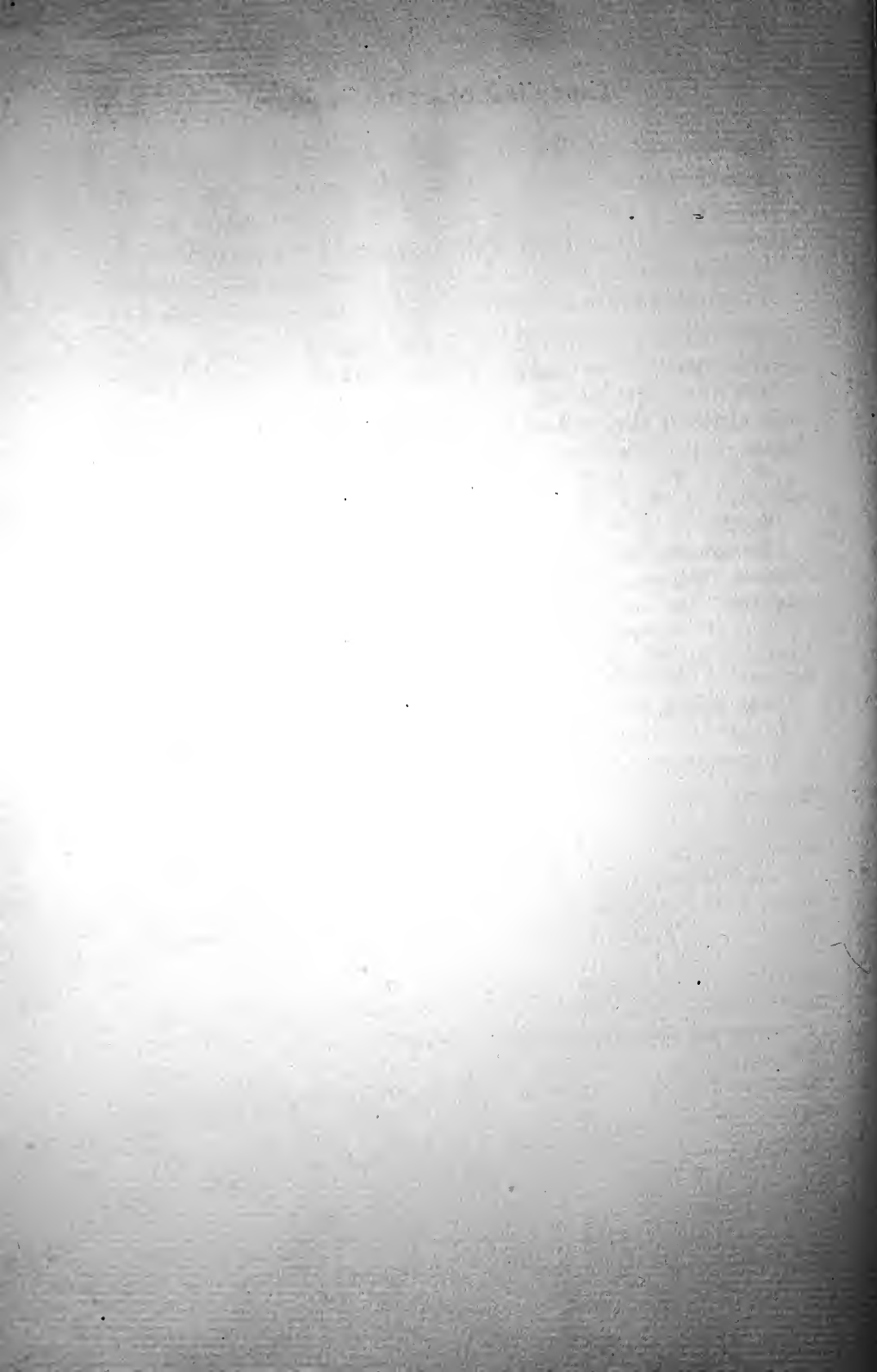
or less constant drawing sensation, preventing over-extension of the spine, and occasioning severe pain on any sudden movement. Some patients have unexpectedly found themselves relieved of all symptoms after some unusually vigorous motion, being conscious that their adhesions have become separated from the abdominal wall with a momentary stab of pain of unusual severity.

A great many of these patients return to the surgeon seeking relief from their pain by further operative interference. I have operated a number of times for such conditions, and while adhesions have existed in the majority of instances, yet in some patients no cause for the abdominal discomfort could be detected. I think it therefore not impossible that a neurotic tendency may be held accountable for this post-operative pain in certain cases; it is at any rate worth the while of both patient and physician to first consider such remedial measures, other than operation, as are available. I have frequently prescribed a course of mild gymnastics, especially such exercises as tend to bring into play the abdominal muscles, together with Swedish movements, resistive motions, exercise on the parallel bars and on the horizontal bar. Such exercises tend to release the adhesions, if any exist, by stretching and even at times rupturing their attachments, but accomplish this so gradually and so gently that no harm would be anticipated, and none has occurred in the cases under my care. If no adhesions are present such a course of treatment is equally proper for the neurasthenia. Abdominal massage may also be beneficial. If operation is undertaken, the chances of new adhesions forming in even greater strength and numbers are not very remote.

If a hernia is suspected, however, I urge operation, believing that by its radical cure the discomfort of the patient will probably be less, as his danger of developing intestinal strangulation certainly will be.

Pain in the cicatrix or in the neighbouring abdominal wall may be attributed to the division of the cutaneous nerves at the

time of operation. This is a sequel which it is often more easy to prevent than to remedy; hence, when possible, long incisions through the rectus muscle should be avoided, since, as was mentioned in a previous chapter, some of the nerves of the abdominal wall are liable to be divided under such circumstances. If a hernia has formed in the wound, its repair, accompanied by dissection and removal of the old scar may result in relief of these symptoms. If any of the main trunks of the abdominal nerves have been divided, the rectus muscle will, as a consequence, be partially deprived of its innervation, and may sag or bulge slightly in the area so affected, favouring the formation of ventral hernia. This fact, as already mentioned, militates somewhat against the universal use of the longitudinal incision passing through the outer border of the right rectus muscle; but unless more than one trunk is divided, the disability produced is negligible, and in incisions of ordinary length no main nerve is divided. Indeed, I am inclined to the opinion that this objection is more theoretical than practical, since I do not remember to have seen a patient in whom post-operative functional defects in the abdominal wall could not with greater justness be attributed to some other condition than to loss of innervation.



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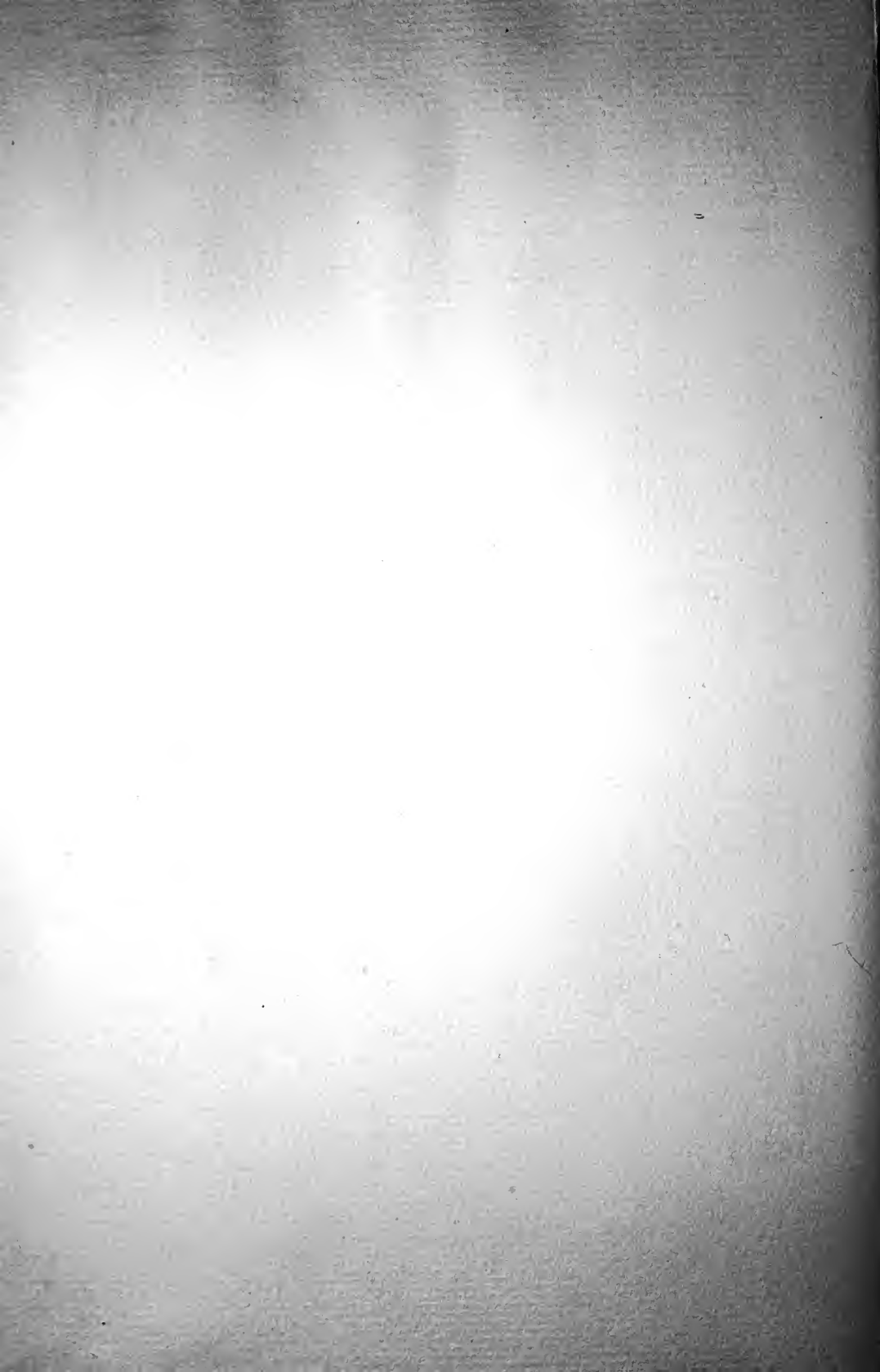
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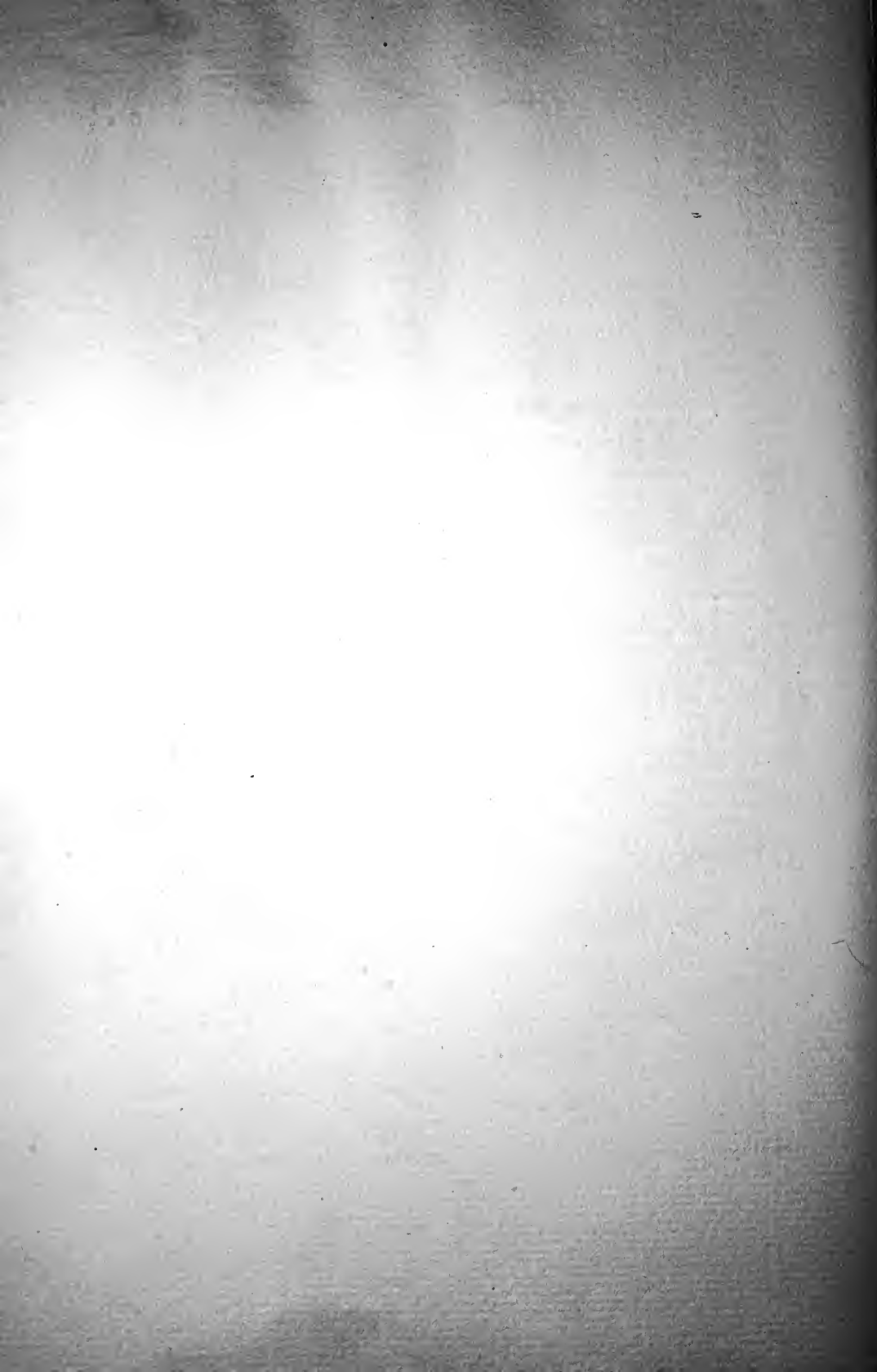
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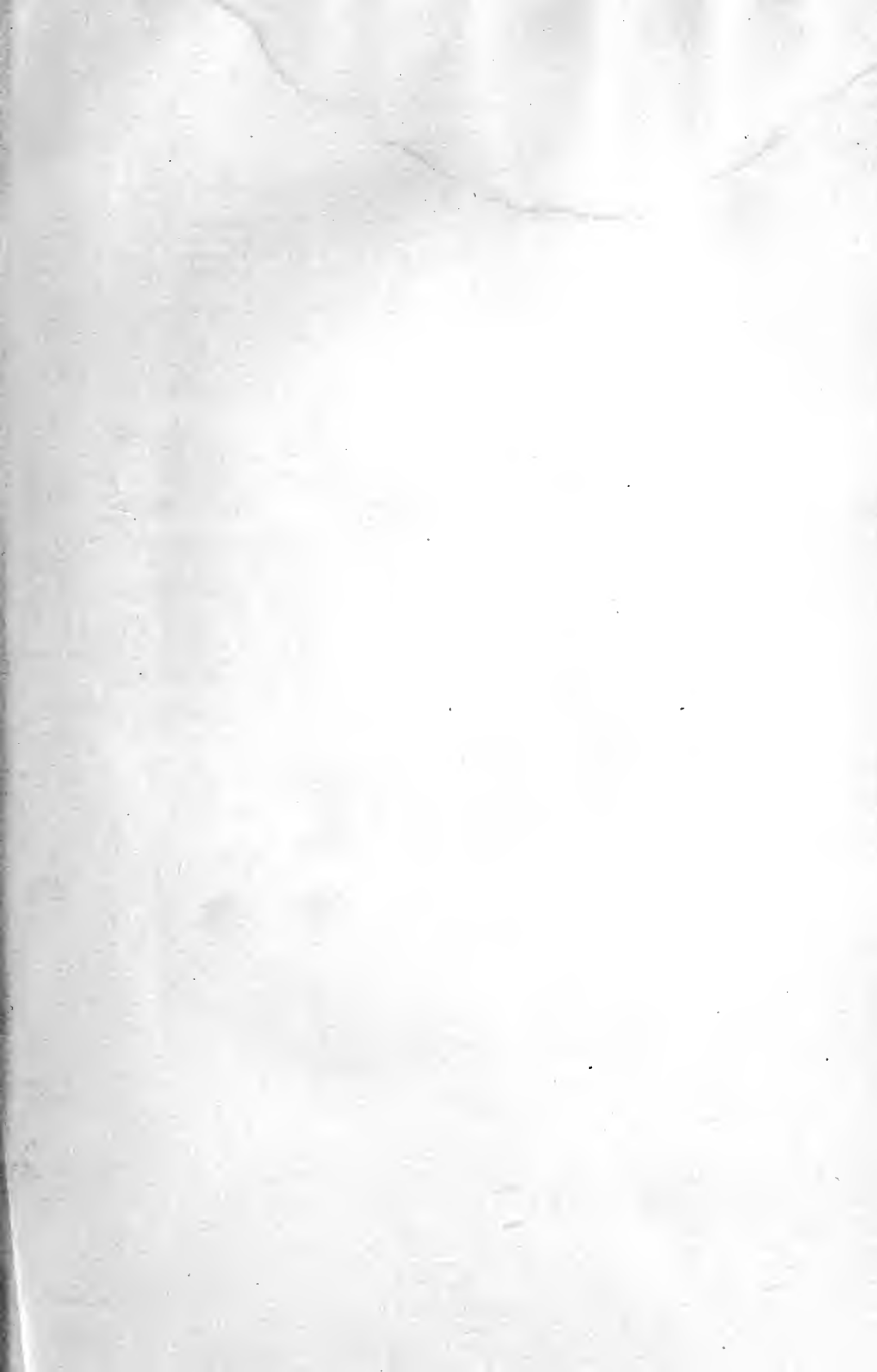
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