SOME OBSERVATIONS ON ACUTE APPENDICITIS.

By CAMERON MacLEOD, F.R.C.S.

(Assistant Surgeon, Charing Cross Hospital; Honorary Surgeon, Connaught Hospital, Walthamstow.)

These observations based on the notes of 157 personal cases will be discussed under the following headings:—

1. Pathology and Symptomatology of obstructive appendicitis.
2. Clinical features depending on the position of the appendix in the abdomen.
3. Perforative appendicitis. { (1) General suppuration.
(2) Local retrocæcal abscess.
(3) Pelvic appendix with suppuration.
4. Secondary Operations.

I. OBSTRUCTIVE APPENDICITIS.

Of the 157 cases, obstruction with secondary acute inflammatory change was present in 60 (38.2%). In all probability this is a conservative estimate of its frequency for two reasons: (a) Unless the appendix is carefully examined as it lies in situ before removal, evidence of kinking or coiling will be lost; (b) The onset of gross inflammatory change may destroy the evidence. Of 117 cases without perforation (endo-appendicitis) evidence of obstruction was found in 53 (45.3%), whereas of 40 cases of perforation (peri-appendicular suppuration) it was found in only 7 (17.5%).

Pathology.

Obstruction may be due to:—

(a) **Fibrous Stricture of the Wall.** 19 cases. This is due to a previous attack resulting in a local fibrosis of the wall proximal to the tip of the appendix. Externally the appendix may appear normal or the distal part is distended and inflamed. In 5 instances the appendix was kinked, subsequent section showing the stricture at this site, which is commonly at the junction of the middle and distal thirds. The distal mucosa shows all grades of inflammatory change and the lumen may contain faecal concretions or pus under tension. Perforations occur immediately distal to the stricture. The proximal mucosa is usually normal, but may be inflamed.

(b) **Kinking.** 19 cases. May be due to a fibrous band, the genito-mesenteric ligament which runs down towards the pelvis. A retrocæcal appendix may be kinked by a similar band running up towards the lower pole of the kidney. Inflammatory adhesions due to previous attacks of appendicitis or to tubercular peritonitis cause kinking by binding the appendix down to the posterior abdominal wall or to other sites. On section the proximal and distal mucosæ are sharply demarcated. Gangrene may occur first at the site of kinking.

(c) **Concretions.** 13 cases. May be pale or "putty-like" and contain Calcium Phosphate, which makes them opaque to X-rays. Spasm of the wall of the appendix at the site of a concretion has been frequently observed. The appendix is often retrocæcal in position. Here gravity would assist emptying, but the proximal part bends towards the cæcum producing a natural kink. Perforation

occurred in 3 cases either through an area of gangrene distal to or at the site of a concretion from pressure necrosis.

(d) **Coiling.** 9 cases. This may be primary or secondary. The primary examples are due to a long appendix and relatively short meso-appendix. The inflammatory changes are slight. Secondary coiling results from adhesions from previous attacks, from changes in the wall or adhesion of the tip of the appendix.

Symptomatology.

(a) **Initial "central" Abdominal Pain.** John Morley⁽¹⁾ has shown that this initial pain is due to obstruction of the lumen of the appendix with consequent increased tension on the muscular wall. He says, "Some degree of obstruction to the lumen of the appendix with retention of inflammatory exudate distal to that obstruction is essential to its production." He believes that this initial pain is a true visceral pain, originating in the appendix itself. This pain is described as occurring in the lower epigastrium or umbilical region and is normally of two types: (a) colicky, due to vigorous peristaltic contraction where the obstruction is partial; (b) continuous aching due to distension where the obstruction is complete. Of the 60 cases of obstructive appendicitis in the present series, a history of initial "central" pain was obtained in 39; fibrous stricture in 10 of 19 cases, kinking in 14 of 19 cases, concretions in 7 of 13 cases, and coiling in 8 of 9 cases. An examination of the case histories of these 39 patients has shown that the pain may occur in one of the following situations:—

1. Epigastric or upper abdominal ...	...	...	16 cases.
2. Umbilical or mid-abdominal ...	...	...	10 cases.
3. Generalized ...	...	...	7 cases.
4. Hypogastric or lower abdominal ...	...	...	6 cases.

Character of central pain. There may be a history of indigestion of many years standing, but this is uncommon. The attacks may take the form of a vague discomfort and flatulent distension, not definitely related to food and relieved by eructations or the "passing of wind." Actual pain may be described as a mild nagging, dull aching or as a "rumbling" pain or merely as a feeling of "tightness." It is frequently more severe and occurs as a colicky or griping pain often of sudden onset and if occurring at night waking the patient in the early hours of the morning. It may be severe enough to "double the patient up" and may thus resemble other forms of "colic."

As a rule this central pain has no relationship to the taking of food. Occasionally the more severe types appear to begin before, during or after breakfast and in others where the pain is epigastric, there may be a definite relationship to meals, the history simulating that of a chronic duodenal ulcer as in the following examples:—

A.G., male, 47. Five years' history of aching pain in epigastrium occurring 1½-2 hours after food, relieved by food and lasting 2 weeks at a time. Has 2 or 3 attacks a year. Occasional "shooting" pains superadded and localized to the R.I.F. 3 months ago attack of hæmatemesis. 3 days before admission noticed motions were loose and black in colour. Before operation. *Test meal.* High rising curve but "came down." *Occult blood test.* Negative. Operation. Right upper paramedian incision. Stomach and duodenum normal. No duodenal ulcer. Appendix long, walls somewhat thickened, contained numerous faecal concretions. Progress. 3 months later perfectly well—full diet without discomfort.

P.V., male, 26 Two years' history of indigestion and mid-epigastric pain of hunger type, always relieved by food. Very slight dull ache lasting one or two weeks with interval of several months' freedom. No nausea nor vomiting. During the last month has had a throbbing sensation in the right iliac fossa. Bowels are regular. Temperature and pulse normal. Tenderness on deep pressure in R.I.F. Barium meal before operation—no evidence of duodenal ulcer. Operation 21.11.34. Inflamed retrocæcal appendix removed.

This initial "central" pain may begin in the left hypogastrium (left iliac fossa) as in the following two cases:—

G.P., female, 26. Two years ago attacks of pain in L.I.F. with nausea and vomiting. Fifteen months ago similar attack but pain more severe and shifted to the R.I.F. Diarrhœa 2 or 3 times daily during attacks. At operation, appendix inflamed, stricture at junction of middle and distal thirds.

W.D., male, 43. Four years ago pain in L.I.F. which woke him at 4 a.m. and lasted 1-2 hours. 5 weeks ago recurring dull ache in R.I.F. lasting $\frac{1}{4}$ - $\frac{1}{2}$ hour. On day of admission onset of flatulence, waking him at 6 a.m. followed by pain in L.I.F. after breakfast lasting $\frac{1}{2}$ hour. Two hours later definite "sicking" pain settling in R.I.F. Has vomited 3 times. Bowels usually regular but constipated during attacks. At operation, appendix kinked at junction of proximal and middle thirds, distal $\frac{2}{3}$ ds somewhat distended and superficial vessels congested.

Other Symptoms. Nausea frequently accompanies the pain but may be absent. Vomiting may follow the onset of the pain especially when food or a purgative is taken. As a rule it occurs once only during the first attack of central pain. It may, however, occur more often and may relieve the pain. It has been described as "bilious vomiting." The bowels may be habitually constipated or only so during the attacks. In a few cases diarrhœa is a prominent symptom even though the appendix is not in the pelvis. It may occur during or after each attack.

Character of subsequent pain in "Right Iliac Fossa." John Morley has shown that the second or localized pain in acute appendicitis is due to irritation of the parietal peritoneum. This irritation may be mechanical or chemical in nature or be due to inflammation spreading from the appendix. The pain is therefore strictly localized to that point at which the appendix comes closest to the anterior or posterior abdominal wall. Central pain may occur in the first attack and the localized pain in the second, but more commonly the central pain is described as "shifting," spreading or settling in the right side of the abdomen.

The character of this local pain depends on the severity of the local change in the appendix. It has been described as a sharp, stabbing, "knife-like" or burning pain or as a dull aching, dragging, nagging or gnawing pain. It may be intermittent at first but tends to become continuous, more constant and to increase in severity. It may be made worse on moving and exercise and may make the patient limp on walking. There is no tendency for the pain to radiate across the abdomen although in cases of retrocæcal appendicitis it may pass round to the right flank. It is often accompanied by nausea, but in the absence of perforation, vomiting is uncommon. It should be remembered that the local pain is never colicky or griping in character. When the central pain is epigastric, the patient may never have had any local pain at all, as in the following cases:—

F.C., male, 29. Four months' history with two attacks of mild nagging pain in epigastrium with vomiting. No history of localizing pain in R.I.F. At operation,

appendix contained a stricture in mid-part. Distal half hyperæmic externally and contained several hard concretions, the mucosa here was congested and œdematous.

J.P., male, 26. Two months' history of vague epigastric discomfort and distension rarely amounting to actual pain. Not definitely related to food. One rather "acute" attack relieved by passing "wind." No vomiting. No history of pain in R.I.F. Slight tenderness duodenal area and in R.I.F. Barium meal before operation. Spastic duodenal cap, spastic colon, chronic appendix. At operation, long retrocæcal appendix, few superficial adhesions, stricture at junction of middle and terminal thirds, mucosa of distal third œdematous with submucous hæmorrhages.

II. CLINICAL FEATURES DEPENDING ON POSITION OF APPENDIX IN THE ABDOMEN.

I. RETROCÆCAL POSITION.

Of 157 "acute" cases the appendix was retrocæcal in 46 (30%).

Pathology.

The appendix may lie to the outer side of the cæcum and ascending colon—the paracæcal position. It may be free but is frequently adherent to or embedded in the posterior wall of the cæcum, when there may be great difficulty in locating it. It may, on the other hand, be adherent to or even lie in a pocket of the posterior parietal peritoneum. Occasionally it appears to be retroperitoneal and closely related to the right ureter. Wilkie has shown that this position favours obstruction where the appendix bends towards its junction with the cæcum. A genito-mesenteric band may accentuate this bend and produce an actual kink distal to which a concretion may be impacted. A band has also been observed passing upwards towards the lower pole of the kidney, kinking the appendix at the junction of its middle and distal thirds.

Owing to the close relationship of the appendix to the cæcum, the latter is commonly affected. In mild cases, the cæcum is distended and atonic, often containing semi-solid fæces (flabby, baggy or bulky cæcum). Adhesions may be found between the cæcum and the anterior parietal peritoneum or a well-marked Jackson's membrane may be present. When the inflammatory changes are more marked, there is an accompanying although variable degree of typhlitis. The cæcum becomes indurated and may closely surround the inflamed appendix. The inflammatory "tumour" thus formed may be so marked as to resemble a tuberculous hypertrophic cæcum and distinction may be difficult where there are coincident calcified mesenteric glands.

If perforation of the distal half of the appendix occurs, it results in the formation of a localized retrocæcal abscess. The cæcal induration increases and the appendix may become more embedded in the cæcal wall. Occasionally perforation occurs near the base and may result in general peritonitis, the pus being commonly found in the pelvis. This may be due to a proximal stricture, conversion of the terminal half into a fibrous cord or to the terminal half of the appendix being firmly bound down to the posterior abdominal wall.

Symptoms.

(a) **Central Pain.** A history of initial central abdominal pain was obtained in 31 of 46 cases. The site distribution was umbilical 12, epigastric 10, generalized 7 and hypogastric (left side) 2.

(b) **Local Pain.** Special characteristics due to retrocæcal position.

(i) *Relationship to cæcum.*

Anteriorly the pain is felt just below and to the right of the umbilicus under the right rectus muscle. It is, therefore, well above and to the inner side of McBurney's point. It may be a dragging pain relieved by lying down. It may occur soon after food or be aggravated by food. Finally it may be aggravated by constipation.

(ii) *Relationship to posterior parietal peritoneum.*

The pain may begin in the right loin posteriorly or laterally. With subsequent involvement of the cæcum and typhlitis this pain may spread round to the front and may be felt in the right iliac fossa as noted above or in the right hypochondrium. On the other hand, it may pass round to the loin from the right iliac fossa.

(iii) *Relationship to posterior abdominal nerves.*

The appendix may be in close relationship to the anterior crural, external cutaneous nerve of the thigh, ilio-inguinal or ilio-hypogastric nerves. The pain may therefore be referred to the groin and down the thigh or beginning in the right loin may "radiate" to the right iliac fossa and down into the testicle. In these cases the similarity to a renal lesion is evident.

(iv) *Relationship to pelvic and posterior abdominal muscles.*

These are the ilio-psoas and the quadratus lumborum muscles. The pain is frequently described as worse on or after moving, walking or undue exertion. It may be produced by hyper-extension of the right leg. There may be flexion of the right hip due to psoas spasm, especially where the terminal part of the appendix is retroperitoneal or in the presence of a retrocæcal abscess.

(c) Other Special Symptoms. Micturition. As a rule there is no abnormality. The symptoms and physical signs, however, may suggest a renal lesion necessitating a preliminary urinary investigation. Occasionally, there is a history of frequency, pain and even hæmaturia during the attacks, indicating a close relationship to the ureter or kidney.

Menstruation. The pain may be worse during the periods. This may be incidental although the right ovary is frequently found enlarged and cystic.

Physical Signs.

(a) Tenderness. It is necessary to keep in mind that the appendix is behind the cæcum and in the absence of any degree of typhlitis, very deep palpation may be required to elicit tenderness. The maximum site corresponds in the main to the position of the "anterior" pain, that is just below and to the right of the umbilicus, but occasionally it is immediately to the right or to the right and above the umbilicus, here corresponding closely to the duodenal point.

Loin tenderness. This may be found where the inflammatory changes in the appendix are marked, where the cæcum and appendix are adherent to the posterior parietal peritoneum and in the presence of a retrocæcal abscess. It is most marked between the outer half of the 12th rib and the iliac crest but may be more lateral. Owing to the presence of typhlitis there is also tenderness in the right iliac fossa. The absence of loin tenderness does not exclude an inflamed retrocæcal appendix.

(b) **Increased Resistance and true Rigidity.** In the absence of intra-abdominal suppuration, true involuntary rigidity is uncommon. Even increased resistance or "guarding" of the abdominal muscles may be absent or in the case of a retrocæcal appendix present only in the loin. If present anteriorly, it is due to the underlying typhlitis and its site and extent depend therefore on the position of the cæcum and amount of cæcal wall involved. As a rule, the right rectus is affected to a variable degree extending either to the level of the umbilicus or into the right hypochondrium.

(c) **Palpable tumour.** Retrocæcal appendicitis produces varying changes in the overlying cæcum. In mild cases the cæcum becomes distended and atonic and can be felt as an indefinite swelling, tender on pressure. Cæcal stasis occurs and where the contents are fluid "gurgling" may be obtained on palpation. Where the contents are semi-solid the "tumour" becomes more defined and distinction from simple constipation must be considered. When inflammatory induration of the cæcum occurs it is felt as a more definite swelling, especially if surrounded by omentum and adherent small bowel. It may be difficult to distinguish this inflammatory "tumour" from a carcinoma of the cæcum, especially when occurring in elderly patients, as in the following case:—

A.W., female, 71. Complained of pain in the "stomach" two months before admission. It was worse on moving and was accompanied by nausea. No relation to food. On day of admission, pain in stomach much worse, also in back. Loss of weight. Temperature 98.6°. Pulse 96. Examination. The right iliac fossa was very full and tender and a palpable tumour could be felt. ?Carcinoma of cæcum. ?Appendicitis. There was much resistance of the abdominal wall extending up to the level of the umbilicus and tenderness in the right loin posteriorly. At operation an inflamed retrocæcal appendix was found, bound down to the right iliac fossa. The cæcum was inflamed and indurated and closely surrounded the appendix, the tip of which lay towards the lower pole of the kidney. Recovery. Discharged 16 days after operation.

In younger patients the mass may be mistaken for a tuberculous hypertrophic cæcal tumour and even at operation the diagnosis may be difficult, especially where coincident calcified glands are present, as in the following cases:—

R.A., male, 8. Three days' history of severe and continuous pain in the right hypochondrium occurring first after lunch. A day later, less severe following a dose of castor oil. On admission: temperature 100.9°. Pulse 116. Tongue furred. Whole abdomen tender and doughy. Indefinite "tumour" felt just to right and below umbilicus where tenderness was maximum. Increased resistance over swelling. At operation there was much induration of the cæcum, also involving the terminal ileum and ascending colon, considered to be tuberculous. Numerous enlarged and firm glands in the mesentery, some calcified. The appendix was retrocæcal in position and thickened. The terminal inch showed a diffuse redness. Progress. Temperature became normal on the 7th day and remained so until discharged from hospital on the 19th day, when he was perfectly well. Microscopical examination of the appendix showed no evidence of tuberculosis.

V.W., female, 5. Extremely ill on admission. Temperature 103°. Pulse 134. Definite mass felt in the right iliac fossa. At operation the cæcum was much indurated. There were many glands, some calcified, in the mesentery of the ileum. On separating the appendix from the cæcum, a small abscess cavity was opened. Cultures of the pus grew *B. coli* and *Streptococcus hæmolyticus*. Abdomen closed

with drainage. The patient subsequently developed bilateral pleural effusions treated by repeated aspiration, and rib-resection. Cultures of the pus showed a pure growth of *Streptococcus hæmolyticus*. The cæcal tumour completely disappeared after operation. A radiogram confirmed the presence of calcified mesenteric glands in the right iliac fossa. Recovery.

(d) **Cutaneous Hyperæsthesia.** As a rule, this sign has only been present in cases of intra-abdominal suppuration. As a diagnostic aid it is of no value in early cases.

(e) **Rovsing's Sign.** Although of little value in diagnosis, the author believes it is more commonly present in cases of retrocæcal appendicitis, especially where the appendix is adherent to the cæcum. The pain is due to distension of the cæcum, which may be produced by pressure in the left iliac fossa or in the epigastrium (transverse colon). It was a striking sign in a case in which there was a small retrocæcal abscess, the appendix being completely embedded in the cæcal wall.

(f) **Rectal Examination.** Where the cæcum is low and the proximal half of the appendix acutely inflamed, tenderness may be present high up on the right side. Apart from this and in the absence of general peritonitis, rectal examination yields a negative result.

2. PELVIC POSITION.

Pathology.

The dependent position of a pelvic appendix favours stasis of fæcal matter in the lumen, but in only one case was there definite evidence of obstruction from a concretion. A barium meal may show the appendix filled with Barium, which remains after the cæcum has emptied. It has been noted that inflammatory changes are most marked close to the tip and perforation through a gangrenous patch always occurs here. It seems probable that the blood supply to the terminal part of the appendix is especially precarious where the organ is long and hanging down over the brim of the pelvis. The organ tends to become adherent to the pelvic wall or contents. Adherence to the common iliac vessels and to the fascia covering the Obturator Internus muscle has been noted and any of the pelvic organs may be secondarily involved. Induration of the cæcum is uncommon, although in one case it formed a definite "tumour" in the right iliac fossa just above the outer half of Poupart's ligament. When suppuration occurs there is a great tendency to localization in the pelvis and spontaneous rupture into the rectum or vagina is not uncommon.

Symptoms.

(a) **Local Pain.** As the appendix is more a mid-line organ, local pain begins in the hypogastrium towards the right of the middle line and tends to spread towards both iliac fossæ. It may be referred to the tip of the penis or down towards the right testicle. If the appendix is in close relation to the Obturator Internus muscle, the pain may be increased by internal rotation of the right hip. Relief has been obtained by drawing up the right leg where the appendix was adherent to the psoas muscle.

(b) **Diarrhœa and Frequency of Micturition.** These symptoms occur with the onset of pelvic peritonitis and do not therefore accompany the initial central pain.

Constipation is followed by the sudden onset of diarrhoea which occurs when the local pain becomes severe. It is therefore noticed as a rule during the few days before admission and continues during the attack.

Frequency may be associated with pain on micturition. There may be a history of previous attacks of cystitis or of gradually increasing frequency and urgency, as illustrated by the following case:

M.K. female, 53. Quite well up to two months ago. In the evening complained of severe pain in the epigastrium with indigestion followed by a severe continuous pain in the lower abdomen, which was "knife-like" and lasted for 16 days. About the end of the third week sudden diarrhoea commenced and a bowel wash-out was followed by two stools which contained pus, and the temperature subsided. One month ago she had "cystitis" with frequency and pain on micturition. The bowels were usually constipated. She often had a dull aching pain in both iliac fossæ low down. At operation the appendix was very adherent to the bladder, right ovary and tube and sigmoid colon.

(c) Vaginal Discharge. Where the tubes are secondarily involved, a history of excessive vaginal discharge may be obtained. Sudden onset of discharge may be due to rupture of a pelvic abscess into the vagina.

(d) Colonic Symptoms. A pelvic appendix is in close relationship to the sigmoid colon to which it may be adherent. An irritative spasm of the sigmoid is thus produced which results in passive distension of the cæcum and pain in the right iliac fossa. Similarly this pain may occur in cases of salpingitis and is responsible for many mistakes in diagnosis.

Symptoms of colonic spasm or tonic hardening of the colon may be due to an inflamed pelvic appendix.

Physical Signs. There may be no physical signs. Diagnosis rests on the history and special symptoms described. As a rule, signs are obtained on pelvic examination but only when the appendix is definitely inflamed and lies in close relationship to the peritoneum of the pelvic floor. Tenderness may then be elicited on rectal examination by palpation through the right antero-lateral wall, on vaginal examination through the right lateral fornix. Usually no "mass" is felt unless peri-appendicular suppuration has occurred.

Abdominal Signs. In the absence of suppuration, these are not well marked, but there may be tenderness on deep pressure over the cæcum. This is probably due to distension of the cæcum from irritative spasm of the sigmoid colon, but may also result from infection of the base of the appendix or of the cæcum itself. As a rule, however, a pelvic appendix is not associated with any degree of typhlitis. In one case, G.S. (see page 184) there was no tenderness on rectal examination, yet the indurated cæcum formed a definite "mass" readily palpable just above Poupart's ligament. In the majority of cases the physical signs are limited to the pelvis and the importance of a pelvic examination is evident.

3. HIGH CÆCUM AND APPENDIX.

In four instances the cæcum was found high up in the right hypochondrium. Distinction from a renal, gall bladder or pulmonary lesion may be extremely difficult. The condition is an upper abdominal one and if gangrene and suppuration occur, becomes one of grave import as the following case illustrates.

E.T., female, 52. Two days before admission complained of colicky pain in left hypochondrium. This "spread" to the right side and became "stabbing" in nature. Nausea and diarrhoea followed soon after onset of pain. On the following day she vomited once. Since the attacks of diarrhoea the bowels had not been opened. There had been no previous attacks. On admission, she complained of being unable to take a deep breath because of the pain. On examination, temperature 102.2°, pulse 104, respirations 32. Urine contained much albumin. There was marked hyperæsthesia and tenderness in the right hypochondrium. Examination of the chest showed impaired breath sounds and diminished air-entry at the right base and a radiogram revealed a raised and immobile right dome indicating a subphrenic abscess. Operation March 31st, 1935. Right paramedian incision. Abdomen filled with offensive pus. Appendix gangrenous in its whole extent and with the cæcum was situated just under the liver. A large anterior subphrenic abscess with flakes of fibrin and slough was also present. The appendix was removed and drainage instituted: (1) Right flank. (2) Through upper and lower ends of incision into the subphrenic and subhepatic regions. (3) Pelvic drainage through suprapubic stab. On fifth day a fæcal fistula developed. On May 9th, 400 c.c. of offensive pus were aspirated from the right pleura. Culture grew a non-hæmolytic streptococcus. Under local anæsthesia, rib-resection and drainage of the pleural cavity. There was an opening through the diaphragm communicating with the subphrenic region. In spite of two blood transfusions she died on June 26th, twelve weeks after operation.

4. ANTE-CÆCAL APPENDIX.

Occasionally the appendix lies in front of the cæcum in close contact with its anterior wall or with the anterior parietal peritoneum. The pain has been described as sharp and aggravated by vibration, moving or stretching and is due to irritation of the sensitive parietal peritoneum. In one case it was believed that the position of the appendix had initiated attacks of partial volvulus of the cæcum. As is to be expected, the physical signs are marked and typhlitis results in an inflammatory tumour, which may be mistaken for an appendix abscess. At operation the cæcal induration may appear to be out of proportion to the changes in the appendix as shown, in the following case:—

J.L., male, 24. Four months ago "cold in stomach" with pain, diarrhoea and vomiting. Constipated between attacks, which have occurred frequently during the last six weeks. Four days before admission, sharp pain in right side which increased in intensity. No nausea nor vomiting during this pain. Constipated for three days before attack—onset of pain accompanied by diarrhoea. Temperature 96°, pulse 96. Tender indurated lump felt in R.I.F. believed to be an abscess. At operation the appendix was coiled and lying in front of the cæcum. Its tip was inflamed and in contact with the antero-lateral wall of the cæcum. Apart from the extreme tip it appeared normal. Cæcal wall was markedly oedematous and indurated with flakes of lymph. On opening the appendix the mucosa appeared normal except at the tip, where there was some inflammation.

III. PERFORATIVE APPENDICITIS. (Peritoneal Suppuration.)

Of 157 cases of acute appendicitis, the appendix had perforated in 40 with:—

1. General suppuration	...	...	...	20
2. Local retrocæcal abscess	...	...	...	14
3. Pelvic appendix with suppuration	...	...	...	6

(a) General Suppuration.

A history of having taken castor oil or other drastic purgatives may be obtained. The patients are always extremely ill. Vomiting is frequent and diarrhoea not uncommon. The tongue is dry and furred and the breath offensive. Both legs or the right leg alone may be drawn up. The temperature is not high except in children or where the condition is complicated by a subphrenic abscess, when it may reach 102°F . In my experience it is between 99° and 101° , often below 100°F . When the general condition is poor, a subnormal temperature may be recorded and is a grave sign. The pulse rate is out of proportion to the temperature, especially in children, when it may reach 132 (Temperature 99.4°). In adults 120 was the maximum pulse rate recorded (Temperature 99.7°). Albumin is frequently present in the urine and in children it is not uncommon to find moist sounds at the bases of the lungs when the toxæmia is extreme. Owing to the presence of pelvic peritonitis signs are obtained on pelvic examination. Rectal examination itself is painful and there is marked tenderness on palpating the pelvic floor, especially on the right side. The rectal mucosa may be oedematous and distended coils of ileum may be noticed.

Operative Mortality. Four deaths occurred in this group:—

1. E.T., female, 52. High cæcum and gangrenous appendix. General suppuration with subphrenic abscess. Death three months after operation. (Already described on page 178.)

2. R.G., female, 62. Gangrenous appendix. General suppuration. Temperature commenced to rise again on 7th day and the lower part of the wound became infected. Sudden death from pulmonary embolism on 14th day.

3. D.B., female, 17. On admission was moribund with a temperature of 95° . Pulse 152. Respirations 40. Operation, paramedian incision. Gangrenous appendix removed. Abdomen drained. Death 4 hours after operation.

4. D.D., male, 5. Appendix perforated at base. Death on 10th day from broncho-pneumonia. Throughout the abdomen was soft and the bowels had opened well.

(b) Localized Retrocæcal Abscess.

The appendix is retrocæcal in position and the abscess, as a rule, well localized by adhesions, but depending on the length of history. The onset is often rapid. Two classes of patients may be recognized: (1) Those with a short history of two or three days' duration. (2) Those with a longer history up to ten days' duration or more. The pain may not be severe and has been described as a "sore feeling," a severe soreness or as a dull aching pain. One patient with a short history described it as an intense localised "cramp." Vomiting is often absent. A history of diarrhoea may be obtained.

Physical Signs. Hyperæsthesia of the skin overlying the abscess may be present. There is definite and well-marked tenderness in the right iliac fossa on light pressure. The tenderness is usually diffuse and may or may not extend into the right loin. Increased resistance is always present over the cæcum and true rigidity is constantly present in the right loin and may extend to the right iliac fossa. This latter sign may mask the presence of the underlying "tumour," which forms an

indefinite, fixed and very tender mass, dull on percussion. It is mainly due to the induration of the cæcal wall lying in front of the abscess together with, in some cases, inflamed and adherent omentum and small bowel. Adults with a palpable tumour usually give a history of at least 7 or 10 days pain and are often surprisingly well. The temperature is below 101° and usually between 99° and 100.5° . The pulse rate is between 90 and 100 per minute. On the other hand, in children and in adults with a short history of two or three days' pain, the temperature is often high and between 100° and 103° , the pulse rate always over 100 and usually between 120 and 140. Clinically no free fluid can be detected although at operation a small quantity of clear exudate is often encountered. Rovsing's sign may be present and was a striking feature in one case in which the appendix was buried in the wall of the cæcum. Rectal examination, as a rule, is negative, although rarely there may be tenderness high up on the right side. Pulmonary signs have been noted, such as a poor air-entry and impaired percussion note at the base of the right lung. Spasm of the psoas muscle with flexion deformity of the right leg may be present.

Treatment. In adults there is a divergence of opinion as to the best method of treatment in this type of case. Where the history is of more than three days' duration and a definite "tumour" can be palpated, many advocate the Oschner-Sherren expectant method, believing that in the majority of cases the local inflammation will subside and the pus become absorbed, the appendix being removed three to six months later. In this series a "tumour" could be palpated clinically in 7 cases, all of whom had had continuous pain for 7 to 10 days or more. They were subjected to immediate operation. The abscess was invariably well localized by adhesions, but the appendix could not be removed in five instances. However, with retrocæcal drainage, subsidence of temperature occurred within 7 days, the general condition rapidly improved and recovery was uneventful.

When operation is undertaken within 3 days of the onset of an attack and a retrocæcal abscess is found, the results of drainage, with or without appendicectomy, are not so satisfactory. Localization is in an early stage, adhesions and tissues are friable and there has been little time for local immunity to develop. In my experience the temperature takes 10 to 21 days to subside and the wound itself frequently becomes infected in spite of superficial wound drainage. If it were possible to diagnose with certainty before operation the position of the appendix and the extent of the local condition, many of these cases would do better if treated expectantly for another week or so. This not being possible and with the ever present danger of further complications occurring, such as subphrenic abscess, general suppuration and pyæmia, there can be no possible doubt that the safest procedure is to operate immediately.

Remote Appendicectomy. In 8 of the 14 cases, the appendix was not removed. In five, appendicectomy was performed at least 6 months later through another incision.

Case reports:—

1. A.H., male, 35. No history available. Temperature 103° . Pulse 140. At operation, appendix felt buried in posterior wall of cæcum. Drainage only. Temperature normal 11th day. Re-admitted 7 months later. Since operation has had no

symptoms. At second operation the appendix was retrocæcal and adherent to the cæcum, only the proximal 1 in. remained, the rest being converted into a fibrous cord. Apart from thickening of its wall, there was no sign of recent inflammation. This wound was not drained superficially and infection occurred on the 4th day. Temperature normal again 7th day. It is important to drain the second wound owing to latent infection in the abdominal wall.

2. H.M., male, 55. Three weeks' history of abdominal pain, at first in umbilical region but for the last 10 days continuous pain in the R.I.F. Occasional vomiting. Temperature 99.4°. Pulse 90. Tenderness and swelling felt in the R.I.F. At operation appendix not seen but on dissection behind cæcum pus was suddenly encountered. Retrocæcal and superficial wound drainage. Temperature normal on 7th day. Readmitted 7 months later. He had no trouble at all except occasional vague pain in the region of wound. At the second operation appendix was found to be retrocæcal and scarcely bound down by adhesions at all, lying free and quite readily removed. Wound drained superficially. No infection.

3. S.C., male, 26. 7 years' history of abdominal pain "off and on," usually beginning around the umbilicus and then becoming localized to the R.I.F. No nausea and no vomiting. 17 days' ago onset of colicky abdominal pain. Temperature 98.8°. Pulse 96. Much hyperæsthesia. Rovsing's sign very marked. Tender, inflammatory mass felt in R.I.F. At operation appendix retrocæcal and completely buried in wall of cæcum. Small abscess cavity. Retrocæcal drainage. Superficial wound drain. Temperature normal 4th day. Readmitted 6 months later. At second operation appendix retrocæcal, lying free and quite readily removed.

4. N.N., female, 13. Two days' history of pain in epigastrium and right loin, with vomiting. Temperature 101.6°. Pulse 128. Marked tenderness R.I.F. and right loin. At operation cæcum very high. Appendix retrocæcal and buried in wall of cæcum. Drainage only. Wound infected in spite of superficial drain. Temperature normal 21st day. Readmitted 8 months later. Since operation has had occasional dull pain in right side. At the second operation the appendix found densely adherent to posterior wall of cæcum, which was accidentally opened and sutured. Superficial wound drain. Uneventful recovery.

5. L.H., female, 40. Several days' history of dull aching pain in right side. Nausea. No vomiting. Temperature 100.4°. Pulse 92. Tender mass felt in R.I.F. At operation appendix not found. Retrocæcal abscess drained. Wound not drained. Superficial infection of wound. Temperature normal 7th day. Readmitted 4 years later. Since operation has had attacks of sharp, burning pain in R.I.F. spreading to middle of abdomen. Has vomited on numerous occasions. There was marked tenderness on pressure in R.I.F. At the second operation (Mr. K. L. James) fibrosed, rather conical appendix 2 in. long, lying behind the cæcum, but not deeply buried in its wall.

(c) Pelvic Appendicitis with Suppuration. (6 cases.)

Four of these cases were children aged 7, 8, 9 and 13 years respectively. Lower abdominal pain increasing in severity had been present from 4 to 7 days. One boy, aged 13, complained that the pain was referred to the tip of the penis. Sore throat, headache and vomiting were prominent symptoms. The bowels were inclined to be loose and sudden diarrhoea may follow a period of intense constipation. All four children were extremely ill on admission, their condition was

aptly described as the "Typhoid state." They lay quite still in bed with flushed cheeks, furred tongue and offensive breath. The temperature varied from 100.8° to 102.4° and the pulse rate from 114 to 134. Respiratory movement was absent in the lower abdomen and some central distension may be present. Exquisite tenderness was present and perhaps more marked on the right side but frequently more or less generalized. Increased resistance or true rigidity was present over a similar area. Rectal examination was extremely painful and a tender indurated mass may be palpated. Examination of the chest in children often reveals the presence of râles, especially at the bases of the lungs.

In female children difficulty is experienced in distinguishing these cases from a primary pneumococcal peritonitis. Here the history is shorter and the onset as a rule more sudden with often a rigor. The patient may exhibit a fairly characteristic pneumonia aspect with cyanosis, rapid respiration rate, working alæ nasi and sordes. Pneumococcal peritonitis, as a rule, lacks the tenderness and resistance or rigidity of appendicitis and the patient is much more ill than the abdominal signs would indicate. The rectum may be "ballooned" and there is tenderness, but this is not so marked as in pelvic appendicitis and a "mass" is never palpable except in the more chronic types.

Both adult cases were females, aged 48. They were not so ill and the temperatures were below 100° . One was definitely tender on palpation through the right lateral vaginal fornix. In the other case with a 4 days' history, a tender indurated mass was felt through the rectal wall.

Treatment. In female children, where the diagnosis is doubtful, peritoneal puncture under local anæsthesia with a lumbar puncture needle and stilette has been advocated. A small mid-line incision under gas and oxygen may be preferred. If the characteristic yellowish-green odourless pus is obtained, pneumococcal peritonitis can be diagnosed and confirmed immediately by bacteriological examination. If a small incision has been made, a drainage tube may be quickly inserted into the pelvis. Where the diagnosis of pelvic appendicitis is reasonably certain and especially if a "mass" can be palpated on pelvic examination, the author recommends a right paramedian incision. Pelvic drainage is instituted through a stab incision over the inner part of the left rectus. As a rule, the temperature does not reach normality until between the 10th and 21st days.

The following are illustrative cases:—

1. H.P., female, 8. Seven days before admission pain in lower abdomen, below umbilicus. The pain disappeared, but it returned, and became much worse. Head-ache, vomiting and diarrhoea. Similar attacks three months ago. Temperature 101.6° . Pulse 120. Flushed, ill-looking child. General tenderness more marked in the right iliac fossa. P.R. very tender. Operation 4.11.35. Right paramedian incision. Pelvis full of pus, gangrenous perforated appendix, which, on section, showed areas of gangrenous mucosa. Examination of pus showed *B. coli* and streptococcus non-hæmolyticus. Drainage and *B. Welchii* serum. Infection of wound occurred about 6th day. **Recovery.**

2. D.H., male, 13. Four days' history of vague abdominal pain and "bilious" vomiting which increased in severity, and became localized to the hypogastrium. Bowels confined for 36 hours, and then sudden passage of loose stools. There was some frequency and urgency of micturition. Pain was referred to the tip of the penis. Pain became generalized on the second day and has been becoming increasingly violent. No vomiting, bowels inclined to be loose. Temperature 101.2°. Pulse 134. Child extremely ill, tongue very coated and furred and breath offensive. Exquisite tenderness all over abdomen. P.R. extremely painful, marked tenderness. Operation 18.9.33. Battle's incision, abdominal wall oedematous. Generalized peritonitis with free pus. Appendix in pelvis, extremely swollen, terminal half gangrenous and perforated. Pus sucked out and appendix removed. Supra-pubic drain and superficial wound drainage. B. Welchii serum was given and Mercurochrome intravenously 10 c.c. of an 0.5% solution. Pus contained B. coli and Streptococcus non-hæmolyticus. On section appendix showed a sharp line of demarcation between the gangrenous distal part and the unaffected proximal part, where a small piece of faecal matter was seen obstructing the lumen. Temperature normal on the 18th day. Discharged 33 days after operation.

3. A.R., female, 48. Four days before admission seized with sudden acute pain at tea, in the upper abdomen, accompanied by much vomiting and diarrhoea. Pain radiated downwards and round to the back. Vomiting continued, but became less frequent. On admission the pain had disappeared. She had had similar attacks one year and two years ago during the same month, and in the same week during the month, the first attack lasting two days and the second three days. Micturition normal. Temperature 99.8°. Pulse 98. Tongue coated, abdomen distended, especially the lower quadrant. General increased resistance, particularly on right side. P.R. tender, hard, indurated mass felt. Operation 8.12.35. Right paramedian incision. Free pus in pelvis, perforated gangrenous pelvic appendix. Pelvic drainage, B. Welchii serum. Recovery. Discharged well on 16th day.

IV. SECONDARY OPERATIONS.

There were 4 cases in the series in which a second operation was necessary. Two were for empyemata, one being secondary to a subphrenic abscess. The other was a child of 5 who developed bilateral empyemata. These two cases have already been described.

Operation for Mechanical Obstruction. The following is an illustrative case:—

F.A., male, 50. History of 40 hours of sudden dull pain in epigastrium, increasing in severity, and passing to the right iliac fossa. No nausea and no vomiting, bowels had not been opened for 2 days. Temperature 98.2°. Pulse 84. Operation, 24.4.32. Grid-iron incision, appendix retrocaecal and gangrenous. Suprapubic drain. Wound became infected, and a rigid tube was placed, without permission, through the incision into the abdominal cavity, three days after operation. Subsequent to this, obstruction occurred and the abdomen was re-opened on May 6th, 1932, through a right paramedian incision under spinal percaïne. There were adhesions between two loops of small bowel which were separated. Recovery was uneventful. He was readmitted a year later, 31.1.33, with a 5 days' history of vomiting, pain, and constipation, which were relieved by an enema 2 days ago, but he had had no action since. Complete recovery occurred on fluid diet and repeated enemata.

Operation for Secondary Peritoneal Infection. The following is an illustrative case:—

G.S., male, 37. Twelve months' history of attacks of colicky abdominal pain every few days, sometimes settling in the right iliac fossa, sometimes in the hypogastrium. At first occasional vomiting. Usually constipated. During last 4 days had diarrhoea, and 2 hours before admission very violent pain low down in the abdomen, rather towards the right side which doubled him up. Temperature 99.4° Pulse 84. Micturition normal. Examination revealed an oval swelling 2 in. x 1 in. lying obliquely about 1 in. above outer part of Poupart's ligament, but only slightly tender. Rectal examination negative. Operation 13.11.33. Grid-iron incision, appendix very adherent to the iliac vessels, and separated with great difficulty through this incision. The abdomen was closed without drainage: the wound was drained superficially. Four days after operation he complained of flatulence and pain in the lower abdomen. Bowels had not been opened for 3 days. Pain referred to the penis and right testicle. 2 days later a rigor occurred. Temperature 102°. Pulse 128. Abdomen distended in its lower part. Tender and rigid in the right iliac fossa. Rectal examination—tender in the recto-vesical pouch, boggy rectal mucosa, no mass felt. Turpentine enema with no relief. Operation 19.11.33. Spinal percaine, 12 c.c. 1/1500. Battle's incision; free pus, gut distended and inflamed. Drainage tubes: (1) Through mid-line stab into pelvis. (2) Superficial drain. Pus showed *B. coli*, non-hæmolytic streptococci and *B. Welchii*. Anti *B. Welchii* serum given and the following day a blood transfusion—1 pint. Temperature normal 4th day after operation.

This case illustrates the difficulty of removing an adherent pelvic appendix through a "grid-iron" incision. In the absence of pelvic drainage, incomplete removal may result in secondary suppuration.

SUMMARY.

1. 157 personal cases of acute appendix have been reviewed.
2. The importance of obstruction of the appendix and its associated symptomatology has been emphasized.
3. The physical signs have been shown to depend on the position of the appendix in the abdomen.
4. Perforative appendicitis has been discussed under the headings of general suppuration, local retrocæcal abscess, and pelvic appendix, with suppuration. Treatment of these cases has been briefly alluded to.
5. Secondary operations are mentioned.

My best thanks are due to the Nursing Staffs, House-Surgeons and dressers, who have so ably assisted me with the note-taking and the care of the patients on whom this paper is based.

REFERENCES.

- (1) Morley, John, *Abdominal Pain*, Edinburgh, 1931, p.112.