

The vermiform appendix (Lecture one)

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, subcaecal 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.

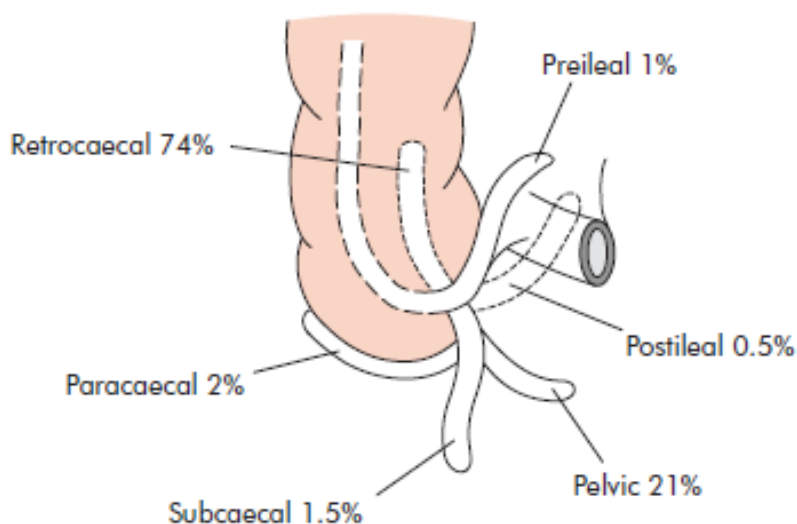


Figure 67.1 The various positions of the appendix (after Sir C. Wakeley, London, formerly PRCS).

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 argentaffin cells (Kultschitzky 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**
- **Slight pyrexia (37.2—37.70C)**
- **corresponding increase in the pulse rate to 80 or 90 is usual**

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, but 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 be 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 be 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 be 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 be 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 be 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.