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# ACUTE APPENDICITIS, PANORAMIC REVIEW

**Esteban Eugenio Iñiguez Avila[1], Jazmín Alexandra Camas Tacuri[2], Karina Alexandra Barreto Vasquez[3], Byron Fabián Pinos Reyes[4], Analy Alejandra Salinas Salinas[5], Diana Marisol Berrezueta Rodriguez[6], Ana Patricia Guailacela Gómez[7], Richard David Tene Fernández[8], Cristian René Chisaguano Sangucho[9], Emily Yessenia Picón Ortega[10]**

*[1]General Practitioner at "CESFAM Bellavista", faculty of Medical Sciences, Universidad de Cuenca. Santiago-Chile ORCID https://orcid.org/0000-0001-7996-0001*
*[2]General Practitioner at "Ministerio de Salud Pública", faculty of Medical Sciences, Universidad Católica de Cuenca Sede Azogues. Ecuador ORCID https://orcid.org/0009-0009-9989-9928*
*[3]General Practitioner at "Ministerio de Salud Pública", faculty of Medical Sciences, Universidad Católica de Cuenca. Ecuador ORCID https://orcid.org/0000-0001-6348-1145*
*[4]General Practitioner at "Ministerio de Salud Pública", faculty of Medical Sciences, Universidad Católica de Cuenca. Ecuador ORCID https://orcid.org/0009-0004-8217-5126*
*[5]General Practitioner at "Hospital Gineco-Obstétrico Isidro Ayora", faculty of Medical Sciences, Universidad de Guayaquil. Ecuador ORCID https://orcid.org/0000-0001-8852-0518*
*[6]General Practitioner at "Consultorios Médicos Cruz del Sur Cumbe", Faculty of Medical Sciences, Universidad de Cuenca. Cuenca- Ecuador. ORCID https://orcid.org/0000-0001-9639-9869*
*[7]General Practitioner at "Hospital Vicente Corral Moscoso", faculty of Medical Sciences, Universidad Católica de Cuenca. Ecuador ORCID https://orcid.org/0009-0004-9041-8503*
*[8]General Practitioner at "Hospital Metropolitano", faculty of Medical Sciences, Universidad de Cuenca. Ecuador ORCID https://orcid.org/0009-0001-9340-704X*
*[9]General Practitioner at "Hospital General de Macas", Macas-Ecuador ORCID https://orcid.org/0009-0002-8628-0842*
*[10]General Practitioner and Mgs in Public Health at "Hospital General de Macas", Macas-Ecuador ORCID https://orcid.org/0009-0001-6761-1135*

***Corresponding Author:*** *Esteban Eugenio Iñiguez Avila* ***Address:*** *Atahualpa 40, La Florinda. Santiago. Chile* ***Postal Code:*** *8260129*

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## ABSTRACT

***Introduction:*** *appendicitis is distinguished by inflammation of the vermiform appendix and usually shows acutely within the first 24 hours. Acute appendicitis is the main source of abdominal surgery in children and the most common abdominal surgical emergency around the globe.*
***Objective:*** *to detail the current information related to acute appendicitis, etiology, epidemiology, pathophysiology, histopathology, anamnesis, physical examination, evaluation, treatment and complications of the disease.*
***Methodology****: a total of 37 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 25 bibliographies were used because the other articles were not relevant for this study. The sources of information were PubMed, Google Scholar and Cochrane; the terms used to search for information in Spanish, Portuguese and English were: acute appendicitis, abdominal pain, appendix, abdominal surgery, acute abdominal treatment.*
***Results:*** *appendectomy by open laparotomy or laparoscopy is the standard treatment for acute appendicitis, however, intravenous antibiotics are exceptionally considered as first line therapy in individuals. The incidence of acute appendicitis varies from 100 to 223 new cases per 100,000 people per year. This disease can occur at any age, however it is most commonly seen in the age range of 5 to 45 years. The lifetime incidence of acute appendicitis is 8.6% in men and 6.7% in women. The risk of appendiceal rupture may vary with 2% of cases being frequently perforated 36 hours after the onset of symptoms.*

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***Conclusions:*** *It is of vital importance to recognize the etiology, epidemiology, pathophysiology, clinical picture and tests that support the diagnostic decision in any case of acute abdomen, especially in cases of acute appendicitis, because an accurate diagnosis will lead us to a rapid intervention, adequate treatment, reducing the risk of mortality and the risk of potential complications in the affected individual. Diagnostic tests and scales play an important role in the diagnosis. The efficacy of antibiotics as primary treatment for uncomplicated acute appendicitis has been extensively investigated, with conflicting and mixed results and conclusions. Comparing the results between individuals who underwent laparoscopic appendectomy and those who underwent open appendectomy, the former group showed a lower incidence of wound infection, a lower level of postoperative analgesic requirement and shorter postoperative hospital stays in the former group, with the main disadvantage being the longer operative time.*

**KEY WORDS**: *appendicitis, pain, appendix, surgery.*

## INTRODUCTION

Appendicitis is distinguished by inflammation of the vermiform appendix and usually shows acutely within the first 24 hours. However, symptoms can sometimes be more indolent and less noticeable in cases of perforation with a contained abscess. Acute appendicitis is the leading cause of abdominal surgery in children and the most common abdominal surgical emergency worldwide. The significance of this disease in terms of pediatric and general surgery underlines the requirement for correct diagnosis, accompanied by prompt intervention and good management. Understanding the clinical peculiarities and the distinctive nature of appendicitis is crucial to provide timely care and prevent related complications. A clinical diagnosis is usually possible, following a period of active observation, when necessary; inflammatory markers and ultrasound are helpful in case of uncertain diagnosis. Appendectomy by open laparotomy or laparoscopy is the standard treatment for acute appendicitis, however, intravenous antibiotics are exceptionally considered as first line therapy in individuals(1-5).

## METHODOLOGY

A total of 37 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 25 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar; the terms used to search for information in Spanish, Portuguese and English were: acute appendicitis, abdominal pain, appendix, abdominal surgery, acute abdominal treatment.

The choice of bibliography presents elements related to acute appendicitis, etiology, epidemiology, pathophysiology, histopathology, anamnesis, physical examination, evaluation, treatment and complications of the disease.

## DEVELOPMENT

### Etiology

Appendicitis is primarily caused by obstruction of the appendiceal lumen which consequently results in inflammation. The obstruction can be caused by multiple factors, such as appendicoliths, appendiceal tumors, intestinal parasites or hypertrophied lymphatic tissues. All these mechanical obstructions lead to the formation of acute appendicitis. It is significant to note that the underlying causes of luminal obstructions can change between different age zones, which underscores the importance of specific considerations when assessing and treating appendicitis.

The appendix naturally contains aerobic and anaerobic bacteria, including Escherichia coli and Bacteroides spp . Obstruction of the appendiceal lumen by any mechanism can result in bacterial overgrowth leading to acute inflammation and abscess formation. Individuals with complicated perforated appendicitis show a significantly higher bacterial load compared to those with uncomplicated appendicitis, suggesting an association between severity and number of bacterial species. In children, acute appendicitis is commonly caused by lymphoid hyperplasia. This condition involves an excessive increase of lymphoid tissue in the appendix, which generates inflammation and localized ischemia, increasing the risk of appendiceal perforation, the creation of a contained periappendiceal abscess and subsequent peritonitis. Reactive lymphoid hyperplasia is commonly misdiagnosed as one of the etiologies of appendicitis. In adults, acute appendicitis is usually due to multiple causes, such as infections, fecaliths or tumors, some of the tumors related to acute appendicitis in adults are appendiceal adenocarcinoma, mucocele and carcinoid tumor(6-8).

### Epidemiology

Acute appendicitis accounts for a large proportion of acute abdominal conditions, showing an incidence ranging from 100 to 223 new cases per 100,000 persons per year. This disease can occur at any age, however it is most commonly seen in the 5 to 45 year age range. This age distribution shows the highest incidence of appendicitis in childhood, adolescence and early adulthood. The mean age of presentation is 28 years. The lifetime incidence of acute appendicitis is 8.6% in males and 6.7% in females. Appendicitis can occur in both sexes and the difference in incidence between males and females is not remarkable(9,10).

### Pathophysiology

Regardless of its origin, appendiceal luminal obstruction generates an increase in intraluminal and intramural pressure. This increased pressure leads to occlusion of small vessels, thrombosis and lymphatic stasis, consequently, the obstructed appendix fills with mucus and distends. As lymphatic and vascular compromise progresses, the appendix wall becomes ischemic and necrotic. Also, bacterial overgrowth develops within the obstructed appendix, initially dominated by aerobic organisms and later shifting to a combination of aerobic and anaerobic bacteria. Organisms frequently involved are E. coli , Peptostreptococcus , Bacteroides and Pseudomonas. After significant inflammation and necrosis develop, the appendix becomes susceptible to perforation, sometimes creating a localized abscess, and in more important cases perforation can lead to peritonitis(8,11).

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**Histopathology**

An important microscopic finding in acute appendicitis is to find neutrophilic infiltration within the muscularis propria of the appendix. The importance of the infection and the duration of the pathology is directly linked to the level and extent of inflammation seen. According to the progression of acute appendicitis, the inflammation involves the appendiceal fat and surrounding tissues. According to histopathological findings, acute appendicitis is divided into three main categories: suppurative or phlegmonous, gangrenous and periappendicitis.

Suppurative or phlegmonous appendicitis: presenting infiltration of neutrophils in the mucosa, submucosa and muscle of the appendix. The inflammatory process is directed throughout the entire wall of the appendix and may cause extensive ulceration. Occasionally, intramural abscesses with vascular thrombosis are evidenced. This presents a multiple macroscopic appearance, however, the findings usually seen are a poorly demarcated serosa, dilatation of the appendix, congestion of the superficial blood vessels and fibrinopurulent serous exudate. However, an increase in appendiceal diameter alone is not a conclusive finding.

Gangrenous appendicitis: governed by necrosis of the appendiceal wall. If not treated, it will end in perforation. In this last alternative, there is a transmural inflammation with areas of necrosis and extensive ulceration of the mucosa. Therefore, perforation is considered a complication of untreated gangrenous appendicitis. Macroscopically, the appendiceal wall appears friable and may have purple, green or black shades.

Periappendicitis: primarily involves serous and subserosal inflammation without extending to the muscularis propria. The macroscopic appearance of periappendicitis changes from normal serosa to congestion, accompanied by exudative infiltration.

The detailed histopathological findings change in uncomplicated and complicated appendicitis(8,12).
Complicated non-perforated appendicitis encompasses 2 different histopathologic categories: severe phlegmonous appendicitis and non-perforated gangrenous appendicitis.

Complicated perforated appendicitis on histopathologic evaluation may show features indicative of abscess formation, defined by marked transmural inflammation and neutrophils infiltrating the affected tissue. The inflammation usually extends beyond the appendix and involves the surrounding mesoappendix(8,13).

**Anamnesis and physical examination**

The primary symptom of acute appendicitis at onset is diffuse or periumbilical abdominal pain that later becomes localized in the right lower quadrant. Stimulation of the T8-T10 visceral afferent nerve fibers gives rise to this initial vague abdominal pain. As the inflamed parietal peritoneum on the adjacent surface becomes irritated, the pain becomes more concentrated in the right lower quadrant. Pain that awakens from sleep or worsens with walking or coughing is reported. In addition to abdominal pain, those affected usually show anorexia, nausea with or without vomiting, diarrhea, malaise and urinary frequency or urgency. About 40% present fever. As the inflammation progresses, signs of peritoneal irritation appear. Localized defense of the right lower abdominal quadrant and rebound pain at McBurney's point, about 1.5 to 2 inches from the anterosuperior iliac spine (ASI) in an imaginary straight line to the umbilicus, are frequently seen.

There may be other diagnoses such as Rovsing's sign which is pain in the right lower quadrant generated by palpation or pressure of the left lower quadrant or Dunphy's sign which is increased abdominal pain on coughing or any activity that raises intra-abdominal pressure. Another sign is the positive psoas sign which is pain in the right lower quadrant with right hip extension or flexion of the right thigh against resistance.

Symptoms usually intensify gradually from the onset of appendicitis and may progress for 12 to 24 hours. However, it is noteworthy to point out that in cases of complicated appendicitis, symptoms may be prolonged and extend beyond 48 hours. About 75% of individuals with acute appendicitis present within 24 hours of the onset of symptoms. The risk of appendiceal rupture can vary with 2% of cases frequently perforating within 36 hours after symptom onset, the risk increasing by 5% for each additional 12 hours without proper medical intervention. After an appendiceal perforation, additional complications may occur, such as pylephlebitis, pylethrombosis, hydroureteronephrosis, intestinal obstruction and formation of internal fistulas(5,8,14).

**Evaluation.**

**Laboratory Tests**

It should contain a total leukocyte count with leukocyte formula and serum C-reactive protein (CRP) concentrations. The white blood cell (WBC) count and CRP concentration have a positive predictive value when used together to differentiate between uncomplicated and complicated appendicitis. A combination of a normal WBC count and a normal CRP amount has a high negative predictive value for acute appendicitis. Increased CRP and WBC values significantly increase the likelihood of complicated appendicitis.

Leukocytosis is seen in two-thirds of individuals with acute appendicitis. A left shift or bandemia may accompany the increase. No laboratory value can confirm or exclude acute appendicitis, however most individuals with acute appendicitis will have a leukocyte count of >10 000 cells/mm3, so it can be said that a leukocyte count ≥17 000 cells/mm3 re relates to complicated acute appendicitis.

**Images**

Diagnosis in the first instance is based on evaluation and clinical examinations. Nevertheless, computed tomography (CT), ultrasound (US) and magnetic resonance imaging (MRI) can improve the specificity of the presumptive diagnosis. Ultrasonography is less sensitive and specific than CT in the case of appendicitis diagnosis. However, ultrasound is useful when avoidance of ionizing radiation is preferred, such as in

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children and pregnant patients. MRI is useful in pregnant women with suspected appendicitis who have undergone an indeterminate ultrasound.

**Computed Tomography (CT)**
An abdominopelvic CT scan with intravenous contrast demonstrates >95% accuracy in the diagnosis of acute appendicitis in adults. Criteria used on CT to diagnose appendicitis include multiple features such as an enlarged appendix with an external diameter of >6 mm to 8 or 9 mm, thickening of the appendiceal wall measuring >2 mm to 3 mm, thickening of the periappendicular fat, enhancement of the appendiceal wall, presence of inflamed soft tissue at the appendiceal base dividing the appendix from the cecum, and the existence of an appendicolith.

**Ultrasonography (US)**
Widely available, it is the primary imaging modality of choice for assessing children and pregnant women with suspected acute appendicitis. Ultrasonographic findings that show increased likelihood of acute appendicitis are an anteroposterior appendiceal diameter >6 mm, the presence of an appendicolith, and increased echogenicity of periappendicular fat. A specific ultrasound compressibility index and an appendiceal diameter of <5 mm are used to rule out appendicitis.

**Magnetic Resonance Imaging (MRI)**
Abdomino-pelvic MRI is considered very sensitive and specific for the diagnosis of acute appendicitis, however, its use is limited due to high costs and the need for accurate interpretation of the images. It is generally used in cases where radiation exposure is less desirable, such as pregnant women. MRI findings compatible with acute appendicitis are luminal distention and dilatation, wall thickening and free periappendiceal fluid.

**Scoring scales in the evaluation of acute appendicitis.**
There are currently a few, these scoring systems use mostly criteria derived from the clinical history, physical examination, and results of laboratory tests and imaging studies. The Alvarado scoring system has been used to assess suspected acute appendicitis and the modified Alvarado scoring system is currently the most commonly used, the latter gives a point value to diagnostic criteria as follows:

Two points each: right lower quadrant pain and leukocytosis.
One point each: right lower quadrant migratory pain, right lower quadrant rebound pain, fever, nausea or vomiting, and anorexia.
The highest score in an individual with suspected acute appendicitis is 9 points. The higher the score, the greater the possibility of acute appendicitis. Alvarado's score of 7 points or more is directly related to acute appendicitis(8,15-19).

**Treatment**
**Clinical Treatment of Acute Appendicitis**
The main treatment option for acute appendicitis remains surgical. Trials have shown that while antibiotic therapy may have comparable results to appendectomy in the short term, nevertheless, 1 in 4 in the antibiotic therapy group required appendectomy within 1 year. The efficacy of antibiotics as primary treatment for uncomplicated acute appendicitis has been extensively investigated, with conflicting and mixed results and conclusions. Adverse events, such as peritonitis 30 days after intervention, were more prevalent in the antibiotic therapy group. Other trials support the use of antibiotic therapy alone even knowing the cumulative incidence of recurrence of appendicitis in uncomplicated acute appendicitis. Despite the availability of alternative therapeutic approaches with primary antibiotic therapy, appendectomy remains the standard practice for treating uncomplicated acute appendicitis.

Antibiotic coverage for acute appendicitis usually involves targeting aerobic and anaerobic bacteria pending culture results. A combination of antibiotics is usually used. A third-generation cephalosporin, such as ceftriaxone or cefotaxime, or a beta-lactamase/beta-lactamase inhibitor, such as ampicillin-sulbactam, provides coverage against aerobic gram-negative bacteria. In addition, metronidazole or clindamycin is used to provide coverage against anaerobic bacteria.

**Surgical Treatment of Acute Appendicitis**
The affected individual should remain under observation without oral intake and should be hydrated intravenously with crystalloid solution. Antibiotics should be administered intravenously. The gold standard therapeutic intervention for acute appendicitis is appendectomy. Laparoscopic appendectomy is preferred to the open approach. Most uncomplicated appendectomies are performed laparoscopically. Multiple studies have compared outcomes between individuals who underwent laparoscopic appendectomy and others who underwent open appendectomy. The results suggest a lower incidence of wound infection, a lower level of postoperative analgesic requirement and shorter postoperative hospital stays in the first group, with the main disadvantage being the longer operative time.

There is some disagreement regarding the preoperative administration of antibiotics for uncomplicated appendicitis. Several individuals with a presumptive diagnosis of acute appendicitis can be treated with a laparoscopic approach without complications. However, depending on related factors, conversion to the open approach is sometimes necessary. The only independent preoperative factor that predicts conversion during laparoscopic appendectomy is the presence of comorbidities. Also, periappendicular abscess and diffuse peritonitis are independent predictors of a higher conversion rate.

Individuals with a known periappendicular abscess due to a perforated appendix may require a percutaneous drainage procedure allowing the inflammation to subside over time, and subsequently perform a laparoscopic appendectomy with less difficulty. Those with a periappendicular abscess should receive broad-spectrum antibiotics, sometimes for multiple weeks prior to appendectomy elective. Although laparoscopic appendectomy can be performed in the presence of a periappendicular abscess, extensive intraoperative irrigation of the abdominopelvic cavity is required(2,8,20-22).

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**Alternative Surgical Techniques**

Open appendectomy could still be the practical alternative in some clinical scenarios, such as appendicitis complicated with phlegmon. Currently, there are alternative surgical techniques, such as natural orifice transluminal endoscopic surgery (NOTES) that accesses the peritoneal cavity through natural orifices such as the gastrointestinal or vaginal tract, achieving a scarless or almost scarless procedure, and relatively less painful, another technique is through single incision laparoscopic surgery (SILS), The possible advantages of the SILS technique are the reduction of postoperative pain, postoperative wound-related complications and recovery time, however, it presents a risk of long-term complications, specifically incisional hernia. In spite of that, more studies on the subject are needed(23,24).

**Complications**

The most common complication of appendectomy is surgical site infection, showing a higher risk in individuals with appendicitis complicated with perforation. Abscesses, wound infections, hematomas and postoperative pain are also common. Recurrent appendicitis can occur in nearly 50 percent of individuals treated non-surgically, sometimes an interval appendectomy can be performed to mitigate the risk of recurrent appendicitis. Another form of recurrent appendicitis is stump appendicitis, which results from incomplete appendectomy and subsequent inflammation in the residual appendiceal stump. Diffuse peritonitis and sepsis are serious consequences of complicated or untreated appendicitis. These complications can result in significant morbidity and sometimes death(1,8,25).

## CONCLUSIONS

It is of vital importance to recognize the etiology, epidemiology, pathophysiology, clinical picture and tests that support the diagnostic decision in any case of acute abdomen, especially in cases of acute appendicitis, because an accurate diagnosis will lead to a rapid intervention, adequate treatment, reducing the risk of mortality as well as the risk of potential complications in the affected individual. Diagnostic tests and scales play an important role in the diagnosis. The efficacy of antibiotics as primary treatment for uncomplicated acute appendicitis has been extensively investigated, with conflicting and mixed results and conclusions. Comparing the results between individuals who underwent laparoscopic appendectomy and those who underwent open appendectomy, the former group showed a lower incidence of wound infection, a lower level of postoperative analgesic requirement and shorter postoperative hospital stays in the former group, with the main disadvantage being the longer operative time.

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