

# Acute appendicitis

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## Abstract

Appendicitis is defined as inflammation of the vermiform appendix, the most common surgical emergency in children and young adults with abdominal pain. The current standard of care for patients with appendicitis is the surgical appendicectomy, either laparoscopic or open. A non-operative strategy with antibiotics is favourable in some cases and emerging evidence suggests there could be wider applicability. Diagnosis is based on history, clinical examination and laboratory tests, although 30–45% of patients exhibit atypical signs and symptoms on presentation. Where the diagnosis remains ambiguous, ultrasound and CT scans are the most widely used imaging modalities. Diagnostic laparoscopy can be a useful approach in low-risk patients, particularly young women. Appendicitis is classified into simple or complex disease, complex in the presence of a peri-appendicular abscess, gangrene or perforation. Complex appendicitis has significantly higher rates of morbidity and mortality. Limiting the progression from simple to complex disease, although not inevitable, is the rationale for early definitive treatment. An appendicectomy performed for suspected appendicitis resulting in a normal appendix on histopathological examination is referred to as a negative appendicectomy. A negative appendicectomy has a postoperative complication rate of around 10%, demonstrating the need for both accurate and timely diagnosis.

**Keywords** Appendicectomy; appendicitis; appendicular; appendix; McBurney's point; right iliac fossa pain

## Introduction

Appendicitis is defined as inflammation of the vermiform (worm-shaped) appendix, a narrow blind ending pouch approximately 5–9 cm long opening off the caecum. Appendicitis is common; over 50,000 emergency appendicectomies are performed each year in the UK.

Mortality associated with appendicitis in developed health-care settings is estimated between 0.05 and 0.25%; however, for patients presenting with perforated appendicitis and generalized peritonitis mortality remains as high as 5%. Morbidity and mortality is increased in complex appendicitis, defined as appendicitis in the presence of a peri-appendicular abscess, gangrenous or perforated appendix.<sup>1,2</sup>

## Background

The ancient Egyptians recognized the presence of the appendix during the mummification process, described as the 'worm of the

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bowel'. Early accounts of an illness suggestive of appendicitis were by Celsus and Galen in the 1st and 2nd century, it was called a 'colic passion'.<sup>3</sup>

The Italian anatomist Berengius Carpus in 1522 published the first formal description of the appendix (referred to as the 'additamentum') but it was not until 1735 whilst operating on a hernia, military surgeon Claudius Amyand documented the first appendicectomy. Amyand's hernia is now the eponymous name given to an inguinal hernia containing the appendix.

In 1880, British surgeon Lawson Tait performed the first known successful appendicectomy for suspected appendicitis. However the term appendicitis wasn't coined until the American Reginald Fitz published his landmark paper in 1886 'Perforating Inflammation of the Vermiform Appendix; With Special Reference to Its Early Diagnosis and Treatment'.<sup>3</sup>

In 1894, American surgeon Charles McBurney proposed his original approach to the open appendicectomy. Aside from a number of slight modifications, this became the standard approach for more than a century. The first laparoscopic appendicectomy was performed in 1980 by the German gynaecologist Kurt Semm. By the late 1990's the laparoscopic appendicectomy was commonplace alongside the laparoscopic cholecystectomy and remains so.

## Surgical anatomy

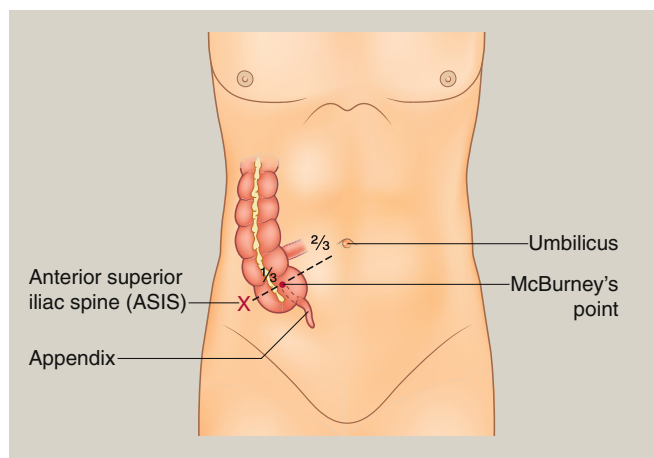
The vermiform appendix is visible as it buds off from the caecum around the 8th week of development in-utero. The appendicular lumen is narrow although in newborns and infants it is funnel shaped, which may account for the rarity of appendicitis in this age group. Similarly, in older adults the lumen may be obliterated reducing the likelihood of appendicitis.

The base of the appendix is typically found 2.5 cm inferior to the ileocaecal valve, where the three taenia coli (longitudinal ribbons of smooth muscle) converge on the surface of the caecum at the posteromedial aspect. Following the taenia coli intraoperatively is a useful strategy to help locate the appendix. McBurney's point represents the surface anatomy for the base of the appendix, a third of the distance along the line between the anterior superior iliac spine (ASIS) and the umbilicus (Figure 1).

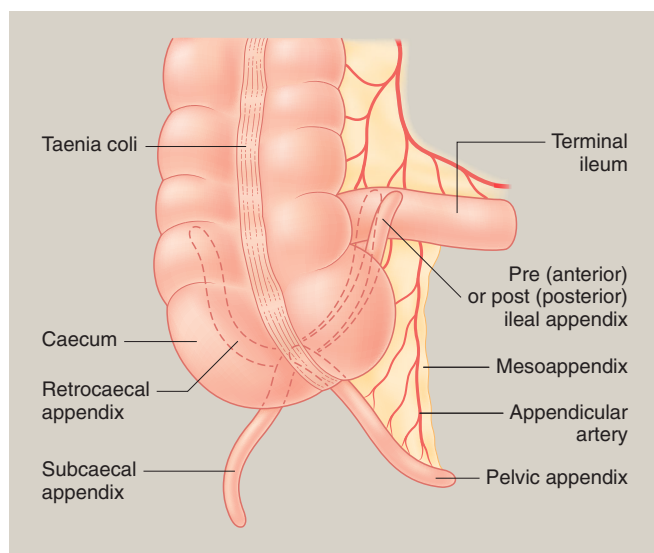
The appendix is usually 5–9 cm in length but can range from 2 cm to 25 cm. It is a relatively mobile structure and may lie in a number of orientations. This can affect the clinical presentation of appendicitis as it irritates adjacent structures (Figure 2). Although uncommon, the caecum may be aberrant through malrotation, situs inversus, adhesions or hypermobility and the appendix found in any quadrant of the abdomen (and the chest).

The appendix receives its blood supply from the appendicular artery, a branch of the ileocolic artery derived from the superior mesenteric artery. The artery travels in the lateral margin of the mesoappendix, a triangular sheet of fatty connective tissue continuous with the inferior part of the ileal mesentery (Figure 2).

Autonomic innervation of the appendix is via the ileocolic branch of the superior mesenteric plexus. Proliferation of these appendicular nerve fibres and up regulation of neuropeptides has been proposed as a non-inflammatory cause of right iliac fossa pain and called neurogenic appendicopathy.<sup>4</sup>



**Figure 1** McBurney's point, the surface anatomy representing the base of the appendix



**Figure 2** Appendix with its mesoappendix containing the appendicular artery in its lateral edge. The dotted lines depict a number of orientations the appendix is found within the population (pelvic, subcaecal, retrocaecal, pre- and post-ileal)

The histological layers of the appendix are similar to that of the colon. The outer serosal layer is a thin peritoneal covering. A muscular layer, muscularis externa, consists of inner circumferential fibres and a thin external layer of longitudinal fibres. Peristalsis of the appendix enables the expulsion of faeces from the lumen back into the caecum.

The submucosa contains connective and lymphoid tissue, and hyperplasia of the lymphoid tissue typically in response to a viral illness is one mechanism thought to cause appendicitis. The lymph tissue occludes the lumen of the appendix resulting in distension, bacterial overgrowth and infection. This is less likely in older adults as the lymphoid tissue starts to recede around puberty. The innermost lining of the appendix is the mucosa. Mucin is secreted by goblet cells in the mucosa and forms mucus. Prolonged occlusion of the appendicular lumen can result in mucus accumulating in the distal portion forming a

mucocoele. Mucocoeles are usually managed with surgical appendectomy due to the risk of underlying malignancy.

The appendix was long regarded as a vestigial structure of no real function but recent work suggests this is not the case. Unlike the colon it contains lymphoid tissue and specialized immune cells that secrete immunoglobulins, antimicrobial substances and sample antigens from the intestinal lumen. The appendix appears to have a role in priming the immune response to enteric pathogens in the colon and managing the normal bacterial flora.<sup>5</sup> It is thought the appendix may act as a reservoir for colonic bacteria (microbiome), promoting recolonization following infection with an individual's normal array of gut flora.

### Epidemiology

The lifetime incidence for appendicitis is around 7–9% with a slight male preponderance (1.4:1). It may present at any age but is most prevalent between 10 and 30 years old. Risk factors for appendicitis include exposure to smoke, repeated antibiotics, inflammatory bowel disease, cystic fibrosis and a family history of appendicitis. There is significant geographical and seasonal variability; it is more prevalent in rural areas, regions associated with low fibre diets and during the summer months. Women are more likely to undergo an appendectomy but have higher rates of negative appendectomies due to the number of potentially mimicking conditions.

### Aetiology

The pathogenesis of acute appendicitis remains unclear. Obstruction of the lumen by a faecolith (hard lump of obstructing faeces) or lymphoid tissue is thought to be the most common cause. This results in distension of the appendix, bacterial overgrowth and infection, venous and lymphatic congestion, ulceration and transmural spread of infection through the appendicular wall. The inflammation and infection may result in thrombosis of blood vessels causing ischaemia, necrosis and perforation. This proposed mechanism is challenged by research showing: acute appendicitis can occur in the presence of a patent lumen; faecoliths are equally as common in the population without appendicitis; and intra-luminal pressures are frequently normal despite acute appendicitis.<sup>6</sup>

Faecoliths, lymphoid hyperplasia, foreign bodies, malignancy (predominantly carcinoid and adenocarcinoma), parasitic and fungal infections, inflammatory bowel disease and trauma are recognized causes of appendicitis. The associated infection is multiorganism; *Escherichia coli*, *Bacteroides* and *Klebsiella* are the most prevalent bacterium cultured. The growth of *Fusobacterium* appears to be associated with a particularly aggressive process and perforated appendicitis.<sup>6</sup> For patients presenting with simple appendicitis, perforation is uncommon even if treatment is delayed for a 24–36 hour period suggesting progression from simple to complex disease is variable.<sup>7</sup>

Following perforation of the appendix intra-abdominal contamination may be contained or generalized. The defect in the appendix may seal itself off against adjacent structures forming an abscess or inflammatory mass (phlegmon). If there is widespread contamination then generalized peritonitis and sepsis develops, a potentially fatal process.

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