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Review Article

Overview of Appendicitis Etiology, Diagnosis and Management

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Abstract

Introduction: Appendicitis is the inflammation of the appendix, which mostly presents as an acute condition occurring within 24 hours of onset, but the chronic condition is also observed frequently. Acute appendicitis represents the most common indication of emergency nontraumatic abdominal surgery in the world. The risk of appendicitis among men is 16.33% and 16.34% in women. The annual incidence is found to be 139.54 per 100,000 people. 18.5% population is associated with overweight and 81.5% with obesity. The initial symptoms include generalized or periumbilical abdominal pain. The pain later becomes localized to the right lower quadrant of the abdomen. Appropriate findings from detailed history, physical examination and laboratory investigation aid in diagnosis and further treatment plans [4].

Aim of the Study: The aim of the present review is to understand the various etiology, histopathology, diagnosis and management of appendicitis.

Methodology: The review is a comprehensive research of PUBMED since the year 1990 to 2022.

Conclusion: In adults and children, appendicitis presents as one of the most common causes of abdominal pain. History, physical examination and laboratory investigations aid in the appropriate diagnosis of acute appendicitis. Pain in the right lower quadrant of the abdomen, along with rigidity and periumbilical pain radiating to the right lower quadrant are the best indicators for ruling disease. Physical examination may show absent or decreased bowel sounds, a positive psoas sign, an obturator sign and a Rovsing sign. The Alvarado score includes clinical and laboratory findings and categorizes patients at low, moderate, or high risk. Ultrasonography is first-line imaging; CT scans and MRI can be used. Treatment modalities mainly include open appendectomy or laparoscopic appendectomy. However, in some patients with severe infections, intravenous antibiotics are considered first-line therapy. Pain management is done using opioids and nonsteroidal anti-inflammatory drugs. The most common complication is a perforation that can lead to sepsis.

Keywords: *Appendicitis; Appendectomy; Sepsis; Psoas Sign*

Introduction

Appendix a hollow organ typically present at the tip of the cecum, in the right lower quadrant of the abdomen. However, the appendix can be present anywhere in the abdominal area depending on developmental issues such as midgut malrotation or any other conditions such as previous abdominal surgeries or pregnancy. The appendix develops in the 5th week of intrauterine life. Appendicitis is inflammation of the appendix, which mostly has an acute presentation occurring within 24 hours or may proceed to a chronic state. The presenting symptoms can be severe if there is a perforation or contained abscess [1,2].

Etiology

Obstruction of the appendiceal lumen is the major cause of appendicitis. Obstruction can be from a stone of the appendix (appendicolith) or other mechanical etiologies. Other known causes of appendiceal obstruction and appendicitis are appendiceal tumors such as carcinoid tumors, appendiceal adenocarcinoma and hypertrophied lymphatic tissue and intestinal parasites. Very commonly, the exact etiology of acute appendicitis is unknown. The appendiceal lumen obstruction leads to bacteria build-up in the appendix, causing acute inflammation. If left untreated, it may cause perforation and abscess formation. Aerobic and anaerobic bacteria such as *Escherichia coli* and *Bacteroides* species are present in the appendix. But, according to recent studies, a significantly higher number of bacterial phyla are present in patients with complicated perforated appendicitis [3].

Epidemiology

The most common occurrence of appendicitis is between the age group of 5 to 45, with a mean age of 28. A higher predisposition rate is seen among males, with an average incidence of 8.6% and 6.7% for men and women, respectively. The overall incidence is approximately 233/per 100,000 people [4].

Histopathology and pathophysiology

The pathophysiology of appendicitis likely roots in the obstruction of the appendiceal orifice. The type of obstruction might differ in the different age groups, but lymphoid hyperplasia is essential in all groups, which leads to inflammation resulting in localized ischemia which further leads to perforation and development of either a contained abscess or frank perforation with resultant peritoneal inflammation. Various causes of obstruction may be lymphoid hyperplasia, fecaliths, infections (parasitic) and benign or malignant tumors [5,6].

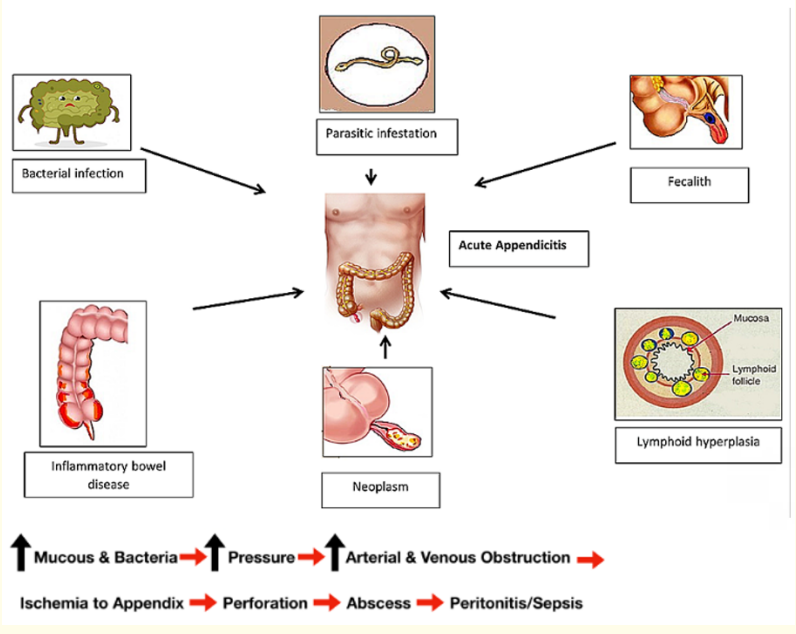

Figure 1: *Shows various etiopathology of appendicitis [7].*

Obstruction causes an increase in intramural and intraluminal pressure leading to small vessel occlusion and statis of lymphatic. After the establishment of complete obstruction, mucus fills the appendix and becomes distended; the appendix becomes ischemic and necrotic. Bacterial build-up then occurs in the obstructed appendix. Aerobic organisms predominate in the early stages and mixed aerobes and anaerobes occur later in the stage [5,6].

Common organisms include:

- *Escherichia coli*
- *Peptostreptococcus*
- *Bacteroides*
- *Pseudomonas.*

Microscopic findings in acute appendicitis are as follows: the proliferation of neutrophils is seen in muscularis propria. The inflammatory reaction and its extent are directly proportional to the duration of the disease present and the severity of the infection. With the progression of the disease, extra appendiceal fat and surrounding tissues become involved in the inflammatory process [6].

Diagnosis

History, clinical signs and symptoms

Accurate diagnosis significantly aids in decreasing morbidity and mortality from perforation and other complications. Signs and symptoms are helpful in ruling the cause and arriving at the causative factor and diagnosis. The location of the appendix is variable and hence that leads to variations in the clinical presentation, making the diagnosis a challenging task [9].

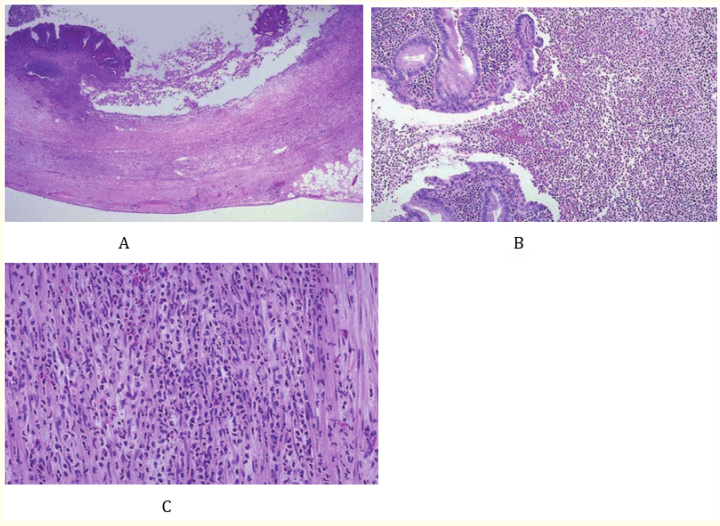

Figure 2: *Showing A. mucosal inflammation and necrosis, B. Mucosa shows ulceration and undermining by extensive neutrophilic exudates, and C. Neutrophils extend into and through the wall of the appendix [8].*

The typical symptom is initial generalized or periumbilical abdominal pain which later localizes to the right lower quadrant of the abdomen. Some uncommon presentations are pain that may have woken the patient up from sleep, pain while coughing or walking pain that may or may not be accompanied by any of the following symptoms [9]:

- Anorexia nausea/vomiting
- Diarrhea
- Fever
- Generalize malaise
- Urinary frequency or urgency [9].

Physical exam findings- in the case of early appendicitis, the signs are often subtle, but as inflammation progresses, signs of peritoneal inflammation become more evident.

Signs include [10]:

- Psoas sign - When a patient is in the left lateral decubitus position, a passive extension of the right leg causes pain. The probable reason is stretching of the psoas major muscle causes irritation to inflamed appendix over psoas muscle. The patient often gives a history of flexing the hip to shorten the psoas major muscle and relieve pain [10].
- Rebound tenderness - When the patient is asked to cough or gentle percussion done over the site of maximum tenderness causes a rebound tenderness.

- Rovsing's sign - Upon palpation of the left lower quadrant, the right lower quadrant elicits pain.
- Dunphy's sign - Increased abdominal pain is noticed while coughing.
- Obturator sign - Pain on passive internal rotation of the flexed thigh.

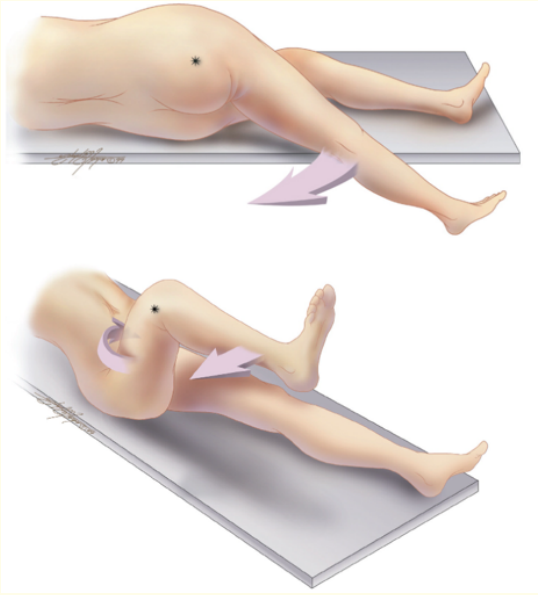

Figure 3: *Illustrate psoas sign and obturator sign [3].*

Lab testing

Laboratory tests include [11]:

- Total leucocyte count
- Neutrophil percentage
- C-reactive protein (CRP) concentration.

Results [11]:

- Increased white blood cells count (WBC) with or without a left shift (classic presentation)
- Presence of ketones found in the urine
- Elevated C-reactive protein may be elevated.

Alvarado score

This score is purely based on clinical history, signs and symptoms and laboratory tests. The scoring criteria for probable appendicitis are as follows [8].

Symptoms	Score
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/vomiting	1
Signs	
Tenderness in right iliac fossa	2
Elevated temperature	1
Rebound tenderness	1
Laboratory findings	
Leucocytosis	2
Shift to the left of neutrophils	1
Total score	10
The probability of acute appendicitis is decided by score as follows: Score < 5: Not sure. Score between 5 - 6: Compatible. Score between 6 - 9: Probable. Score > 9: Confirmed.	

Table: *Alvarado score [8].*

Imaging

Appendicitis is traditionally diagnosed clinically. However, imaging modalities are needed to rule out carcinoma and other causes of obstruction. These include a plane radiograph, abdominal CT scan, ultrasonography and MRI [12].

CT-scan

An abdominal CT scan can diagnose appendicitis with 95% of accuracy, which leads to its frequent usage. According to CT criteria for appendicitis, enlarged appendix (more than 6 mm in diameter), peri-appendiceal fat stranding, appendiceal wall thickening (more than 2 mm), presence of appendicolith and appendiceal wall enhancement should be present [13].

Ultrasonography

Abdominal ultrasonography is one of the commonly used primary imaging modalities used to evaluate patients presenting with acute abdominal pain. A specific index of compressibility is used to come to a diagnosis of appendicitis that includes a diameter of less than 5 mm to exclude appendicitis. According to other evidence, the criteria for having acute appendicitis include the presence of an appendicolith, an anteroposterior diameter of more than 6 mm and an increased echogenicity of the peri-appendiceal fat. One of the major drawbacks related to sonography is in obese patients and the operator variability [13].

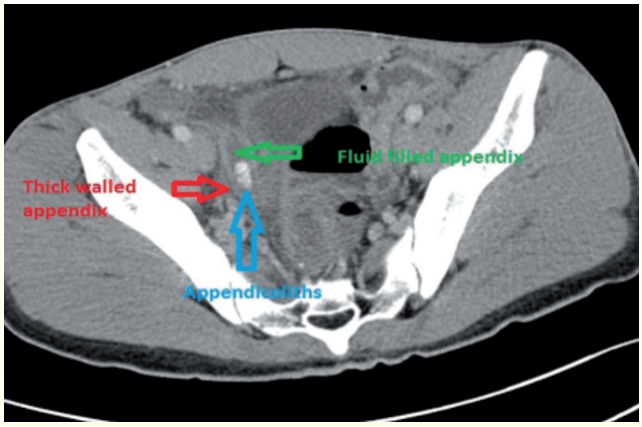

Figure 4: *Showing typical CT scan findings of appendicitis [8].*

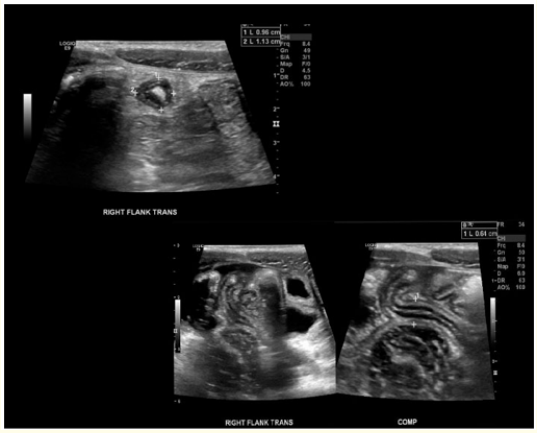

Figure 5: *Shows a blind-ending tubular structure of up to 7 mm in diameter in ultrasound of the right lower quadrant suggestive of acute appendicitis [12].*

MRI

MRI exhibits high sensitivity and specificity, but an abdominal MRI is an expensive modality and demands precision and clinical experience to interpret the results. Therefore, MRI is indicated in special groups of patients, such as pregnant women, where radiation exposure from CT scans is not advisable [13].

Treatment

The following modalities are present for the treatment of appendicitis [8]:

- Open appendicectomy
- Laparoscopic appendicectomy
- Conservative management
- Management of complications.

Appendicectomy

Incision - McBurneys: oblique, muscle splitting incision, Rutherford Morison's incision: an oblique muscle cutting incision, Lanz: 4 - 7 cm incision along the lines of Langer, Fowler-Weir extension: extension of McBurney's incision via a staged separation of muscles, Davis-Rockey: a transverse right lower quadrant skin incision. After opening up the abdomen using any of the above incisions, the caecum is identified. The location of the appendix is at the ileocecal junction. The mesoappendix is dissected, clamped and tied. After securing the appendix with purse string or Z stitch, it is cut from the base and invagination of the appendicular stump has proceeded. A retrograde appendicectomy is indicated if the appendix is retrocaecal and adherent. If there is extensive dissection and pus discharge, a drain is placed [8].

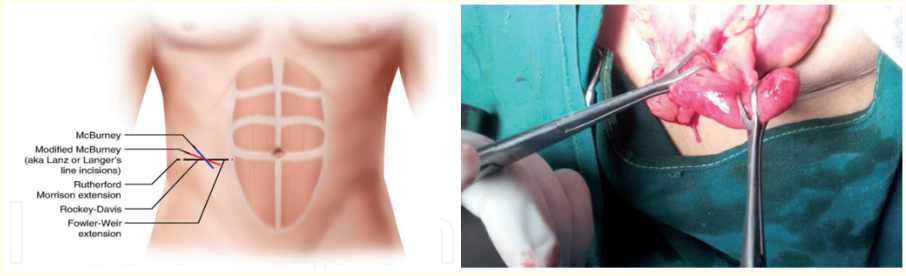

Figure 6: *Illustrates various incisions for appendectomy and open appendectomy [8].*

Laparoscopic appendectomy

According to various studies, laparoscopic surgery is superior to open surgery appendectomy. Single endoligature (end loop) is used for appendicular stump closure and is a procedure of choice. Other alternatives are metal clips, endo-stapler, polymer clips and bipolar endocoagulation. The drawback of endoclip is that appendicular bases up to 16 mm can be clipped, which is not offered by endoloop. In bipolar coagulation, the technique excludes the use of clip applicators, knot pushers and needle holders required. The laparoscopic surgical method includes port placement in a specific region of the abdomen, creating pneumoperitoneum [14-16].

Mesoappendix is tightly secured by bipolar coagulation forceps and the appendix is skeletonized. The base of the appendicular stump can be secured by various other methods, as described above. In case the appendix is friable or badly infected, the port site infection is prevented by using a specimen retrieval bag when. The pelvic cavity is thoroughly examined, the wash is given and a drain is placed if necessary.

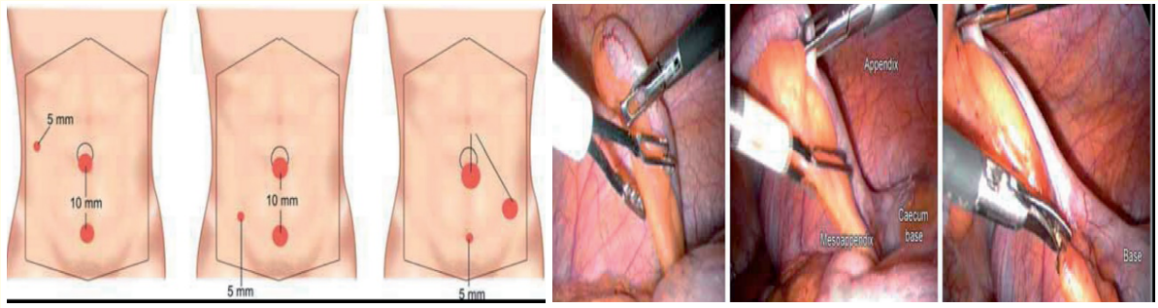

Figure 7: *Illustrates various port placement sites and securing of mesoappendix at the surgical site [8].*

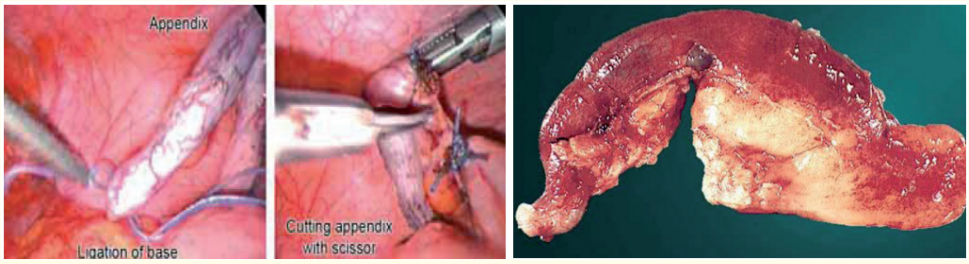

Figure 8: *Showing removal of the appendix after ligating base at the surgical site and gross specimen of the resected appendix [8].*

Conclusion

In adults and children, appendicitis presents as one of the most common causes of abdominal pain. History, physical examination and laboratory investigations aid in the appropriate diagnosis of acute appendicitis. Pain in the right lower quadrant of the abdomen, along with rigidity and periumbilical pain radiating to the right lower quadrant are the best indicators for ruling disease. Physical examination may show absent or decreased bowel sounds, a positive psoas sign, an obturator sign and a Rovsing sign. The Alvarado score includes clinical and laboratory findings and categorizes patients at low, moderate, or high risk. Ultrasonography is first-line imaging; CT scans and MRI can be used. Treatment modalities mainly include open appendectomy or laparoscopic appendectomy. However, in some patients with severe infections, intravenous antibiotics are considered first-line therapy. Pain management is done using opioids and nonsteroidal anti-inflammatory drugs. The most common complication is a perforation that can lead to sepsis.

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