The vermiform appendix

Anatomy

It is a blind muscular tube with mucosal, submucosal, muscular and serosal layers. Morphologically, it is the undeveloped distal end of the large caecum found in many lower animals. At birth, the appendix is short and broad at its junction with the caecum, but differential growth of the caecum produces the typical tubular structure by about the age of 2 years. During childhood, continued growth of the caecum commonly rotates the appendix into a retrocaecal but intraperitoneal position. In approximately a quarter of cases, rotation of the appendix does not occur resulting in a pelvic, suhcaecal or paracaecal position. Occasionally, the tip of the appendix becomes extraperitoneal lying behind the caecum or ascending colon. Rarely, the caecum does not migrate during development to its normal position in the right lower quadrant of the abdomen. In these circumstances the appendix can be found near the gall bladder or, in the case of situs inversus viscerum, in the left iliac fossa causing diagnostic difficulty if appendicitis develops.

The position of the base of the appendix is constant, being found at the confluence of the three taeniae coli of the caecum which fuse to form the outer longitudinal muscle coat of the appendix. The mesentery of the appendix or mesoappendix arises from the lower surface of the mesentery of the terminal ileum, and itself is subject to great variation. The appendicular artery, a branch of the lower division of the ileocolic artery, passes behind the terminal ileum to enter the mesoappendix a short distance from the base of the appendix. It then comes to lie in the free border of the mesoappendix. An accessory appendicular artery may be present but, in most people, the appendicular artery is an 'end-artery', thrombosis of which results in necrosis of the appendix (syn. gangrenous appendicitis). Four, six or more lymphatic channels traverse the mesoappendix to empty into the ileocaecal lymph nodes.

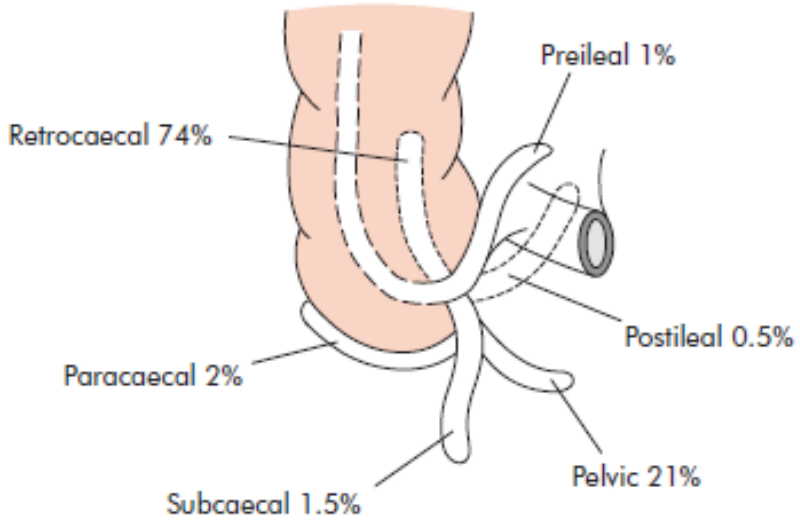


Figure 67.1 The various positions of the appendix (after Sir C. Wakeley, London, formerly PRCS).

Microscopic anatomy

The appendix varies considerably in length and circumference. The average length is between 7.5 and 10 cm. The lumen is irregular, being encroached upon by multiple longitudinal folds of mucous membrane lined by columnar cell intestinal mucosa of colonic type. Crypts are present but are not numerous. In the base of the crypts lie argentaffln cells (Kultschitzsky cells) which may give rise to carcinoid tumours. The appendix is the most frequent site for carcinoid tumours which may present with appendicitis due to occlusion of the appendiceal lumen.

The submucosa contains numerous lymphatic aggregations or follicles. The prominence of lymphatic tissue in the appendix of young adults seems important in the aetiology of appendicitis.

Acute appendicitis

Acute appendicitis is relatively rare in infants, and becomes increasingly common in childhood and early adult life, reaching a peak incidence in the teens and early 20s. After middle age the risk of developing appendicitis in the future is quite small. The incidence of appendicitis is equal amongst males and females before puberty. In teenagers and young adults the male:female ratio increases to 3:2 at the age of 25 years, thereafter the greater incidence in males declines.

Aetiology

- There is no unifying hypothesis regarding the aetiology of acute appendicitis.
- While appendicitis is clearly associated with bacterial proliferation within the appendix, no single organism is responsible, indeed a mixed growth of aerobic and anaerobic organisms is usual. The initiating event causing bacterial proliferation is controversial.
- Obstruction of the appendix lumen has been widely held to be important, and indeed some form of luminal obstruction by either a faecolith or stricture is found in the majority of cases.
- Obstruction of the appendiceal orifice by tumour, particularly carcinoma of the caecum, is an occasional cause of acute appendicitis in middle age and the elderly. Intestinal parasites, particularly **Oxyuris vermicularis**, can proliferate in the appendix and occlude the lumen.

Pathology

Obstruction of the appendiceal lumen seems to be essential for development of appendiceal gangrene and perforation. Once obstruction occurs, continued mucus secretion and inflammatory exudation increase intraluminal pressure, obstructing lymphatic drainage. Oedema and mucosal ulceration develop with bacterial translocation to the submucosa. Resolution may occur at this point either spontaneously or in response to antibiotic therapy. Where the condition progresses, further distension of the appendix may cause venous obstruction and ischaemia of the appendix wall. With ischaemia, bacterial invasion occurs through the muscularis propria and submucosa producing acute appendicitis. Finally, ischaemic necrosis of the appendix wall produces gangrenous appendicitis, with free bacterial contamination of the peritoneal cavity. Alternatively, the greater omentum and loops of small bowel become adherent to the inflamed appendix, walling off the spread of peritoneal contamination

resulting in a phlegmonous mass or paracaecal abscess. Rarely, appendiceal inflammation resolves leaving a distended mucus-filled organ termed a mucocele of the appendix.

It is the potential for peritonitis that is the great threat of acute appendicitis. Peritonitis occurs as a result of free migration of bacteria through an ischaemic appendicular wall, through frank perforation of a gangrenous appendix or delayed perforation of an appendix abscess. Factors which promote this process include extremes of age, immunosuppression, diabetes mellitus, faecolith obstruction of the appendix lumen, a free-lying pelvic appendix and previous abdominal surgery which limits the ability of the greater omentum to wall off the spread of peritoneal contamination. In these situations a rapidly deteriorating clinical course is accompanied by signs of diffuse peritonitis and systemic sepsis syndrome.

Risk factors for perforation of the appendix

- **Extremes of age**
- **Immunosuppression**
- **Diabetes mellitus**
- **Faecolith obstruction**
- **Pelvic appendix**
- **Previous abdominal surgery**

Clinical diagnosis — history

The classical features of acute appendicitis begin with poorly localised colicky abdominal pain. This is due to midgut visceral discomfort in response to appendiceal inflammation and obstruction. The pain is frequently first noticed in the periumbilical region and is similar to, but less intense than, the colic of small bowel obstruction. Central abdominal pain is associated with anorexia, nausea and usually one or two episodes of vomiting which follow the onset of pain. Anorexia is a useful and constant clinical feature, particularly in children. The patient often gives a history of similar discomfort which settled spontaneously.

With progressive inflammation of the appendix, the parietal peritoneum in the right iliac fossa becomes irritated producing more intense, constant and localised somatic pain which begins to predominate. This is often reported by the patient as an abdominal pain which has shifted and changed in character. Typically, coughing or sudden movement exacerbates the right iliac fossa pain.

The classical visceral—somatic sequence of pain is present in only about half those patients subsequently proven to have acute appendicitis. Atypical presentations include pain which is predominantly somatic or visceral and poorly localised. Atypical pain is more common in the elderly in whom localisation to the right iliac fossa is unusual. An inflamed appendix in the pelvis may never produce somatic pain involving the anterior abdominal wall, but may instead cause suprapubic discomfort and tenesmus. In this circumstance, tenderness may only be elicited on rectal examination and is the basis for the recommendation that a rectal examination should be performed on every case of lower abdominal pain.

During the first 6 hours there is rarely any alteration in temperature or pulse rate. After that time, slight pyrexia (37.2—37.70C) with corresponding increase in the pulse rate to 80 or 90 is usual. However, in 20 per cent of

cases there is no pyrexia or tachycardia in the early stages. In children a temperature greater than 38.5C suggests other causes, for example mesenteric adenitis.
Typically, two clinical syndromes of acute appendicitis can be discerned, acute catarrhal (nonobstructive) appendicitis and acute obstructive appendicitis. The latter is characterised by a much more acute course. The onset of symptoms is abrupt and there may be generalised abdominal pain from the start. The temperature may be normal and vomiting is common, so that the clinical picture may mimic acute intestinal obstruction. Once recognised, urgent surgical intervention is required because of the more rapid progression to perforation.

Symptoms of appendicitis
- **Peri-umbilical colic**
- **Pain shifts to the right iliac fossa**
- **Anorexia**
- **Nausea**

Clinical diagnosis — signs
The diagnosis of appendicitis rests more on thorough clinical examination of the abdomen than on any aspect of the history or laboratory investigation. The cardinal features are those of an unwell patient with low grade pyrexia, *localised abdominal tenderness, muscle guarding and rebound tenderness*. Inspection of the abdomen may show limitation of respiratory movement in the lower abdomen. The patient is then asked to point to where the pain began and to where it moved (*the pointing sign*). Gentle superficial palpation of the abdomen, beginning in the left iliac fossa moving anticlockwise to the right iliac fossa, will detect muscle guarding over the point of maximum tenderness, classically McBurney point. Asking the patient to cough or gentle percussion over the site of maximum tenderness will elicit rebound tenderness.
Deep palpation of the left iliac fossa may cause pain in the right iliac fossa *(Rovsing's sign)*, which is helpful in supporting a clinical diagnosis of appendicitis. Occasionally an inflamed appendix lies on the psoas muscle and the patient, often a young adult, will lie with the right hip flexed for pain relief *(the psoas sign)*. Spasm of the obturator internus is sometimes demonstrable when the hip is flexed and internally rotated. If an inflamed appendix is in contact with the obturator internus, this manoeuvre will cause pain in the hypogastrium *(the obturator test)*. Cutaneous hyperaesthesia may be demonstrable in the right iliac fossa, hut is rarely of diagnostic value.

Clinical signs in appendicitis
- **Pyrexia**
- **Localised tenderness in the right iliac fossa**
- **Muscle guarding**
- **Rebound tenderness**

Signs to elicit in appendicitis

- **Pointing sign**
- **Rovsing's sign**
- **Psoas sign**
- **Obturator sign**

The Alvarado (MANTRELS) score

Symptoms	**Score**
Migratory RIF pain	1
Anorexia	1
Nausea and vomiting	1
Signs	
Tenderness (RIF)	2
Rebound tenderness	1
Elevated temperature	1
Laboratory	
Leucocytosis	2
Shift to left	1
Total	10

Special features, according to position of the appendix

Retrocaecal

Rigidity is often absent and even on deep pressure tenderness may he lacking (silent appendix), the reason being that the caecum, distended with gas, prevents the pressure exerted by the hand from reaching the inflamed structure. However, deep tenderness is often present in the loin, and rigidity of the quadratus lumborum may he in evidence. Psoas spasm, due to the inflamed appendix being in contact with that muscle, may be sufficient to cause flexion of the hip joint. Hyperextension of the hip joint may induce abdominal pain when the degree of psoas spasm is insufficient to cause flexion of the hip.

Pelvic

Occasionally early diarrhoea results from an inflamed appendix being in contact with the rectum. When the appendix lies entirely within the pelvis there is usually complete absence of abdominal rigidity, and often tenderness over McBurney's point is lacking as well. In some instances deep tenderness can he made out just above and to the right of the symphysis pubis. In either event, a rectal examination reveals tenderness in the rectovesical pouch or the pouch of Douglas, especially on the right side. Spasm of the psoas and obturator internus muscles may he present when the appendix is in this

position. An inflamed appendix in contact with the bladder may cause frequency of micturition.

Post ileal

Here the inflamed appendix lies behind the terminal ileum. It presents the greatest difficulty in diagnosis because the pain may not shift, diarrhoea is a feature and marked retching may occur. Tenderness, if any, is ill-defined, although it may he present immediately to the right of the umbilicus.

Special features, according to age

Infants

Appendicitis is relatively rare in infants under 36 months of age and for obvious reasons the patient is unable to give a history. Because of this, diagnosis is often delayed and thus the incidence of perforation and postoperative morbidity is considerably higher than in older children. Diffuse peritonitis can develop rapidly due to the underdeveloped greater omentum, which is unable to give much assistance in localising the infection.

Children

It is rare to find a child with appendicitis who has not vomited. Children with appendicitis usually have complete aversion to food. In addition, they do not sleep during the attack and very often bowel sounds are completely absent in the early stages.

The elderly

Gangrene and perforation occur much more frequently in elderly patients. Elderly patients with lax abdominal walls or obesity may harbour a gangrenous appendix with little evidence of it, and the clinical picture may simulate subacute intestinal obstruction. These features coupled with coincident medical conditions produce a much higher mortality for acute appendicitis in the elderly.

The obese

Obesity can obscure and diminish all the local signs of acute appendicitis. Delay in diagnosis coupled with the technical difficulty of operating in the obese make it wiser to consider operating through a midline abdominal incision

Pregnancy

Appendicitis is the most common extra uterine acute abdominal condition in pregnancy with a frequency of from one in 1500 to one in 2000 pregnancies. Diagnosis is complicated by delay in presentation; early nonspecific symptoms are often attributed to the pregnancy, and the changing location of the appendix during pregnancy. As pregnancy develops during the second and third trimesters, the caecum and appendix are progressively pushed to the right upper quadrant of the abdomen. This displacement can result in flank or back pain, and may be confused with pyelonephritis, while lower abdominal pain may be confused with torsion of an ovarian cyst. Foetal loss occurs in 3—5 per cent of cases, increasing to 20 per cent if perforation is found at operation.

Differential diagnosis

The differential diagnosis differs in patients of different ages and in adult life, females have the added differential of diseases of the female genital tract.

Differential diagnosis in Children

1) In acute gastroenteritis there is intestinal colic together with diarrhoea and vomiting, but localised tenderness does not usually occur. There is often a history of other family members being affected. Post ileal appendicitis may mimic this condition, thus hospital admission and careful observation are warranted. Where serious doubt persists laparoscopy or surgical exploration may be indicated**.**

2) ***In mesenteric lymphadenitis***, the pain is colicky in nature and the patient may be completely free from pain between attacks, which last for a few minutes. Cervical lymph nodes may be enlarged. If present, shifting tenderness when the child turns on to his or her left side is convincing evidence. The condition presents a common diagnostic difficulty in children and if doubt exists exploration is advisable.

3) It may be impossible clinically to distinguish ***Meckel's diverticulitis*** from acute appendicitis. The pain is similar, however signs may be central or left-sided. Occasionally, there is a history of antecedent abdominal pain or anaemia.

4) intussusception. Appendicitis is uncommon before the age of 2 years, whereas the median age for intussusception is 18 months. A mass may be palpable in the right lower quadrant and the preferred treatment of intussusception is reduction by careful barium enema.

5) Henoch—Schönlein purpura

This is often preceded by a sore throat or respiratory infection. Abdominal pain can be severe and be confused with intussusception or appendicitis. There is nearly always an ecchymotic rash, typically affecting the extensor surfaces of the limbs and on the buttocks. The face is usually spared. The platelet count and bleeding time are within normal limits.

6) Lobar pneumonia and pleurisy

Lobar pneumonia and pleurisy, especially at the right base, may give rise to right-sided abdominal pain and mimic appendicitis. Abdominal tenderness is minimal, pyrexia is marked and chest examination may reveal a pleural friction rub or altered breath sounds on auscultation. A chest radiograph is diagnostic.

Differential diagnosis in Adults

1) Terminal ileitis

In its acute form terminal ileitis may be indistinguishable from acute appendicitis unless a doughy mass of inflamed ileum can be felt. An antecedent history of abdominal cramping, weight loss and diarrhoea suggests regional ileitis rather than appendicitis. The ileitis may be nonspecific, due to Crohn's disease or Yersinia infection. Yersinia enterocolitica causes inflammation of the terminal ileum, appendix and caecum with mesenteric adenopathy. If suspected, serum antibody titres are diagnostic and treatment with intravenous tetracycline antibiotic is appropriate. If Yersinia infection is suspected at operation, a mesenteric

lymph node should be excised, divided, and half submitted for microbiological culture (including tuberculosis) and half for histological examination.

2) Ureteric colic

Ureteric colic does not commonly cause diagnostic difficulty as the character and radiation of pain differ from those of appendicitis. Urinalysis should always be performed and the presence of red cells should prompt a supine abdominal X-ray. Renal ultrasound or an intravenous urogram is diagnostic.

3) Right-sided acute pyelonephritis

This is accompanied and often preceded by increased frequency of micturition. It may cause difficulty in diagnosis, especially in women. The leading features are tenderness confined to the loin, fever (temperature 39C), and possibly rigors and pyuria.

4) Perforated peptic ulcer

(Duodenal contents pass along the paracolic gutter to the right iliac fossa.) There is usually a history of dyspepsia and a very sudden onset of pain, which starts in the epigastrium and passes down the right paracolic gutter. In appendicitis the pain starts classically in the umbilical region. Rigidity and tenderness in the right iliac fossa are present in both conditions, but in perforated duodenal ulcer the rigidity is usually greater in the right hypochondrium. Radiography may show gas under the diaphragm.

5) Testicular torsion

Testicular torsion in a teenager or young adult male is easily missed. Pain can be referred to the right iliac fossa.

6) Acute pancreatitis

Acute pancreatitis should be considered in the differential diagnosis of all adults suspected of acute appendicitis and when appropriate excluded by serum or urinary amylase measurement.

7) Rectus sheath haematoma

This is a relatively rare but easily missed differential diagnosis. It usually presents with acute pain and localised tenderness in the right iliac fossa, often after an episode of strenuous physical exercise. Localised pain without gastrointestinal upset is the rule. Occasionally, in an elderly patient, particularly those on anticoagulant therapy, a rectus sheath haematoma may present with a mass and tenderness in the right iliac fossa following minor trauma.

Differential diagnosis in Adult females

1) Salpingitis

Typically, the pain is lower than in appendicitis and is bilateral. A history of vaginal discharge, dysmenorrhoea and burning pain on micturition are all helpful differential diagnostic points. There may be a history of contact with sexually transmitted disease. When suspected, the opinion of a gynaecologist should be obtained, and high vaginal swab taken for Chlamydia culture. When serious diagnostic uncertainty persists, diagnostic laparoscopy should be undertaken.

2) Mittelschmerz

Midcycle rupture of a follicular cyst with bleeding produces lower abdominal and pelvic pain, typically midcycle. Systemic upset is rare, pregnancy test is negative and symptoms usually subside within hours. Occasionally, diagnostic laparoscopy is required.

3) Torsion/haemorrhage of an ovarian cyst

This can prove a difficult differential diagnosis. When suspected, pelvic ultrasound and a gynaecological opinion should be sought. If encountered at operation, ovarian cystectomy should be performed, if necessary, in women of child-bearing years. Documented visualisation of the contralateral ovary is an essential medicolegal precaution.

4) Ectopic gestation

Usually there is a history of a missed menstrual period and urinary pregnancy test may be positive. Severe pain is felt when the cervix is moved on vaginal examination. Signs of intraperitoneal bleeding usually become apparent and the patient should be questioned specifically regarding referred pain in the shoulder. Pelvic ultrasonography should be carried out in all cases where an ectopic pregnancy is a possible diagnosis.

Differential diagnosis in **Elderly**

Sigmoid diverticulitis

In some patients with a long sigmoid loop, the colon lies to the right of the midline and it may be impossible to differentiate between diverticulitis and appendicitis. A trial of conservative management with intravenous fluids and antibiotics is often appropriate, with a low threshold for exploratory laparotomy in the face of deterioration or lack of clinical response.

Intestinal obstruction

The diagnosis of intestinal obstruction is usually clear. As with diverticulitis, intravenous fluids, antibiotics and nasogastric decompression should be instigated with early resort to laparotomy.

Carcinoma of the caecum

When obstructed or locally perforated, carcinoma of the caecum may mimic or cause obstructive appendicitis in adults. A history of antecedent discomfort, altered bowel habit or unexplained anaemia should raise suspicion. A mass may be palpable and barium enema or colonoscopy is diagnostic.

Investigation

The diagnosis of acute appendicitis is essentially clinical. A full blood count and urinalysis should be performed in all cases. In women of reproductive years, it is wise to obtain a urinary pregnancy test before proceeding to exploration. Pelvic ultrasound is of value in excluding tubal or ovarian disease if suspected. Abdominal ultrasound examination is a useful diagnostic tool, particularly in children, with a diagnostic accuracy of appendicitis in excess of 90 per cent.

In dehydrated or elderly patients or where comorbid conditions dictate, serum urea and electrolytes should be checked. If a diagnosis of intestinal obstruction, intussusception or ureteric colic is being entertained, a supine abdominal X-ray should be performed.

Preoperative investigations in appendicitis

Routine

- Full blood count
- Urinalysis

Selective

- Pregnancy test
- Urea and electrolytes
- Supine abdominal radiograph
- Ultrasound of the abdomen/pelvis
- Contrast-enhanced CT scan of the abdomen

Differential diagnosis of acute appendicitis

Children	Adult	Adul female	Elderly
Gastroenteritis	Regional enteritis	Mittelschmerz	Diverticulitis
Mesenteric adenitis	Ureteric colic	Pelvic inflammatory disease	Intestinal obstruction
Meckel's diverticulitis	Perforated peptic ulcer	Pyelonephritis	Colonic carcinoma
Intussusception	Torsion of testis	Ectopic pregnancy	Torsion appendix epiploicae
Henoch–Sch◌nlein purpura	Pancreatitis	Torsion/rupture of ovarian cyst	Mesenteric infarction
Lobar pneumonia	Rectus sheath haematoma	Endometriosis	Leaking aortic aneurysm

Treatment

The treatment of acute appendicitis is appendicectomy.

Mesoappendix displayed demonstrating the appendicular artery.

Appendicectomy

Appendicectomy may be performed by conventional open operation or by using laparoscopic techniques. Appendicectomy should he performed under general anaesthetic with the patient supine on the operating table. When a laparoscopic technique is to be used, a nasogastric tube should be inserted and the bladder must be empty (ensure the patient has voided before leaving

the ward). Prior to preparing the entire abdomen with an appropriate antiseptic solution, the right iliac fossa should be palpated for a mass. If a mass is felt, it may, on occasion, be preferable to adopt a conservative approach. Draping of the abdomen is in accordance with the planned operative technique, taking account of any requirement to extend the incision or convert a laparoscopic technique to open operation.

Conventional appendicectomy (keep in your mind the names of the incisions)

When the preoperative diagnosis is considered reasonably certain, the incision that is widely used for appendicectomy is the so-called **gridiron incision.** The gridiron incision is made at right angles to a line joining the anterior superior iliac spine to the umbilicus, its centre being along the line at McBurney's point

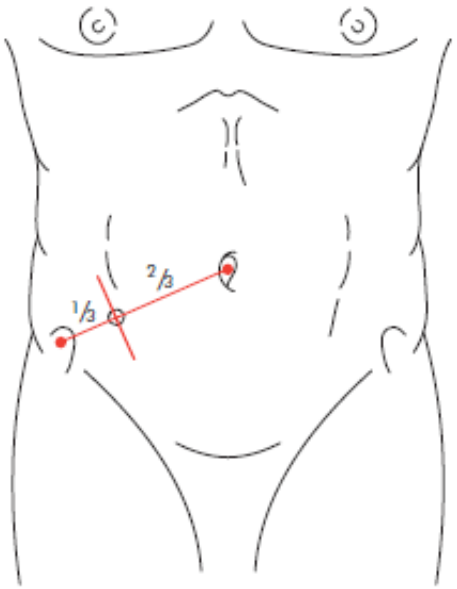


Figure 67.12 Gridiron incision for appendicitis, at right angles to a line joining the anterior superior iliac spine and umbilicus, centred on McBurney's point (courtesy of Mr M. Earley, FRSCI, Dublin, Ireland).

In the subcutaneous tissues an arterial twig from the superficial circumflex iliac artery usually requires ligation. The external oblique is incised in the line of its fibres along the length of the incision. The fibres of the internal oblique and transversus abdominis are split, and with suitable retrac-tion the peritoneum is opened. If better access is required, it is possible to convert the grid-iron to a Rutherford Morrison incision by cutting the internal oblique and transversus muscles in the line of the incision.

In recent years, a transverse skin crease **(Lanz) incision** has become more popular, as the exposure is better and extension, when needed, is easier. The incision, appropriate in length to the size and obesity of the patient, is made approximately 2 cm below the umbilicus centred on the midclavicular midinguinal line. The external oblique aponeurosis, internal oblique and transversus muscles are split in the direction of the fibres and the peritoneum

is opened. When necessary the incision may be extended medially, with retraction or suitable division of the rectus abdominis muscle.

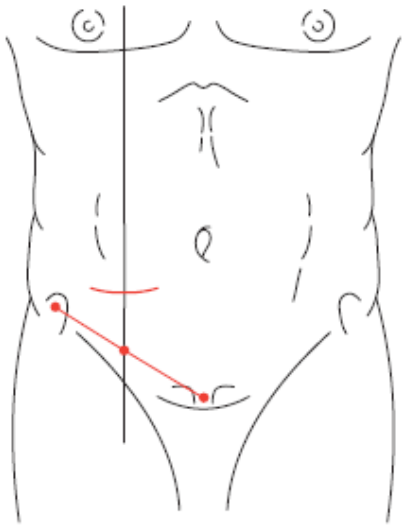


Figure 67.13 Transverse or skin crease (Lanz) incision for appendicitis, 2 cm below the umbilicus, centred on the mid-clavicular–midinguinal line (courtesy of Mr M. Earley, FRSCI, Dublin, Ireland).

When the diagnosis is in doubt, particularly in the presence of intestinal obstruction, *a lower midline abdominal incision* is to be preferred over a right lower paramedian incision. The latter, although widely practised in the past, is difficult to extend, more difficult to close and provides less good access to the pelvis and peritoneal cavity.

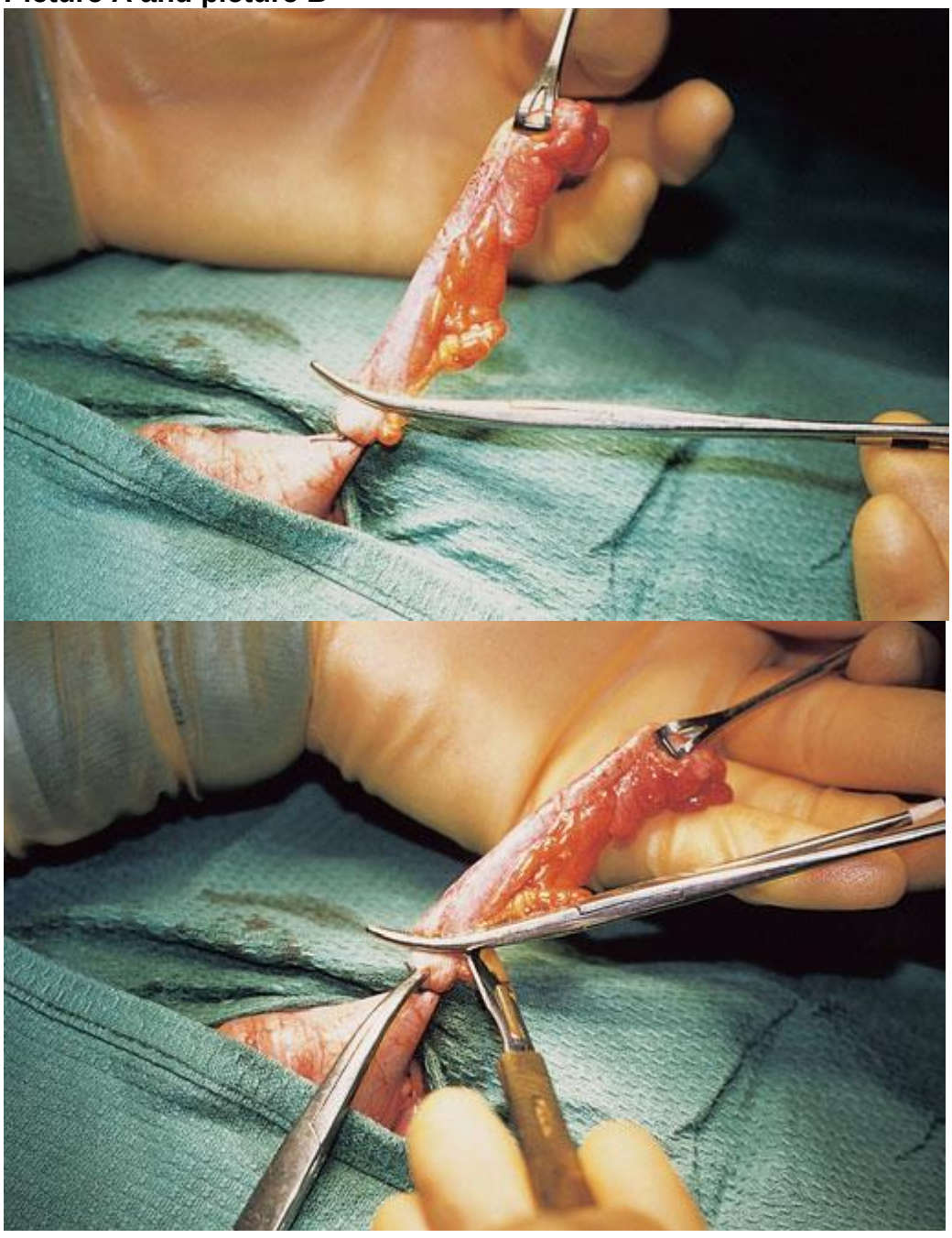
Rutherford Morrison's incision is useful if the appendix is paracaecal or retrocaecal and fixed. It is essentially an oblique muscle-cutting incision with its lower end over McBurney's point and extending obliquely upwards and laterally as necessary. All layers are divided in the line of the incision.

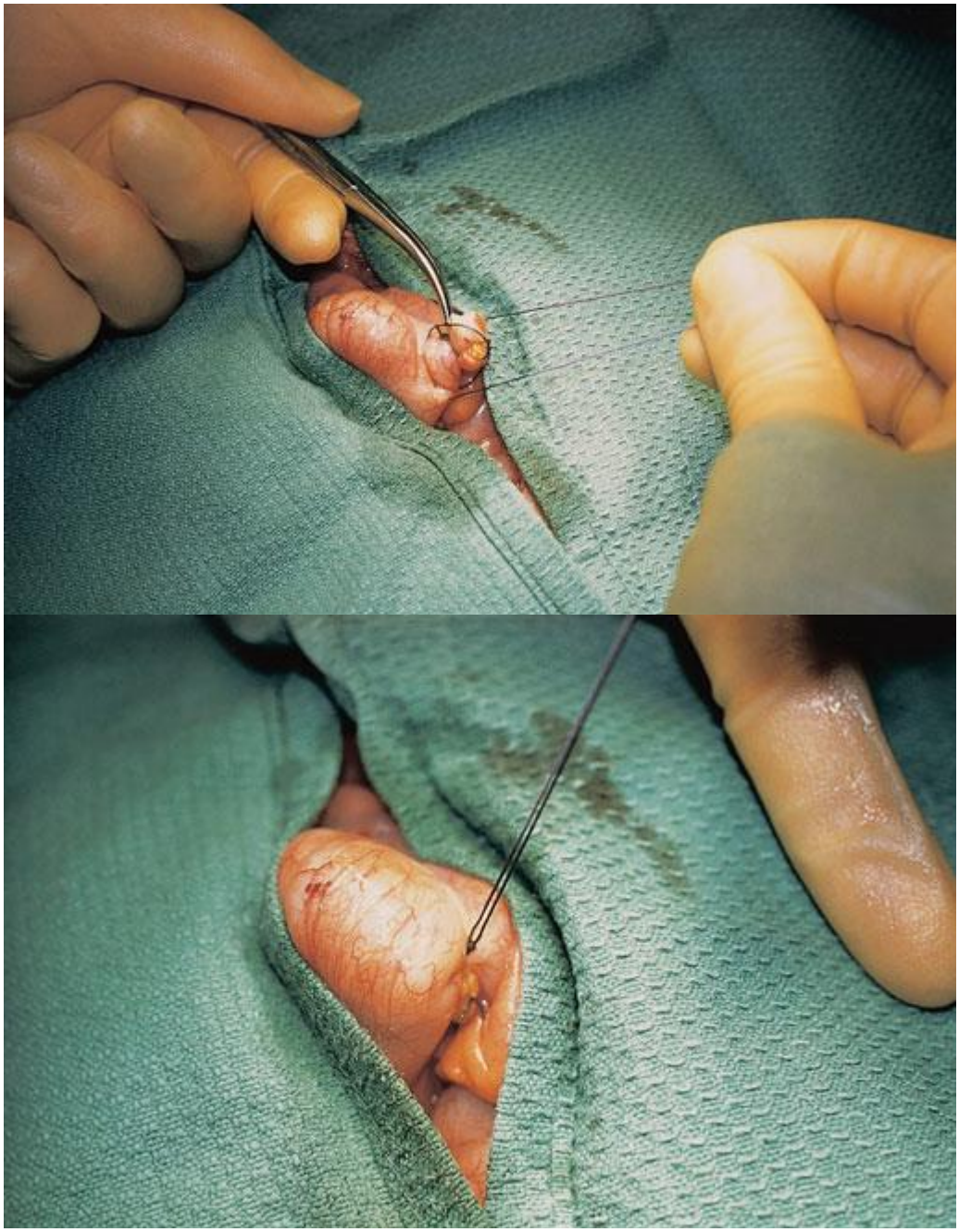
Removal of the appendix(للأطلاع)

It will be assumed that the abdomen has been opened by a skin crease incision. A retractor is placed under the medial side of the wound and the peritoneum, and the abdominal wall is elevated. Serous exudates is removed with a sucker. Pus, if present, is likewise removed having first retained a specimen for microbiological culture. The caecum is identified by the presence of teniae coli, and using a finger or a swab the caecum is withdrawn. A turgid appendix may be felt at the base of the caecum. Inflammatory adhesions must be gently broken with a finger which is then hooked around the appendix to deliver it into the wound. The appendix is conveniently controlled using a Babcock or Lane's forceps applied in such a way as to encircle the appendix and yet not damage it. The base of the mesoappendix is clamped in a haemostat, divided and ligated. When the mesoappendix is broad the procedure must be repeated with a second, or rarely, a third haemostat. The appendix, now completely freed, is crushed near its junction with the caecum in a haemostat, which is removed and reapplied just distal to the crushed portion. An absorbable 2/0 ligature is tied

around the crushed portion close to the caecum. The appendix is amputated between the haemostat and the ligature. An absorbable 2/0 or 3/0 purse-string or ‘Z’ suture may then be inserted into the caecum about 1 cm from the base. The stitch should pass through the muscle coat, picking up the taeniae coli. The stump of the appendix is invaginated while the purse-string or ‘Z’ suture is tied, thus burying the appendix stump. Many surgeons believe that invagination of the appendiceal stump is unnecessary.

Picture A and picture B





How to perform appendicectomy (a) Mesoappendix divided between artery forceps and ligated. **(b)** Appendix crushed and ligated at its base and about to be divided. **(c)** 'Z' suture inserted prior to inversion of the appendiceal stump. **(d)** Appendiceal stump inverted, the 'Z' suture having been tied.

Methods to be adopted in special circumstances(للأطلاع)

When the caecal wall is oedematous, the purse-string suture is in danger of cutting out. If the oedema is of limited extent this can be overcome by inserting the purse-string suture into more healthy caecal wall at a greater distance from the base of the appendix. Occasions may arise when, because of the extensive oedema of the caecal wall, it is better not to attempt invagination.

When the base of the appendix is inflamed, it should not be crushed but ligated close to the caecal wall just tightly enough to occlude the lumen, after

which the appendix is amputated and the stump invaginated. Should the base of the appendix be gangrenous, neither crushing nor ligation must be attempted. Two stitches are placed through the caecal wall close to the base of the gangrenous appendix, which is amputated flush with the caecal wall, after which these stitches are tied. Further closure is effected by means of a second layer of interrupted seromuscular sutures.

Retrograde appendicectomy

When the appendix is retrocaecal and adherent, it is an advantage to divide the base between haemostats. The appendiceal vessels are then ligated, the stump is ligated and invaginated, and gentle traction on the caecum will enable the surgeon to deliver the body of the appendix which is then removed from base to tip. Occasionally, this manoeuvre requires division of the lateral peritoneal attachments of the caecum.

Drainage of the peritoneal cavity

This is usually unnecessary provided adequate peritoneal toilet has been done. If, however, there is considerable purulent fluid in the retrocaecal space or the pelvis, a soft silastic drain may be inserted through a separate stab incision. The wound should be closed using absorbable sutures to oppose muscles and aponeurosis. In the presence of soiling or if a gangrenous appendix has been delivered through the wound, it is often wise to leave open or to delay primary closure by inserting a gauze wick between interrupted skin sutures.

Problems encountered during appendicectomy

• ***A normal appendix is found*** — this demands careful exclusion of other possible diagnoses, particularly terminal ileitis, Meckel's diverticulitis and tubal or ovarian causes in women. It is usual to remove the appendix to avoid future diagnostic difficulties, even though the appendix is macroscopically normal, particularly if a skin crease or gridiron incision has been made. A case can be made for preserving the macroscopically normal appendix seen at diagnostic laparoscopy, although approximately a quarter of seemingly normal appendices show microscopic evidence of inflammation.

• ***The appendix cannot be found*** — the caecum should he mobilised and the taenia coli should be traced to their confluence on the caecum before the diagnosis of 'absent appendix' is made.

• ***An appendicular tumour is found*** — small tumours (under 2.0 cm in diameter) can he removed by appendicectomy; larger tumours should he treated by a right hemicolectomy.

• ***An appendix abscess is found and the appendix cannot he removed easily*** — this should be treated by local peritoneal toilet, drainage of any abscess and intravenous antibiotics. Very rarely a caecectomy or partial right hemicolectomy is required.

• ***Appendicitis complicating Crohn's disease***

Occasionally, a patient is operated on for acute appendicitis who is found to have concomitant Crohn's disease of the ileo-caecal region. Providing the caecal wall is healthy at the base of the appendix, appendicectomy can he performed without increasing the risk of an enterocutaneous fistula. Rarely, the appendix is involved with the Crohn's disease. In this situation a conservative approach may be warranted, and a trial of intravenous

corticosteroids and systemic antibiotics used to resolve the acute inflammatory process.

Appendix abscess مهم جدا

Failure of resolution of an appendix mass or continued spiking pyrexia usually indicates that there is pus within the phlegmonous appendix mass. Ultrasound or abdominal CT scan may identify an area suitable for insertion of a percutaneous drain. Should this prove unsuccessful, laparotomy through a midline incision is indicated.

Pelvic abscess

Pelvic abscess formation is an occasional complication of appendicitis and can occur irrespective of the position of the appendix within the peritoneal cavity. The most common presentation is a spiking pyrexia several days following appendicitis; indeed the patient may have already been discharged from hospital. Pelvic pressure or discomfort associated with loose stool or tenesmus is common. Rectal examination reveals a buggy mass in the pelvis, anterior to the rectum, at the level of the peritoneal reflection. Pelvic ultrasound or CT scan will confirm. Treatment is transrectal drainage under general anaesthetic.

Management of an appendix mass مهم جدا

If an appendix mass is present and the condition of the patient is satisfactory, the standard treatment is the conservative Ochsner Sherren regimen. This strategy is based on the premise that the inflammatory process is already localised and that inadvertent surgery is difficult and may be dangerous. It may be impossible to find the appendix and, occasionally, a faecal fistula may form. For these reasons it is wise to observe a nonoperative programme, but to be prepared to operate should clinical deterioration occur.

Careful record of the patient's condition and the extent of the mass should be made, and the abdomen regularly re-examined. It is helpful to mark the limits of mass on the abdominal wall using a skin pencil. A nasogastric tube should be passed and intravenous fluid and antibiotic therapy instigated. Temperature and pulse rate should be recorded 4-hourly and a fluid balance record maintained. Clinical deterioration or evidence of peritonitis is indication for early laparotomy. Clinical improvement is usually evident within 24—48 hours at which time the nasogastric tube can be removed and oral fluids introduced. Failure of the mass to resolve should raise suspicion of a carcinoma or Crohn's disease. Using this regime approximately 90 per cent of cases resolve without incident. It is advisable to remove the appendix usually after an interval of 6—8 weeks.

Note

Criteria for stopping conservative treatment of an appendix mass

- A rising pulse rate
- Increasing or spreading abdominal pain
- Increasing size of the mass

Postoperative complications مهم جدا

Postoperative complications following appendicectomy are relatively uncommon and reflect the degree of peritonitis that was present at the time of operation and intercurrent diseases that may predispose to complications.

1) Wound infection

This is the most common postoperative complication which occurs in 5—10 per cent of all cases. This usually presents with pain and erythema of the wound on the fourth or fifth postoperative day, often soon after hospital discharge. Treatment is by wound drainage and antibiotics when required. The organisms responsible are usually a mixture of Gram-negative bacilli and anaerobic bacteria, predominantly bacteroides species and anaerobic streptococci.

2) Intra-abdominal abscess

Intra-abdominal abscess has become a relatively rare complication after appendicectomy with the use of perioperative antibiotics. Postoperative spiking fever, malaise and anorexia, developing 5—7 days after operation, suggest an intraperi-toneal collection. Interloop, paracolic, pelvic and subphrenic sites should be considered. Abdominal ultrasonography and CT scanning greatly facilitate diagnosis and allow percuta-neous drainage. Laparotomy should be considered in patients suspected to have intrabdominal sepsis in whom imaging fails to show a collection, particularly those with continuing ileus.

3) Ileus

A period of adynamic ileus is to be expected after appen-dicectomy, and may last for a number of days following removal of a gangrenous appendix. Ileus persisting for more than 4—5 days, particularly in the presence of a fever, is indicative of continuing intra-abdominal sepsis and should prompt further investigation.

4) Respiratory

In the absence of concurrent pulmonary disease, respiratory complications are rare following appendicectomy. Adequate postoperative analgesia and physiotherapy, when appropriate, reduce the incidence.

5) Venous thrombosis and embolism

These are rare after appendicectomy except in the elderly and women taking the oral contraceptive pill. Appropriate prophylactic measures should be taken in such cases.

6) Portal pyaemia (Pylephlebitis)

Pylephlebitis is a rare but very serious complication of gangrenous appendicitis associated with high fever, rigors and jaundice. It is due to septicaemia in the portal venous system and may leads to the development of intrahepatic abscesses (often multiple). Treatment is with systemic antibiotics and percutaneous drainage of hepatic abscesses as appropriate.

7) Faecal fistula

Leakage from the appendicular stump rarely occurs, but may follow if the encircling stitch has been put in too deeply or if the caecal wall was involved by oedema or inflammation. Occasionally, a fistula may result following appendicectomy in Crohn’s disease.

8) Adhesive intestinal obstruction

Adhesive intestinal obstruction is the most common late complication of appendicectomy. At operation often a single band adhesion is responsible. Occasionally, chronic pain in the right iliac fossa is attributed to adhesion formation after appendicectomy. In such cases laparoscopy is of value in confirming the presence of adhesions and allowing division.

9) Right inguinal hernia

This is said to be more common following a grid-iron incision for appendicitis due to injury to the iliohypogastric nerve.

Recurrent acute appendicitis

Appendicitis is notoriously recurrent. It is not uncommon for patients to attribute such attacks to 'biliousness' or dyspepsia. The attacks vary in intensity, may occur every few months and the majority of cases ultimately culminate in severe acute appendicitis. If a careful history is taken from patients with acute appendicitis many remember having had milder but similar attacks of pain. The appendix in these cases shows fibrosis indicative of previous inflammation. Chronic appendicitis, per se, does not exist. Patients labelled thus are usually examples of the recurrent form of the disease.

Less common pathological conditions

Mucocele of the appendix

Mucocele of the appendix may occur when the proximal end of the lumen slowly becomes completely occluded, usually by a fibrous stricture, and the pent up secretion remains sterile. The appendix is greatly enlarged and sometimes it contains several millilitres of mucus.The symptoms produced are those of mild subacute appendicitis unless infection supervenes, when the mucocele is converted into an empyema.Rupture of a mucocele of the appendix is a cause of pseudomyxoma peritonei. Occasionally, the mucocele is caused by a mucus secreting adenocarcinoma, in which case a right hemicolectomy is the correct treatment.

Diverticulae of the appendix

Diverticulosis of the appendix is relatively rare and the diverticulae may be true congenital (all coats) or acquired (no muscularis layer). The condition may occur in conjunction with mucocele, in which case the intramural pressure rises sufficiently to cause herniation of the mucous membrane through the muscle coat at several points. More often, there is no demonstrable obstruction to the lumen. The patient usually gives a history of previous recurrent attacks of appendicitis. If encountered during the course of an operation for another condition, a diverticulae-bearing appendix should be removed because of a propensity to perforate if inflamed.

Intussusception of the appendix

This is rare and occurs mostly in childhood. It can be diagnosed only at operation. The symptoms usually are not acute. Untreated, the condition may pass on to an appendiculocolic intussusception. The appendix may slough, and this accounts for most of the very rare cases in which the appendix is absent. The treatment is appendicectomy.

Neoplasms of the appendix

Carcinoid tumour (syn. argentaffinoma)

Carcinoid tumours arise in argentaffln tissue (Kultschitzsky cells of the crypts of Lieberkuhn) and are most commonly found in the vermiform appendix. Carcinoid tumour is found once in every 300—400 appendices subjected to histological examination and is 10 times more common than any other neoplasm of the appendix. In many instances the appendix had been removed because of symptoms of subacute or recurrent appendicitis. The tumour can occur in any part of the appendix, but it frequently does so in the distal third. The neoplasm feels moderately hard, and on sectioning the appendix it can be seen as a yellow tumour between the intact mucosa and the peritoneum. Microscopically, the tumour cells are small, arranged in small nests within the muscle and have a characteristic pattern using immunohistochemical stain for Chromogranin B. Unlike carcinoid tumours arising in other parts of the intestinal tract, carcinoid tumour of the appendix rarely gives rise to metastases. Appendicectomy has been shown to be sufficient treatment, unless the caecal wall is involved, the tumour is 2 cm or more in size, or involved lymph nodes are found, otherwise right hemicolectomy is indicated.

Primary adenocarcinoma

Primary adenocarcinoma of the appendix is extremely rare. It is usually of the colonic type and should be treated by right hemicolectomy (as a second-stage procedure if the condition is not recognised at the first operation).

Important subtitles

- Pathophysiology of appendicitis
- Management of appendicular mass
- Differential diagnosis of appendicitis
- Complications of appendicectomy
- Alvarado score
- Clinical features of appendicitis
- Signs of appendicitis