

COMPLICATIONS ASSOCIATED WITH APPENDICITIS*

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IN a discussion of postoperative complications Cutler and Scott¹ state that, "With the period that follows operative intervention begin the trials and tribulations of the surgeon." This statement is probably nowhere more true than in the case of those patients who require surgical attention because of a septic appendix, and in whom infection has extended beyond the confines of this organ. It is a well known fact that today the mortality of appendectomy for uncomplicated acute appendicitis is almost negligible, whereas in the more advanced cases, when peritonitis of some degree has supervened, the mortality continues to be disturbingly high. For the most part, deaths from acute appendicitis are due to some phase of peritonitis either directly, as from toxemia, severe sepsis and ileus, or indirectly from the later complications of peritonitis, e.g., intestinal obstruction, empyema, pneumonia, etc. If one consults the records of the surgical clinic in any large hospital, the more serious complications of acute appendicitis will be found to include general peritonitis, residual or secondary abscesses, intestinal obstruction, major wound sepsis, pneumonia, pylephlebitis, liver abscess, empyema, pulmonary embolism, fecal fistula, postoperative hemorrhage and thrombophlebitis. The present discussion is concerned with the abdominal complications encountered in the management of the perforated appendix and, in particular, with those which occur following operative intervention.

GENERAL PERITONITIS

Diffuse peritonitis is most often the result of sudden perforation in the obstructive type of acute appendicitis which,

according to Allen,² is responsible for 95 per cent of the deaths from this disease. The obstruction of the appendix is usually due to a fecalith. The process advances rapidly due to interference with the blood supply of the appendix and consequent necrosis of its wall. Perforation may occur as early as four hours following the onset of symptoms. Due to the sudden flooding of the unprepared peritoneum with septic material, little opportunity is afforded for the usual walling-off process to take place and a diffuse or general peritonitis ensues. Coller and Potter³ found eighty-eight cases of general peritonitis among 336 patients with acute appendicitis, in all stages of the disease, admitted to the University of Michigan Hospital over a three-year period, an incidence of 22.2 per cent. Stafford and Sprong⁴ found 106 instances of general peritonitis in a similar group of 1,317 patients admitted to the Johns Hopkins Hospital over an eight-year period. The incidence of peritonitis in this group was, therefore, 14.9 per cent. Barrow and Ochsner⁵ found 179 cases of general peritonitis in a group of 1,039 cases of acute appendicitis admitted to the Charity Hospital in New Orleans, an incidence of 17 per cent. The diagnosis of acute appendicitis with general peritonitis is not difficult. The patient complains of severe generalized abdominal pain, with nausea and vomiting. The abdomen becomes distended, tense and rigid. There is tenderness throughout, although it remains more marked in the right lower quadrant. Auscultation reveals a silent abdomen. The temperature is considerably higher (101°F.) than in uncomplicated acute appendicitis, and the pulse rate is increased accordingly. The leucocyte count is also

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high, e.g., 25,000 to 30,000. If the infection continues unchecked, the unmistakable picture of a terminal peritonitis develops. The pulse becomes rapid and thready, there is profuse diaphoresis, the skin is cold and clammy, abdominal distention is marked, the eyes are sunken, the expression is anxious and there is pallor and cyanosis, signs which denote impending death. It goes without saying that the most important treatment is prophylactic, i.e., recognition of the disease and removal of the appendix before infection has spread beyond this viscus. The management of the patient with general peritonitis remains a controversial matter. Many authors, (Horsley,⁶ Herrick,⁷ Davis, Stafford and Sprong⁸ and others), advise prompt operation regardless of the stage of the disease. It is our opinion that these patients with widespread or general peritonitis are best treated by delayed operation and we recommend the Ochsner regimen in order to improve the patient's general condition and to allow localization of the infection to take place before any operative procedure is performed. However, we agree with Allen and his associates that if one sees these patients within four to six hours from the time of perforation, prompt operation is best. By means of a careful history, very often the time of perforation can be determined. There is often an acute increase in the severity of the pain followed by a period of temporary relief. In such instances, while there is soiling of the regional peritoneum and perhaps an early local peritonitis, the peritoneum is capable of handling this limited amount of infection, provided further contamination is prevented by removal of the appendix. Moreover, protective adhesions have not yet formed so that harm does not come from an operation in this stage.

As a postoperative complication, general peritonitis must be regarded as one of the most serious since the mortality is always high. From their study of the literature, Ochsner, Gage and Garside⁹ concluded that peritonitis may be the cause of death in

as many as 77.5 per cent of patients dying of appendicitis. Fortunately, general peritonitis is not one of the common postoperative complications. When it does occur, it may be due (1) to contamination of the peritoneum by transperitoneal drainage of abscesses, (2) to failure on the part of the surgeon to drain when drainage is indicated at the time of the original operation, or (3) to an ill timed operation whereby early adhesion formation is interfered with; and what would be a localized infection if let alone, is converted into a spreading peritonitis. Occasionally, because of an especially virulent type of infection, general peritonitis will supervene regardless of the time and type of the original operative procedure. The subject of drainage is again a controversial matter. The present day trend is to drain less frequently than formerly, especially in cases in which a diffuse peritonitis is found at operation. However, the axiom, "When in doubt, don't drain," is capable of doing harm in the hands of young or inexperienced surgeons. Hanford¹⁰ gives the following indications for drainage:

(1) Any appendiceal abscess. With this statement practically all authors agree. Drainage is also advised when tissue of doubtful viability must be left in the abdominal cavity, e.g., (a) necrotic tissue, such as part of the wall of an abscess; (b) part of the appendix; (c) the whole of the appendix; (d) damaged tissue, such as the meso-appendix stump, which might become necrotic in the presence of infection.

(2) In acute diffuse peritonitis with creamy purulent or fibrinopurulent exudate of considerable amount or with a malodorous exudate. Some authors would disagree with this statement.

(3) Insecure or doubtful closure of the cecum or the appendix stump.

(4) An unrecovered loose fecalith.

(5) Gross soiling by cecal contents.

(6) Infection or contamination of the retroperitoneal tissue as in a retrocecal appendix.

(7) Uncontrolled bleeding or doubt as to the control of bleeding.

As previously mentioned, general peritonitis may be the result of operative intervention which interferes with the walling-off of a local peritonitis following perforation. In the case of a slow perforation, as in the inflammatory type of appendicitis, the infection is efficiently localized if given a chance. In these slow perforations, the defensive mechanisms of the peritoneum come into play and prevent spread of the process by limiting the infection to the right lower quadrant or pelvis. Loops of intestine and the omentum become adherent to the cecum and appendix and adhesions quickly form. An abdominal mass may become palpable, although this need not be an abscess in the strict sense of this term. The process terminates by progressing to the stage of suppuration or, more often, by spontaneous resolution. Thus, in cases seen during the third, fourth or fifth day of the disease, with a mass present or in the stage of development, operation is best deferred. If performed during this so-called "danger period," Love¹¹ points out that protective adhesions are broken down and a spreading or general peritonitis may thus be provoked. Moreover, removal of the appendix under these circumstances presents technical difficulties and is attended with the danger of injury to the cecum or intestine. Excessive bleeding may be encountered and often the procedure is prolonged and an undue amount of trauma is inflicted. Simple drainage, on the other hand, is of little value and corresponds to attempts at incision and drainage of a superficial cellulitis while still in the stage of brawny induration. By delaying intervention until the proper time, extraperitoneal drainage of an abscess is possible or, in the case of spontaneous regression of the mass, a clean appendectomy may be performed at a later date.

Spreading peritonitis induced by or following operation may present a variable

clinical picture. In young and otherwise healthy adult patients, the usual picture of general peritonitis described above may be observed. However, in elderly persons or those weakened by their infection, fluid and salt imbalance or by a prolonged operation involving excessive trauma and hemorrhage, spreading or general peritonitis may exhibit a very atypical course. Here the usual signs of peritonitis are apt to be far less striking than usual. There is commonly some abdominal discomfort and distention, associated with absence of peristaltic sounds. Nausea and vomiting are common. The temperature may be high or, again, may be but slightly elevated. The pulse is rapid and later becomes thready and uncountable. Therefore, in any patient who fails to do well following operation, the possibility of a general peritonitis should be considered and when suspected the usual regimen (Ochsner) for the treatment of peritonitis should be instituted. This consists in Fowler's position, hot applications to the abdomen, nothing by mouth, liberal quantities of morphine, duodenal syphonage, intravenous fluids, glucose and sodium chloride, blood transfusions, oxygen and drugs of the sulfonamide group. Secondary operations are rarely indicated, as the outcome depends chiefly upon the resistance of the patient and the virulence of the infection. As in any other case of peritonitis treated by the Ochsner regimen, careful vigilance is necessary in order to detect local abscesses as they develop. When present, these should, of course, be drained at an early date.

SECONDARY OR RESIDUAL ABSCESES

Secondary intra-abdominal abscesses are prone to occur in certain fossae or regions of the peritoneal cavity. These abscesses may represent a favorable termination in cases of general peritonitis which have been treated conservatively and in which the patient has succeeded in overcoming his infection. In our experience, about 60 per cent of the patients with general

peritonitis treated by the deferred operative method, develop abscesses. Similarly, abscesses may be encountered in cases of general peritonitis which have been treated by prompt operation and they may develop regardless of whether or not drainage was instituted and whether or not the appendix was removed. Moreover, they may occur as a postoperative complication following drainage in cases of a localized appendiceal abscess and here, again, regardless of whether or not the appendix was removed. It is for this reason that contamination of the uninvolved peritoneum should be avoided, and that extraperitoneal drainage should be performed whenever possible. Rarely such abscesses may develop as a complication of appendectomy when only a local peritonitis was present at the time of operation. C. W. Cutler, Jr.,¹² in a study of 1,651 patients with acute appendicitis operated upon at the Roosevelt Hospital, found secondary abscesses which required further surgery in thirty-three patients. Such abscesses were found in 4.5 per cent of all cases of suppurative appendicitis. In this group of thirty-three cases, about 60 per cent followed general peritonitis, whereas the remainder occurred as a complication of suppurative appendicitis with local or spreading peritonitis. In his series the mortality was 21 per cent in the entire group, or 13 per cent if the subphrenic abscesses were excluded.

As shown in Figure 1, the common sites for these secondary or residual abscesses are (1) the pelvis, in which case the abscess occupies the cul-de-sac of Douglas, (2) the left lower quadrant, (3) the subdiaphragmatic spaces, and (4) the ileocecal region. True residual abscesses following general peritonitis are often found either in the pelvis or in the subphrenic spaces. This is due to the fact that with the patient in the recumbent position, the marked anterior convexity of the lumbar spine tends to deflect purulent exudates upward or downward, allowing collections to form in the more dependent or isolated recesses of the peritoneal cavity. For the same

reason, residual abscesses in the mid-abdomen are uncommon.

The presence of a secondary intra-abdominal abscess is often suggested by the fact that following operation fever persists, or subsequent to a fall to normal, it suddenly becomes elevated several days later. Along with this, the patient experiences a certain amount of abdominal pain or discomfort, the location of which may be of some diagnostic value. If the process continues for a considerable time, the temperature curve exhibits septic swings and the patient appears worn and haggard from the effects of the continued sepsis. He feels weak and exhausted, has anorexia and malaise and later may develop a secondary anemia. Physical examination reveals localized tenderness on abdominal, rectal, or vaginal examination and a mass may be palpable. Infections in the subphrenic spaces are more difficult to detect and require special attention and study.

Pelvic Abscesses. Abscesses situated in the rectovesical or recto-uterine pouches are the most common of the residual abscesses. In fact, this is the most desirable location for such abscesses and one of the advantages of the Ochsner regimen in the treatment of peritonitis, either independently or in conjunction with operation, is the assistance which it renders in localization of the general infection in the pelvis. With the patient in the recumbent position, the cul-de-sac becomes the most dependent portion of the peritoneal cavity. Whether the factor of gravity alone is important in allowing exudates to settle in the pelvis is problematical. Nevertheless, Fowler's position is one of maximum comfort for the patient and when abdominal distention is marked, it relieves pressure on the diaphragm and thus diminishes respiratory embarrassment. The old view that absorption is less rapid from the pelvis than from the diaphragmatic peritoneum, is no longer tenable. In the pelvis, however, there is a minimal amount of movement, whereas in the subphrenic spaces, localization is interfered with through the constant mo-

tion of the diaphragm. All agree that localization of infection in the pelvis is much to be preferred to localization in the

morphine are among the most important items in this regard. Gastroduodenal suction and the intravenous administration

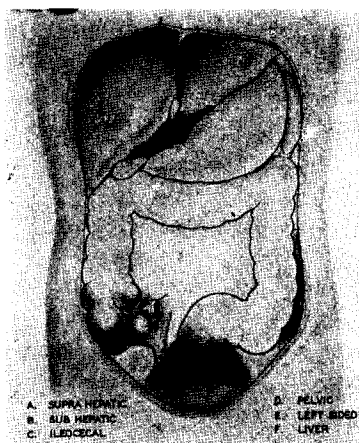


FIG. 1. Diagrammatic sketch showing the more common locations of the residual or secondary intraperitoneal abscesses associated with appendicitis. (Redrawn from Ochsner, A., Gage, I. M. and Garside, E. The intra-abdominal postoperative complications of appendicitis. *Ann. Surg.*, 91: 544, 1930.)

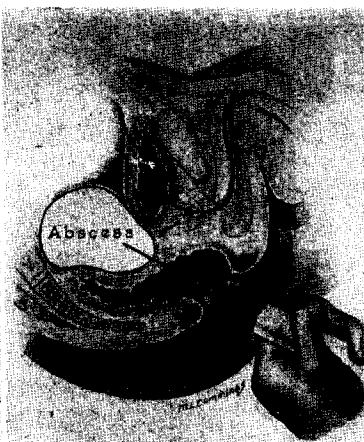


FIG. 2. Diagram showing method of confirming diagnosis of abscess in the rectovesical pouch. If pus is obtained on aspiration, drainage by rectum is then instituted.

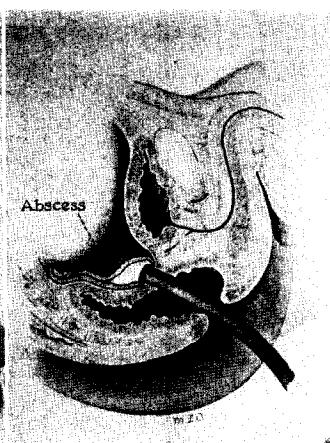


FIG. 3. A short longitudinal incision has been made through the anterior wall of the rectum at the site of the needle puncture and a stiff rubber tube inserted. The tube is held in place by means of one suture through the rectal wall. The end of the tube is left long and extends out through the anus.

subphrenic or subhepatic spaces, since in the pelvis recognition of an inflammatory mass or abscess is far easier and, also, since here surgical drainage, should it become necessary, is a simpler procedure. It is common experience that the mortality of pelvic abscesses is lower than that of abscesses situated in the upper quadrants of the abdomen. As in the case of localization of infection at any other point in the peritoneal cavity, the presence of an inflammatory mass or area of infiltration does not necessarily denote a true abscess. It is only when suppuration has taken place that surgical drainage is indicated. The majority of these inflammatory masses will undergo spontaneous resolution under proper conservative treatment and such treatment should first be given a thorough trial. The principles involved are essentially those entailed in the treatment of general peritonitis. Restriction of all food and fluid by mouth and the liberal use of

of solutions of glucose and sodium chloride are valuable adjuncts. Under conservative therapy, over one-half of such pelvic masses will subside and no operative intervention will be necessary.

Diagnosis. A pelvic abscess should always be suspected in any patient who, following operation, continues to run a septic course. Wound infection and other causes of fever, e.g., urinary tract infection, pneumonia, thrombophlebitis, etc., should, of course, be considered and excluded. Abscess formation in the cul-de-sac is always to be looked for in patients being treated conservatively for general peritonitis. Daily rectal examinations should be made. An inflammatory mass or infiltration is easily felt as a hard, firm, tender tumor mass bulging into the upper rectum anteriorly. It is usually felt at the tip of the examining finger. Subjective symptoms referable to the bladder, e.g., dysuria, urgency or frequency may be present. In the later

stages, diarrhea is not uncommon. Repeated digital examination of the rectum will enable the surgeon to follow changes in the size of the mass. Thus it may diminish, an indication of spontaneous resolution, or it may enlarge downward. Areas of softening indicative of suppuration should be sought for. Large cul-de-sac masses may arise out of the pelvis and then become palpable on abdominal examination. As suppuration occurs in a pelvic mass, the anal sphincter relaxes and the anus becomes patulous. The rectal mucosa becomes edematous and succulent and has a soft, thick, velvety feel. When these findings are encountered, surgical drainage is indicated. In general, our preference is for abdominal drainage and this should be performed in the extraperitoneal manner. Many surgeons, however, more or less routinely advise drainage by way of the rectum or vagina. In rectal puncture there is always the danger of injury to the great vessels of the pelvis. The bladder may also be injured during this procedure and Stafford and Sprong report a fatality due to this accident which was followed by a persistent rectovesical fistula and a fatal ascending infection of the urinary tract. In our opinion, rectal drainage should be reserved for those pelvic abscesses which are large and which point low down in the rectum, and in which a large area of softening can be demonstrated. When this is the case, the diagnosis is first confirmed by aspiration of the abscess with a large gauge needle. (Fig. 2.) The bladder having been emptied previously, the patient is placed in the lithotomy position. If pus is obtained on aspiration, drainage of the cavity is established by making a vertical incision in the anterior rectal wall at the site of the needle puncture, evacuating the pus and inserting drains. (Fig. 3.) In properly selected cases, this is a very simple technical procedure and provides an efficient form of drainage. Undrained cul-de-sac abscesses may spontaneously rupture into the rectum and thereby undergo spontaneous cure.

Left Lower Quadrant Abscesses. Ab-

cesses in the left lower quadrant of the peritoneal cavity occasionally occur but are relatively uncommon. They are encountered more frequently as a postoperative complication than in patients undergoing conservative treatment for general peritonitis. Barrow and Ochsner call attention to the fact that abscesses in this locality are seen only in patients with a shallow pelvis and that they are most often found in children. They frequently are associated with an abscess which fills the pelvis and then extends upward and points to the left. The general signs and symptoms are those of any other secondary or residual abscess plus the localizing signs of tenderness, possible muscle spasm and skin edema, and a palpable mass in the left lower quadrant. The principles of treatment are similar. Here, again, it should be mentioned that many will subside spontaneously. If suppuration occurs, drainage will be necessary and is best performed through a small muscle splitting incision, taking care to avoid contamination of the main peritoneal cavity. As a rule, there is no great urgency for surgical intervention and, before proceeding with surgery, one should be certain that suppuration has taken place and ample time should be allowed to be certain that firm adhesions are present, in order that these protective barriers are not broken down in the process of drainage.

Subdiaphragmatic Abscess. Suppurative disease of the appendix is responsible for more instances of subphrenic abscess than any other single lesion. Ochsner and DeBakey¹³ in their analysis of 3,533 cases of subphrenic abscess, collected from the world literature, found lesions of the appendix to be the etiological factor in 30.9 per cent, and in 25.3 per cent of their own seventy-five cases. In 15,000 collected cases of acute appendicitis, they calculate that subphrenic abscesses occurred as a complication in 0.9 per cent. They emphasize the point that many subphrenic infections do not progress to the stage of abscess and, also, the fact that due to

difficulties in diagnosis many subphrenic abscesses are never recognized. Faxon,¹⁴ in a recent communication, reported 124 consecutive operative cases of subphrenic abscess at the Massachusetts General Hospital, and found the etiology to be a lesion of the appendix in thirty-eight, or 31 per cent. Wellman and Maddock,¹⁵ in a review of fifty-two cases of subphrenic abscess, observed at the University of Michigan Hospital over a ten-year period, found that twenty-one, or 40.3 per cent, occurred as a complication of appendicitis.

The mechanism whereby infection may reach the subdiaphragmatic spaces from the somewhat distant right iliac fossa is of interest. The route most often described is that of direct extension along the right paracolic gutter. Overholt,¹⁶ by experimental studies, has demonstrated the fact that a negative pressure is created in the upper abdomen by respiratory movements, and this would tend to cause septic material to be aspirated upward and into this region. Considerable attention has been given to the possibility of extension by way of the lymphatics by Munro,¹⁷ Barnard,¹⁸ and Truesdale.¹⁹

In order to appreciate fully the significance of subphrenic infections, a brief review of the anatomy of the region is necessary. Following the earlier descriptions by Martinet²⁰ and Barnard,²¹ the term subphrenic region has come to denote that space in the upper abdomen bounded superiorly by the diaphragm and inferiorly by the transverse colon and mesocolon. Thus, subhepatic abscesses properly belong in this group. Detailed descriptions of the anatomy of the region are found in the excellent treatises by Ochsner,^{22,23,24} Nather and Ochsner,²⁵ Ochsner and DeBakey, Ochsner and Graves,²⁶ and by Faxon.²⁷ The main subphrenic space is divided by the liver into a suprahepatic and an infrahepatic portion. Each of these compartments is in turn subdivided into three smaller spaces. Passing from the diaphragm to the liver, the falciform suspensory ligament divides the supra-

hepatic space into right and left spaces of approximately equal size. The right suprahepatic space is divided by the lateral extension of the cardinal ligament of the liver, i.e., the right lateral ligament into a large right anterior superior space and a smaller posterior superior space, leaving a single left superior space. The infrahepatic space is also divided into right and left halves by the round ligament and the ligament of the ductus venosus. While there is but one right inferior space, on the left side and separated by the stomach and gastrohepatic omentum are the left anterior inferior and the left posterior inferior spaces.

The right posterior superior space is the one most commonly involved in all subphrenic abscesses, and this is especially true in those infections of appendiceal origin. Thus Ochsner and DeBakey found in a review of 1,461 cases of subphrenic abscess that the right posterior superior space was involved in 33.7 per cent, and in 55.7 per cent of their own seventy cases. In Faxon's study, the right posterior superior or right inferior spaces were involved in 66 per cent of the cases in which the infection originated in the appendix. Subphrenic abscesses may be residual, as in cases of a resolving general peritonitis, or secondary when infection has extended from the appendix to the peritoneum but when general peritonitis has not occurred. With regard to diagnosis, the condition is suggested by continued evidence of sepsis (fever and leucocytosis) in a patient known to have had a local or general appendiceal peritonitis and in whom evidence of a suppurative process elsewhere in the abdomen, as well as extra-abdominal causes for fever have been excluded. Faxon stresses the following points in the history and examination: (1) tenderness over the twelfth rib or lower costal margin, sometimes best elicited by compression of the thorax, (2) findings indicative of a high, fixed diaphragm on the affected side, and (3) manifestations of diaphragmatic irritation, e.g., pain referred

to the shoulder or neck, hiccoughs and discomfort on deep respiration. The liver is often displaced downward.

duced into the abdominal cavity and since it may remain unabsorbed for as long as two weeks, its presence may confuse the



FIG. 4. A, roentgenogram in anteroposterior projection showing the appearance in a late case of subdiaphragmatic abscess. The right diaphragm is elevated and a large gas bubble is seen beneath the diaphragm. B, lateral projection in same case as A. The large collection of gas under the diaphragm is shown.

The roentgenological examination will assist materially in the diagnosis, although the roentgen findings are not pathognomonic until the late stages when a gas bubble and fluid level can be demonstrated. (Fig. 2.) However, in conjunction with consistent clinical findings, roentgen evidence of a high fixed diaphragm and an associated pleural effusion calls for a presumptive diagnosis of subphrenic abscess. (Figs. 3 and 4.) In order to be of the greatest assistance, particularly in the localization of the infection, the roentgenological study should include, in addition to the usual anteroposterior films, lateral views as well as fluoroscopic examination. (Fig. 5.) In the case of patients who continue to have unexplained fever following perforation of the appendix, it is our practice to have roentgen studies of the diaphragm every third day since, in such instances, the possibility of infection in the subphrenic spaces must always be borne in mind. It is to be remembered that at the time of laparotomy or abdominal paracentesis, air may be intro-

duced into the abdominal cavity and since it may remain unabsorbed for as long as two weeks, its presence may confuse the picture. At the present time most authors condemn the practice of aspiration of the subphrenic spaces as a diagnostic procedure. It is an unreliable method, as failure

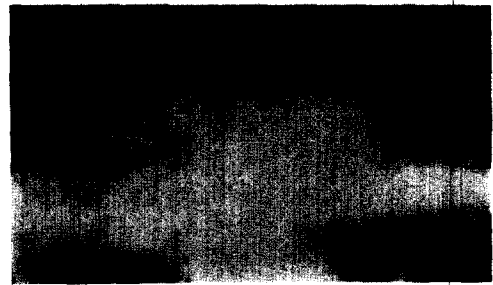


FIG. 4. C, anteroposterior projection, with patient lying on left side. The large collection of air is shown and a definite fluid level is present. The irregular shadows in this film at the left are due to the injection of lipiodol into a sinus tract resulting from a previous unsuccessful attempt at drainage.

to obtain pus does not exclude abscess. Moreover, the danger of contamination of uninvolved portions of the peritoneum, the pleura, or both, cannot be minimized. When, however, the question is one of differential diagnosis between subphrenic

abscess and empyema, a carefully performed thoracentesis is not objectionable. Ochsner and DeBakey suggest that ap-

They are most likely to occur when, due to errors in judgment, drainage was omitted at the time of the original operation. In

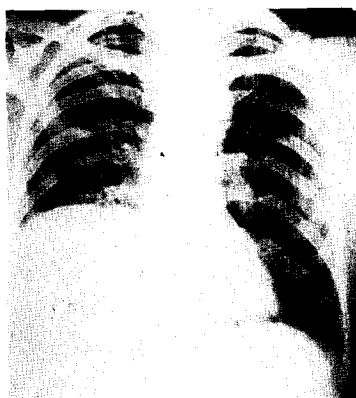


FIG. 5. Early roentgen findings in a case of subdiaphragmatic abscess. The right diaphragm is elevated and there is partial obliteration of the costophrenic sulcus due to pleural effusion. Fluoroscopy showed the diaphragm on this side to be immobile.

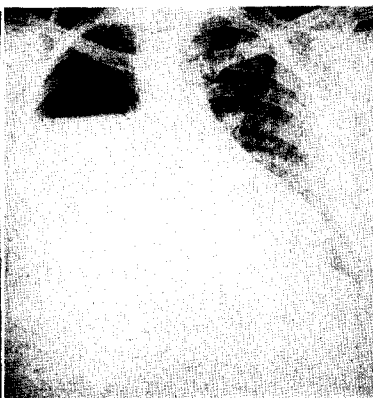


FIG. 6. Roentgenogram in case of right subphrenic abscess with an unusually extensive associated pleural effusion. In this case, repeated thoracenteses were performed before the correct diagnosis was made. It was after these were done that the fluid level appeared, due to the air introduced at the time of the taps. Cultures of the fluid were consistently negative.



FIG. 7. Roentgenogram in case of subdiaphragmatic abscess involving the right anterosuperior space. This shows the value of the lateral projection in the localization of the abscess.

proximately 75 per cent of the cases of subphrenic infection will subside spontaneously under conservative measures, and suppuration demanding surgical drainage will occur in only 25 per cent. They believe that when the aforementioned findings suggesting subphrenic space infection fail to subside within a week, it is justifiable to assume the presence of an abscess and to proceed with surgery. In cases in which the diagnosis remains in doubt, exploratory operation is advised by them since, if performed extraserously, the risk is slight. The technical procedures for extraserous drainage are well described in the papers by Ochsner devoted to this matter. Undrained subphrenic abscesses may rupture through the diaphragm, with a resultant empyema, bronchopleural fistula, pneumonia or lung abscess.

Right-sided or Ileocecal Abscess. These local abscesses are relatively uncommon as postoperative complications, especially in cases where drainage has been employed.

the early stages before a definite mass has developed, they may be confused with a wound infection. The symptoms and signs may be similar. In each there is continued fever, tachycardia, leucocytosis, pain, tenderness, swelling and induration in the neighborhood of the wound. Later, in the case of an ileocecal abscess, an intra-abdominal mass becomes recognizable. In either case, whether localized intraperitoneal infection or wound sepsis, the early treatment is conservative, i.e., hot wet dressings, physiological rest and chemotherapy. If an intra-abdominal abscess is suspected, the usual conservative measures for peritonitis should be employed in order to facilitate localization and to minimize the danger of spread of infection beyond the right iliac fossa. Under these conditions the mass becomes more localized and later may increase in size if suppuration occurs. Suppuration is disclosed by the presence of softening or possibly fluctuation, while the temperature chart reveals a "picket

fence" type of curve. When this takes place, surgical drainage is indicated. However, the operation should not be performed until one is certain that the surrounding adhesions are sufficiently strong so as not to be broken down easily, since contamination of the remainder of the peritoneal cavity must be avoided and every effort should be made to perform an extraperitoneal type of drainage operation. In cases of general peritonitis, treated conservatively by the Ochsner regimen, the right iliac fossa is a common site for localization of the infection and subsequent abscess formation. The diagnosis and treatment of these abscesses are essentially the same as in the case of those which occur postoperatively. It is important to note that the majority of abscesses encountered in the right lower quadrant occur not as a postoperative complication, but rather primarily following the slow perforation of an infected appendix. Far more common than the true abscesses, are the inflammatory masses or infiltrations in this region, and a distinction between these two lesions should be made. In the treatment of such inflammatory masses, whether true abscesses or inflammatory infiltrations, Lehman and Parker²⁸ advocate conservative therapy. During the years 1936 to 1937, 83.3 per cent of their abscess cases were treated along conservative lines and 65 per cent were carried through without operation. Under certain conditions they found it necessary to abandon conservative therapy and resort to surgical intervention. Such operative procedures are classed as "forced operations." They regard as indications for a forced operation during the course of conservative treatment, acute intestinal obstruction, or growth in the size of the abscess, with threatened perforation into the anterior abdominal wall or rectum along with an associated increase in the signs of sepsis. It has been pointed out by Wangenstein²⁹ that prolonged delay in draining large abscesses is attended with certain dangers, since such an abscess may rupture into the free peritoneal cavity, an

accident which is almost invariably fatal, as the unprepared peritoneum is then suddenly flooded with septic material and an overwhelming infection of the peritoneum ensues. Again, such an undrained abscess may burrow into the mesentery and cause erosion of a large blood vessel, with disastrous results.

DISORDERS OF THE LIVER

Pylephlebitis and Liver Abscess. Fortunately, hepatic abscesses occur but rarely as a complication of the septic appendix, but constitute a most serious problem when present. The mode of spread of infection whereby suppurative appendicitis is responsible for hepatic abscesses is most often by way of the portal vein, i.e., following pylephlebitis. A less common cause is extension to the liver from a subphrenic space infection or abscess. Ochsner, DeBakey and Murray,³⁰ in a series of 575 cases of pyogenic abscess collected from the literature, found 197, or 34.2 per cent, to be secondary to appendiceal disease. In their own series of forty-seven cases of pyogenic liver abscess, five, or 10.6 per cent, were due to appendicitis, while in their personal series of 5,293 cases of acute appendicitis over a ten-year period, there were five instances of secondary liver abscess, an incidence of 0.094 per cent. The liver abscesses complicating acute appendicitis are usually multiple, and the right lobe is more commonly involved than the left. Occasionally, small abscesses may coalesce to form a large solitary abscess.

The usual clinical picture of pylephlebitis and liver abscesses complicating acute perforated appendicitis is characterized by high fever and chills, usually of abrupt onset. There is localized pain and tenderness in the region of the liver. The liver is enlarged. In the study of Ochsner, DeBakey and Murray, jaundice proved to be a less common finding than is generally supposed. These authors found jaundice to be present in only 36.4 per cent of their collected cases, and 24.7 per cent in their own series. When present, it was a late

development and they regard its presence as of grave prognostic import. Koster³¹ emphasizes the importance of splenomegaly ascites and tenderness along the course of the portal vein as of diagnostic significance. The leucocyte count is often unusually high, with a proportional increase in the percentage of polymorphonuclear leucocytes. Roentgen studies are of value and show elevation and fixation of the diaphragm, particularly the right. In the series of Ochsner, DeBakey and Murray, a positive roentgen diagnosis was made in twenty-three of twenty-eight cases examined roentgenologically, or an incidence of 82.1 per cent. Koster suggests the use of thorium dioxide (thorotrast) in cases in which there is doubt of the diagnosis, and also for the purpose of determining the character and extent of the suppurative process in the liver. He administers the drug intravenously in doses of 25 cc. on three successive days, following which roentgenograms are taken. In normal persons the x-ray shadow of the liver is of uniform density. An abscess will appear as an area of lesser density, and in multiple abscesses the liver shadow will show a mottled appearance. Judging from the reported cases, this procedure seems to be of value as far as accuracy of diagnosis is concerned. However, sufficient evidence has not yet accumulated to determine whether or not thorotrast is entirely without danger. Most authors condemn exploratory puncture of the liver in doubtful cases. While the prognosis of pyogenic abscess of the liver is decidedly bad, this is particularly true in the case of multiple lesions, the type most often found in association with appendicitis. Thus in the series reported by Ochsner and his associates, the mortality for single abscesses was 37.5 per cent in contrast with a mortality of 95 per cent in the cases in which multiple abscesses were present.

Acute Hepatitis. Simeone and Stewart³² report two cases of acute appendicitis with perforation and general peritonitis in which, during the postoperative period,

bleeding due to hypothermia occurred. This, they believe, was due to disturbed liver functions consequent upon an acute hepatitis which, in turn, was due to severe intraperitoneal sepsis. Since, under such circumstances, such bleeding may result in marked loss of blood and extension of infection, they recommend frequent plasma prothrombin determinations in cases of peritonitis. Since the hypothermia is due to a depression of liver function, the administration of vitamin K is less effective than usual and, therefore, in addition to its use, repeated blood transfusions should be given.

ILEUS

Ileus, as a postoperative complication, may be of two types, (1) acute mechanical intestinal obstruction and (2) adynamic or paralytic ileus. A distinction should be made between these two types, although in some instances the two may co-exist.

VanBeuren³³ reports that of 130 patients with acute ileus operated on at the New York Presbyterian Hospital from 1932 to 1935, eight, or 6 per cent, occurred as complications of acute appendicitis. The incidence of late obstructions due to adhesions following operations for acute appendicitis would be considerably higher. VanBeuren also found that in 380 patients with acute appendicitis coupled with acute diffuse peritonitis operated on at the Presbyterian Hospital between 1916 and 1938, acute ileus developed as a postoperative complication in twenty-eight cases, or 7.4 per cent. This author reports a mortality of 56 per cent in a series of thirty-four cases of acute ileus complicating acute appendicitis with abscess or general peritonitis. In this group of cases, the mortality of the mechanical type of ileus was 47 per cent, whereas that of the paralytic type was 63 per cent.

Acute Mechanical Obstruction. Due to adhesive bands, a loop of bowel, usually the terminal ileum, may be caught and angulated so that a mechanical obstruction is produced in cases of localized or general

peritonitis. While these recent light adhesions are unlike the dense, firm adhesive bands seen in late adhesive obstructions, nevertheless they are entirely capable of causing complete mechanical blockage to the flow of the intestinal stream. This is made possible because of the fact that in peritonitis, and especially in patients having had an operation involving an unusual amount of trauma or manipulation, there is associated some degree of paralytic ileus. Due to the consequent loss of the normal propulsive power of the intestinal muscle, the coils become dilated with fluid and gas and a dangerous angulation at the point of fixation occurs. Great distention of the bowel interferes with its blood supply and, if not corrected, may lead to necrosis of the wall with perforation. Many of the postoperative obstructions, therefore, represent a combination of mechanical and adynamic ileus.

While the diagnosis of small intestinal obstruction due to adhesive bands but occurring weeks, months or years after operation is ordinarily easily made, the recognition of this type of obstruction which occurs during the postoperative period may be more difficult. Here, as in postoperative general peritonitis, the symptoms may be relatively mild and insidious. They often are overshadowed by persistence of the symptoms and signs of the original peritonitis. Thus abdominal pain and obstipation are difficult of evaluation. However, during the postoperative period, any increase in pain, especially if it is colicky and cramp-like in character, should be the cause for concern. Nausea and vomiting, if persistent and severe, should suggest mechanical or paralytic ileus. The presence of "fecal" vomiting is indicative of a low obstruction. Abdominal distention is due either to mechanical or adynamic ileus. In mechanical obstruction, auscultation reveals active peristalsis. This examination likewise is of less value than in those patients who are not convalescing from an abdominal operation and peritonitis. X-ray examination is of the greatest impor-

tance. The simple flat plate or scout film of the abdomen, taken with the patient in the supine position, is usually sufficient. The administration of barium by mouth is absolutely contraindicated and a very ill patient should not be subjected to complicated or prolonged examinations. Wangensteen³⁴ has pointed out that while gas is normally present throughout the gastrointestinal tract, it is visualized in the x-ray film of the abdomen only in the stomach and colon, except in the case of patients under three years of age. In the small intestine, while gas is present, it is so intimately mixed with fluid that it is not visualized under conditions of normal peristaltic activity. When stasis occurs due to mechanical or functional ileus, the fluid and gas separate and gas can be demonstrated. If ileus is present, dilated small bowel may be seen within a few hours following the onset, and subsequent films may demonstrate a progression of the process. Dilated small bowel is recognized by its central position, its feathery cross striations and the transverse position of the parallel coils. (Fig. 8.) The presence of many coils suggests a low obstruction, and any great degree of asymmetry suggests a mass as the cause of the displacement. (Fig. 9.) By means of the roentgenogram alone, it is impossible to distinguish between mechanical and adynamic ileus. Blood chemistry studies show an increase in the nonprotein nitrogen, a fall in the plasma chlorides and usually an increase in the carbon dioxide combining power. In these early postoperative adhesive obstructions, treatment by gastroduodenal suction after the method of Wangensteen³⁵ or, preferably, by the use of the "long" Miller-Abbott tube, is eminently successful. In this type of case, in the past, simple enterostomy usually effected a prompt cure. The decompression of the distended coils of bowel above the obstruction served to release the kink at the site of fixation and, with the resumption of peristaltic activity, this complication was corrected. At the present time, intestinal suction

achieves the same result by means of what might be termed as "internal enterostomy" and surgical intervention is rarely neces-

dilates and remains motionless. It becomes filled with its normal secretions and, since these are not moved onward, upper gastro-

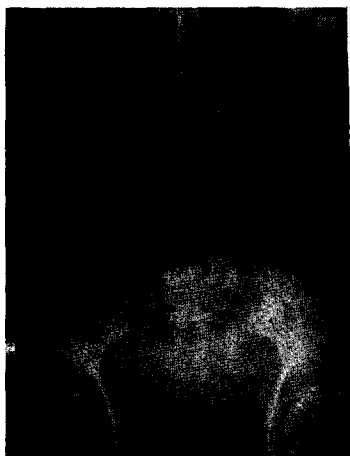


FIG. 8. "Scout film" of abdomen in case of small intestinal obstruction. This shows the parallel arrangement and transverse position of the intestinal coils and their central location in the roentgenogram. The fine cross-striations are characteristic of dilated small intestine.



FIG. 9. "Scout film" of abdomen showing high grade obstruction of the small bowel with gaseous distention of the ileum and jejunum. There is an absence of bowel pattern in the right lower quadrant, suggesting the presence of a mass at that point.

sary. Occasionally, in low obstructions in which adequate decompression is impossible by means of duodenal suction and in which technical difficulties are encountered in the passage of the Miller-Abbott tube beyond the pylorus or the ligament of Treitz, enterostomy may be necessary in order to avoid further delay and, in the very ill patient, to avoid the exhausting effects of repeated fluoroscopic manipulations. Still less frequently, gastroenteric suction may fail to relieve the obstruction and reoperation becomes necessary in the event that it is due to some unrelated condition.

Adynamic Ileus. Adynamic, paralytic or functional ileus is an accompaniment of peritonitis and may be regarded as a protective mechanism insofar as, with its occurrence, peristaltic activity ceases. Here, there is no single point of occlusion of the lumen of the bowel. Due to the loss of its contractile power, the intestine

intestinal stasis ensues. Due to reverse peristalsis, vomiting follows. Pain ordinarily is not severe or characteristic. The abdomen is distended and is silent on auscultation. Due to pressure on the diaphragm, respiration may be embarrassed. As already mentioned, mechanical and functional ileus may frequently co-exist.

The treatment of adynamic ileus is the treatment of the underlying peritonitis. The patient should be kept in the Fowler's position. Here, the use of duodenal suction by the method of Wangenstein is of the greatest value. Gastroduodenal suction serves to keep the upper portion of the digestive tract free of gas, swallowed air and retained secretions. Drugs such as eserine or pituitary derivatives are contraindicated because of the danger of spreading infection if violent peristalsis is stimulated. Moreover, they are inefficient in restoring the normal tonus and rhythmical contractions of the bowel.

Morphine, on the other hand, has a stimulating effect upon the intestinal musculature by increasing tone and rhythmic contractions, as shown by Orr.³⁶ Since it also minimizes the discomfort of the indwelling duodenal tube and the intravenous needles, it should be used freely. Plasma chlorides should be maintained at a normal level. Ochsner^{37,38,39} recommends heat applied to the abdomen by means of body bakes. He believes that, due to the vasodilatation produced in the abdominal wall, there is a reciprocal vasoconstriction in the splanchnic areas which, in turn, has a beneficial effect upon distention. Distention may also be combated by oxygen therapy employing high concentrations of oxygen as recommended by Fine.⁴⁰ As the body defenses begin to overcome the infection, the tone and activity of the bowel will return to normal.

FECAL OR INTESTINAL FISTULA

Fecal fistula is an uncommon complication of operation for acute appendicitis, either with or without an associated peritonitis. In a series of ninety-four cases of intestinal fistula seen at the University of Michigan Hospital between the years of 1925 and 1934, and studied by Ransom and Coller,⁴¹ thirty, or 32 per cent, developed following operations upon the appendix. Eight of these developed in the hospital following operation. In all of them the infection had extended beyond the appendix at the time of the original operation, and there was either a local abscess or a general peritonitis. These eight fecal fistulas occurred among 234 cases of acute appendicitis with abscess or general peritonitis, and which were treated by operation, an incidence of 3.4 per cent. The incidence of fistulas for the total number of operations for acute appendicitis with and without perforation (1,067) was only 0.8 per cent. In a series of 109 fecal fistulas observed in the Johns Hopkins Hospital over a period of forty years, Lewis and Penick⁴² found that forty-nine, or 44.9 per cent followed appendicitis. Marshall and Lahey⁴³ found

perforated appendicitis to be the etiological factor in ten of the thirty-seven cases of abdominal fistulas reported by them. These authors state that the most common cause of intestinal fistula is an infection which produces gangrene and perforation of the bowel and that, in their experience, cecal fistulas usually were the result of a direct extension of an infection of the appendix to the cecal wall, with a resultant sloughing of the wall. Fistulas involving the small intestine were more often the result of secondary operations for pelvic abscess or intestinal obstruction and were due to injury to the small bowel at the time of operation. Dixon and Deuterman⁴⁴ mention that a fecal fistula may follow drainage of an appendiceal abscess in cases in which the appendix is not removed at the original operation, since a fecalith in the remaining portion of the appendix may cause the development of such a fistula. Probably in some cases an unrecognized and unrelieved intestinal obstruction in the terminal ileum results in perforation of the bowel at the point of the obstruction, whereupon a fistula ensues.

Because it is believed by some surgeons that postoperative fistulas are due to improper treatment of the appendiceal stump, there has been much discussion in the literature regarding the merits and disadvantages of invagination of the stump at the time of appendectomy. Some authors maintain that such a technic is responsible for a high incidence of fecal fistulas, whereas it is contended that simple ligation without invagination reduces this incidence. It has been our practice to invert the stump with a purse-string suture of catgut or silk, or by means of three mattress sutures of silk whenever the condition of the cecal wall will permit this procedure. We have seen no instance of fecal fistulas which we could attribute to invagination of the appendiceal stump, and similar experiences are recorded by Lewis and Penick and by Dixon and Deuterman. Some fistulas are caused by the use of improper drainage materials. Fortunately,

glass and hard rubber drains, once so commonly used, have been largely superseded by drains of soft rubber, gutta-percha, or drains of the cigarette variety. A heavy gauze drain allowed to remain in contact with a suture line is apt to provoke leakage; hence, when cigarette drains are used, the gauze should not project beyond the end of the Penrose tubing. The tip of the drain may be placed near but not against the suture line. Moreover, when feasible, it is well to interpose the omentum between the suture line and the drain.

In the forty-nine cases of fistulas following appendicitis reported by Lewis and Penick, the opening was in the cecum in twenty-one, or 72.4 per cent, in the ileum in four, or 13.7 per cent, and in the appendix in a similar number of cases. In the remainder of their cases, the point of communication could not be determined. In the thirty fistulas associated with appendicitis studied by Ransom and Collier, the opening was in the terminal ileum in thirteen, in the cecum in four, in both cecum and ileum in two, in the sigmoid in one, and was undetermined in ten cases.

The diagnosis of an intestinal fistula ordinarily is not difficult. In the case of most cecal fistulas, the discharge is semi-solid and is not especially irritating to the skin. The fistulas higher in the small intestine are associated with an irritating discharge and, due to the fluid character of the contents, considerable quantities of fluid, electrolytes and food substances may be lost. Occasionally, it may be difficult to distinguish between a fecal fistula and a colon bacillus infection of the wound or in a hematoma. Dixon mentions the importance of the history of the passage of gas in such cases as indicative of fistula and, in doubtful cases, suggests the use of a dye such as carmine red by mouth. Roentgen studies following injection of the fistulous opening with some radio-opaque material is often of value in localization. Injection in conjunction with a barium enema often gives additional information.

The fistulas associated with appendicitis

tend to heal spontaneously. This is particularly true of the cecal fistulas. When healing fails to occur in these cases there is usually an outgrowth of the cecal mucous membrane so that it becomes continuous with the skin, producing the direct or lip type of fistula. In such cases, surgical closure is necessary. The ileal fistulas are more apt to be complete and are less likely to heal spontaneously than are those in the cecum. Here, the added complications of spur formation, herniation, or obstruction distal to the fistula are mechanical factors which serve to maintain the fistulous opening and they must be recognized and corrected by the proper surgical procedures. As a rule, in the fistulas associated with appendicitis, conservative treatment should be given a prolonged trial before resorting to operative closure. Even though a surgical repair may be necessary at a later date, a successful result is much more likely to be obtained when the local inflammatory reaction has been given a chance to subside before operation is attempted.

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