

Lissa C. Sakata and Lindsey Perea

Always keep it in the differential

Learning Objectives

1. The learner should be able to describe the etiology of acute appendicitis.
2. The learner should be able to formulate a differential diagnosis for right lower quadrant abdominal pain.
3. The learner should be familiar with physical “signs” specific for acute appendicitis.
4. The learner should know how to manage acute appendicitis.
5. The learner should know potential complications of acute appendicitis.

Case Scenario

A 20-year-old male with no past medical history presents to the emergency department with complaints of abdominal pain that began suddenly the night before. Initially, his pain was dull and around his umbilicus. The morning of presentation, it became sharp and located in the right lower quadrant. He complains

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of nausea and vomiting. On examination, he is afebrile with normal vital signs. He has focal tenderness to palpation in the right lower quadrant and voluntary guarding.

Epidemiology/Etiology/Pathophysiology

Acute appendicitis is the most common surgical emergency, accounting for approximately 300,000 operations annually in the USA. Appendicitis most frequently occurs during the second and third decades of life, but can occur at any age. There is a slight male predominance (1.3:1). The lifetime incidence in the USA is 8.6% for males and 6.7% for females.

Acute appendicitis occurs when there is obstruction of the appendiceal lumen. This may be secondary to a fecalith, lymphoid hyperplasia, malignancy, parasite, foreign body, or idiopathic causes. Once occluded, the appendix distends secondary to mucosal secretion which in turn limits venous return from the appendix. This leads to stasis and bacterial overgrowth in the appendiceal wall. Progressive ischemia may occur and lead to perforation of the appendiceal wall.

Differential Diagnosis

Differential diagnoses include inflammatory, gynecological, and mechanical etiologies. Inflammatory conditions include acute mesenteric adenitis, gastroenteritis, epididymitis, Meckel's diverticulitis, Crohn's disease, peptic ulcer disease, urinary tract infection, and Yersinia infection. Gynecological conditions include pelvic inflammatory disease, ruptured ovarian follicle, or ruptured ectopic pregnancy. Mechanical problems which may mimic appendicitis include testicular or ovarian torsion and intussusception.

Diagnosis

The classic presentation of acute appendicitis is dull, crampy, intermittent abdominal pain that starts in the periumbilical region. The dull intermittent pain is due to stimulation of visceral afferent nerve fibers from T8 to T10, as the appendiceal intraluminal pressure increases. Nausea, vomiting, and anorexia often accompany the abdominal pain. The pain then migrates to the right lower quadrant and becomes sharp and constant. Movement worsens the pain. The sharp, localized right lower quadrant pain is somatic and due to the inflammation of the appendiceal wall extending to the serosa and irritating the peritoneum. The classic presentation is not always present.

Physical examination is critical to the diagnosis and is used in conjunction with history and imaging. Abdominal tenderness will be at the anatomical location of the inflamed appendix.

Classically, maximal tenderness is at McBurney's point, located one-third the distance from the right anterior superior iliac spine to the umbilicus. Guarding or muscular resistance with palpation, as well as rebound tenderness when the hand is quickly removed, may be present.

Several signs exist that may help localize the location of the appendix based on examination. Rovsing's sign occurs when pain in the right lower quadrant is caused by left lower quadrant palpation. It suggests a localized peritoneal process in the right lower quadrant. The obturator sign is performed with the patient lying supine and pain is elicited with internal rotation of the flexed right hip. This suggests irritation of the obturator muscle by a low lying pelvic appendix. The psoas sign is performed with the patient lying on their left side. Pain with extension of the right thigh suggests a retrocecal appendix that is lying in contact with the iliopsoas muscle [1].

Due to differences in the location of the inflamed appendix, the clinical presentation is variable. If the appendix is retrocecal, the patient may have minimal anterior abdominal tenderness. In pregnancy, the appendix may be shifted upward, and pain elicited in the right upper quadrant. Once the appendix is ruptured, abdominal findings are more diffuse and less localized. A rectal examination should be performed, and a pelvic examination in females to rule out pelvic inflammatory disease or a pelvic mass.

Appendicitis is often associated with a low-grade fever, where a high temperature suggests a ruptured appendix or an alternative diagnosis. A mild leukocytosis may be present and associated with a left shift. A leukocytosis greater than $18,000 \text{ cells/mm}^3$ is suggestive of a perforated appendix. A normal white blood cell count does not rule out appendicitis. Urinalysis is performed to rule out urinary tract infection as a cause of symptoms. Pyuria and microscopic hematuria is common with acute appendicitis because of ureter or bladder irritation by the inflamed appendix. Bacteriuria is usually not present.

Imaging is generally unnecessary in young males with signs and symptoms consistent with appendicitis and a high clinical suspicion. The most common imaging modalities used are ultrasound and computed tomography (CT). Ultrasound is inexpensive, does not have ionizing radiation, and is readily available. Due to the operator-dependent nature of ultrasound, there is a variable sensitivity of 55–96% and specificity of 85–98%. Ultrasound findings may include a noncompressible appendix, diameter greater than 5 mm, wall thickening $>2 \text{ mm}$, hyperemic wall by Doppler, presence of a fecalith, and periappendiceal fluid. Transvaginal ultrasound may help rule out gynecological disease in female patients. CT of the abdomen and pelvis with IV and oral contrast is 92–97% sensitive and 85–94% specific. It has the advantage of improved accuracy and can identify other pathology. Oral contrast may not be tolerated in patients who are vomiting and can

be performed without. Findings may include a dilated appendix >5 mm, wall thickness ≥ 2 mm often with concentric thickening of the wall, periappendiceal fat stranding, presence of a fecalith, and periappendiceal fluid. Free air or fluid, abscess or phlegmon suggests perforation. An abscess on CT is recognized as a rim-enhancing fluid collection; this is typically accompanied by a patient history of symptoms more than 48 h. Disadvantages of CT scanning are that it is expensive, exposes the patient to radiation, and is more time-consuming than ultrasound [2].

Diagnostic laparoscopy should be performed when the diagnosis of appendicitis remains unclear. This is especially useful in women when gynecological etiologies have not been ruled out. Intraoperatively, even if a normal appendix is encountered, it is usually removed, and in the future, a diagnosis of appendicitis can be ruled out. When appendicitis is not found, it is prudent to search for other etiologies of the patient's symptoms.

Complications

Abscess may occur after appendectomy, more commonly after perforation. Patients may be ill appearing and significantly tender. A fever, leukocytosis, and abdominal pain are common findings in abscesses, but one must also consider an abscess in the differential postoperatively in patients with ileus, diarrhea, or occasionally bowel obstruction.

Management

Intravenous antibiotics covering gram-negative and anaerobic flora should be initiated upon suspicion of acute appendicitis. Laparoscopic or open appendectomy is the treatment of choice for appendicitis without abscess (Figs. 2.1, 2.2 and 2.3). Periappendiceal abscesses should be treated with ultrasound- or CT-guided percutaneous drainage and antibiotics. Smaller abscesses (<3 cm) may be treated with antibiotics alone. An interval appendectomy may be planned at a later date (8 weeks); however, recurrence rates of 4% in 5 years in larger series suggest expectant management is also acceptable.

In the patient with contained perforation particularly with cecal involvement and who does not exhibit signs of peritonitis, initial nonoperative management may be advisable until inflammation subsides as urgent surgery may lead to more extensive surgery requiring colectomy [3].

Another less common scenario involving incidental intraoperative diagnosis of Crohn's disease is worth mentioning. If gross findings of Crohn's are found at surgery intended for appendectomy (mesenteric thickening, creeping fat), then

appendectomy is necessary to avoid diagnostic confusion in the future. If the appendiceal base or cecum is involved, the appendix should be left alone as the risk of fistulization is high.

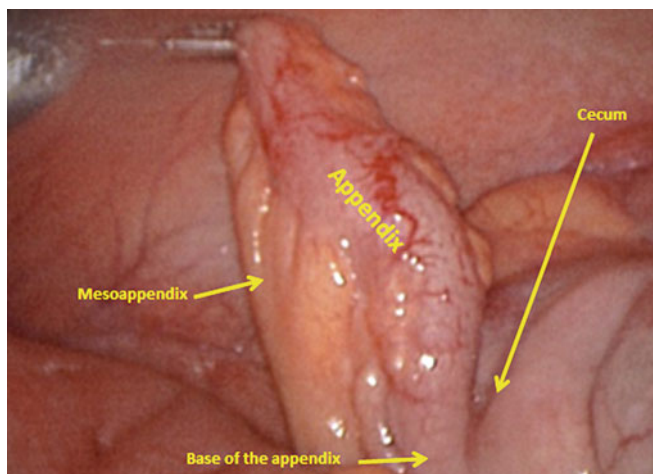
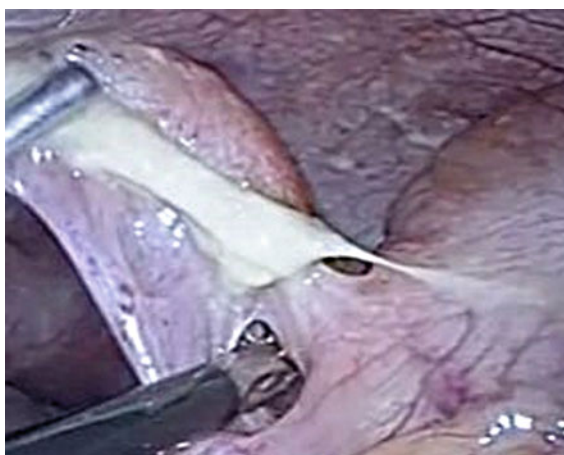


Fig. 2.1 Anatomy of the appendix. Image shows mild inflammation and congestion of the appendix. © Dale Dangleben, MD

Fig. 2.2 Laparoscopic appendectomy with fibrinous exudate. AQ window is being created through the mesoappendix at the base.
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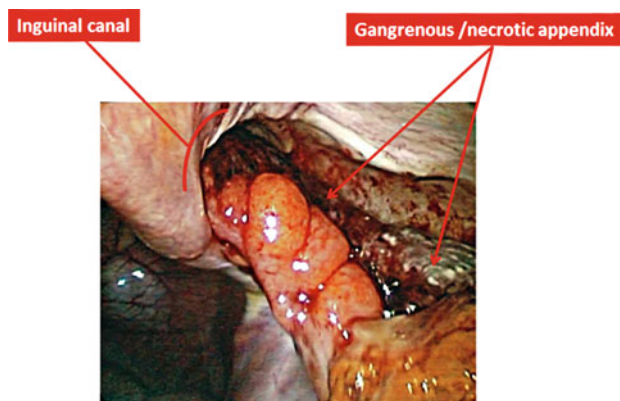


Fig. 2.3 Gangrenous appendicitis in an inguinal hernia (Amyand's hernia). © Dale Dangleben, MD

Recent large, randomized trials have questioned the traditional surgical approach and suggested a nonoperative approach for uncomplicated appendicitis. It is reasonable to individualize the decision to each patient in light of this new data, yet more studies are needed before the surgical option is no longer considered first line given the lack of long-term follow-up studies.

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