

# Acute appendicitis: literature review

## *Apendicitis aguda: revisión de la literatura*

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### ABSTRACT

Acute appendicitis is the most common abdominal pathology in the world and it represents the main cause of emergency abdominal surgery; it is the most frequent cause of surgery in patients between 20 and 30 years of age, and it does not have a sex predominance. Its clinical picture is variable, and this fact should be considered in diagnostic studies for accurate diagnosis. The approach of acute appendicitis can be laparoscopic or open surgery. The purpose of our review is to present updated information on this common topic.

### RESUMEN

*La apendicitis aguda es la patología quirúrgica abdominal más común en el mundo y representa la causa principal de cirugía abdominal de urgencia; se informa que su mayor frecuencia se observa en la población de entre 20 y 30 años y no tiene predominio de género. Su presentación clínica es variable en algunas ocasiones, por lo que se deben utilizar estudios imagenológicos para su diagnóstico certero. El tratamiento de la apendicitis aguda es mediante cirugía con abordaje laparoscópico o abierto. El propósito de nuestra revisión es exponer la información actualizada sobre este tema tan común.*

## INTRODUCTION

Appendicitis is defined as inflammation of the vermiform appendix and represents the most common cause of acute abdomen and emergency surgical indication in the world.

The study of the cecal appendix dates back to the anatomical drawings made by Leonardo da Vinci in 1492. It was later detailed by Berengario da Carpi in 1521 and illustrated in the work of Andreas Vesalius *De Humani Corporis Fabrica*, published in 1543.<sup>1</sup>

## ANATOMY

The vermiform appendix is a tubular structure located on the posteromedial wall of the cecum, 1.7 cm from the ileocecal valve, where the taenias of the colon converge on the cecum. Its average length is 91.2 and 80.3 mm in men and women, respectively. The appendix is a

true diverticulum, since its wall is made up of mucosa, submucosa, longitudinal and circular muscle and serosa. Its anatomical relationships are the iliopsoas muscle and the lumbar plexus posteriorly, and the abdominal wall anteriorly. The irrigation of the cecal appendix comes from the appendicular artery, a terminal branch of the ileocolic artery, which crosses the length of the mesoappendix to end at the tip of the organ. The mesoappendix is a structure of variable size in relation to the appendix, which entails variability in its positions.<sup>2-4</sup> Therefore, the tip of the appendix can migrate to different locations: retrocecal, subcecal, preileal, postileal, and pelvic.<sup>3,5</sup>

## EPIDEMIOLOGY

Acute appendicitis represents the most common indication of emergency nontraumatic abdominal surgery in the world. This pathological

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process occurs more frequently between the second and third decades of life. The risk of presenting it is 16.33% in men and 16.34% in women. Its annual incidence is 139.54 per 100,000 habitants; in 18.5% it is associated with overweight and in 81.5% with obesity.<sup>6-8</sup>

### ETHIOPATHOGENESIS

The central pathogenic event of acute appendicitis is obstruction of the appendicular lumen, which may be secondary to fecaliths, lymphoid hyperplasia, foreign bodies, parasites, primary tumors (carcinoid, adenocarcinoma, Kaposi's sarcoma, lymphoma, etc.) or metastatic tumors (colon and breast). Inflammation of the appendicular wall is the initial phenomenon, vascular congestion, ischemia, perforation and, occasionally, development of localized (contained) abscesses or generalized peritonitis ensue later. During these phenomena, bacterial proliferation occurs, in the early course of the disease, aerobic microorganisms appear and later, mixed forms (aerobic and anaerobic) appear.<sup>9,10</sup> Normally, the cecal appendix functions as a reservoir for the *E. coli* microbiota and *Bacteroides sp.*, which are the most common; however, patients with predominantly different microbiota, such as *Fusobacterium*, have been found. This latter correlates with cases of complicated (perforated) appendicitis.<sup>11</sup> Such bacteria invade the appendicular wall and then produce a neutrophilic exudate; the flow of neutrophils causes a fibrinopurulent reaction on the serous surface, as well as irritation of the adjacent parietal peritoneum.<sup>12</sup> Once inflammation and necrosis occur, the appendix is at risk of perforation, leading to the formation of localized abscesses or diffuse peritonitis. The time to appendicular perforation is variable. In general, perforation correlates to the evolution of the appendicular clinical picture: no appendicular perforation if less than 24 hours of evolution and perforation when more than 48 hours.<sup>13</sup>

However, the etiology of acute appendicitis is currently uncertain and poorly understood. Recent theories focus on genetic factors, environmental influence and infections. As a sample it is reported that people with a family history of acute appendicitis have three times

a higher risk than those with no family history of suffering from it.<sup>10</sup>

### CLINICAL MANIFESTATIONS

Abdominal pain is the most frequent symptom that occurs in patients, although other symptoms such as anorexia, nausea, constipation/diarrhea and fever are also described.<sup>9,14</sup> Pain is typically periumbilical and epigastric, and later migrates to the lower right quadrant; however, despite being considered a classic symptom, migratory pain occurs only in 50 to 60% of patients with acute appendicitis.<sup>9</sup> The appearance of nausea and vomiting occurs after the installation of pain, and fever usually manifests around six hours after the general clinical picture. This varies considerably from person to person, which in some cases is attributable to the location of the tip of the appendix. For example, an anteriorly located appendix produces marked and localized pain in the right lower quadrant, whereas a retro-cecal one can cause dull abdominal pain or pain in the lower lumbar region. Likewise, due to the irritation produced by the appendix, other symptoms such as urinary urgency, dysuria or rectal symptoms such as tenesmus or diarrhea may appear.<sup>14</sup>

The physical examination of these patients should initiate with the measurement of vital signs. A body temperature greater than 38 °C, tachycardia and, in some cases, tachypnea can be found. The early clinical signs of appendicitis are often non-specific.<sup>14</sup> However, as inflammation progresses, involvement of the parietal peritoneum causes tenderness in the right lower quadrant that can be elicited on physical examination; also, pain can be exacerbated by movement or cough.<sup>15</sup>

The maximum localization of pain in the abdomen almost always corresponds to the McBurney point, which is located two thirds of the distance from the navel on a line drawn from it to the right anterior superior iliac spine. The patient will be sensitive and will show signs of peritoneal irritation with localized muscular defense (it occurs only if there is peritonitis).<sup>15</sup> Rectal and/or vaginal examination can cause pain in patients with pelvic localized appendicitis, therefore their presence or

absence does not rule out appendicular pathology, and its routine use in the exploration of these patients is controversial.<sup>15-17</sup>

Different clinical signs have been described in the physical examination to facilitate diagnosis. It is worth mentioning that they are reported in only 40% of patients with appendicitis, so their absence does not rule out the diagnosis. These include Blumberg (pain from sudden decompression in the right iliac fossa), Rovsing (palpation in the left iliac fossa elicits referred pain in the right fossa), psoas sign (pain in the right iliac fossa [RIF] from extension of the right hip), obturator sign (pain in the RIF after flexion and internal rotation of the right hip), etc.<sup>18,19</sup>

### LABORATORY

Leukocyte count greater than 10,000 cells/mm<sup>3</sup> and left deviation, C-reactive protein greater than 1.5 mg/l are likely diagnostic indicators for acute appendicitis. Leukocytosis greater than 20,000/ $\mu$ l is associated with appendicular perforation; however, appendicular perforation is reported in up to 10% of patients with normal white blood cell and C-reactive protein values, so the absence of these altered values does not rule out perforation.<sup>20,21</sup> The sensitivity and specificity of these laboratory tests for the diagnosis of acute appendicitis are reported from 57 to 87% for C-reactive protein and from 62 to 75% for leukocytosis. Therefore, other studies have been attempted for the timely diagnosis; such is the case of pro-calcitonin and bilirubin. Both have been shown useful for diagnosing complicated cases of appendicitis.<sup>22,23</sup>

### CT SCAN

It represents one of the imaging studies that allows us to make a more precise diagnosis and, also, to differentiate between perforated and non-perforated acute appendicitis.<sup>24</sup> The radiological signs described for the diagnosis of acute appendicitis are the following: an increase in appendicular diameter greater than 6 mm (sensitivity 93%, specificity 92%), appendicular wall thickness greater than two millimeters (sensitivity 66%, specificity 96%), thickened peri-appendicular fat (sensitivity

87%, specificity 74%), and of the appendicular wall (sensitivity 75%, specificity 85%).<sup>25-27</sup>

### ABDOMINAL ULTRASOUND

It is an operator-dependent method; however, inexpensive and ideal for diagnosis. The findings reported by ultrasound are an appendicular diameter greater than 6 mm, with a sensitivity of 88%, specificity of 92%, and positive predictive values of 94% and negative predictive values of 86%.<sup>28,29</sup>

### X-RAY IMAGES

They are of little use in establishing the diagnosis of appendicitis; however, the following radiographic findings have been associated with acute appendicitis:

1. Appendicolith in the lower right quadrant.
2. Ileus located to the right iliac fossa.
3. "Erasure" of the psoas muscle image.
4. Free air (occasionally).
5. Increased density in the right lower quadrant.

Despite the above, some recommend that the evaluation of patients with clinical suspicion of acute appendicitis should be submitted to other studies, due to their high number of false negatives.<sup>30,31</sup>

### MAGNETIC RESONANCE

It is considered the radiographic study of choice in pregnant women with clinical suspicion of acute appendicitis. The magnetic resonance parameter is the appendicular diameter, when greater than 7 mm (filled with fluid) it is considered as a diagnostic, and those between 6-7 mm are considered inconclusive findings.<sup>32-34</sup>

### DIAGNOSIS

The diagnosis of this pathology is made according to findings on clinical interrogation, physical examination and laboratory and/or imaging. Different diagnostic modalities have been studied and compared, the use

of laboratory values alone is ineffective for diagnosis. However, when used together, the diagnostic possibility increases.<sup>35</sup> The diagnostic efficacy by physical examination as the only study method ranges from 75% to 90%. Its efficacy depends on the experience of the examiner.<sup>36</sup> Therefore, different diagnostic systems have been designed, in order to combine the clinic with the laboratory findings to determine therapeutic behavior in this type of patient.

### DIAGNOSTIC SCORING SYSTEMS

There are different systems for the diagnosis of acute appendicitis; Alvarado's scale is the most widely used for diagnosis and has been modified since its introduction. There are reviews in which this scale is compared with clinical judgment, and it has been found that the scale has a lower sensitivity (72% vs 93%), since some cases ruled out by the Alvarado score do occur.<sup>37</sup> Likewise, when comparing this scale with radiographic studies, it is comparatively less sensitive and specific in relation to computed tomography images.<sup>38</sup>

The modified Alvarado scale scores according to the following criteria:<sup>39-41</sup> migratory pain towards the right iliac fossa (1 point), anorexia (1 point), nausea and vomiting (1 point), pain on palpation in the right iliac fossa (2 points), positive rebound in the right iliac fossa (1 point), temperature greater than 37.5 °C (1 point) and leukocytosis (2 points).

The handling will be according to the sum of points:<sup>39-41</sup>

- Score 0-3: low risk for appendicitis and could be discharged with the counseling to return if there is no symptomatic improvement.
- Score 4-6: hospitalization; If the score remains the same after 12 hours, surgical intervention is recommended.
- Male with a score of 7-9: appendectomy.
- Nonpregnant female with a score of 7-9: diagnostic laparoscopy and appendectomy if indicated by intraoperative findings.

There are other systems for the diagnosis of acute appendicitis: RIPASA, appendicular

inflammatory response (AIR), pediatric appendicitis score (PAS), adult score for appendicitis (ASA). Comparing the scales, the AIR system (as opposed to Alvarado) reduces the number of unnecessary hospital admissions, optimizes the usefulness of radiographic studies and prevents negative abdominal examinations, which is corroborated by the best discrimination observed in the ROC curve (receiver operative characteristic), 0.97 versus 0.92, respectively.<sup>42</sup>

### TREATMENT

The current treatment for acute appendicitis ranges from surgical modalities to conservative management. Therefore, and for its understanding, it is necessary to know a classification of acute appendicitis such as the described by the Mexican Association of General Surgery; namely:<sup>43</sup>

- Acute appendicitis: leukocyte infiltration to the basement membrane in the cecal appendix.
- Uncomplicated appendicitis: acute appendicitis without perforation data.
- Complicated appendicitis: perforated acute appendicitis with and without localized abscess and/or purulent peritonitis.

Previously, the management of uncomplicated appendicitis by conservative treatment with antibiotics was considered an alternative; however, the latest meta-analysis results comparing conservative versus surgical management have found surgical management as the treatment modality of choice in this type of patients.<sup>44-46</sup> It is important to recognize that if a patient wants conservative treatment and accepts the recurrence risk of 38%, this type of approach can be offered.<sup>42</sup>

Management is surgical, by laparoscopic approach ideally; however, the open modality will always be a choice when the conditions and means are not available for laparoscopic approaches.<sup>47,48</sup>

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