



ACUTE APPENDICITIS: IMAGING FINDINGS AND CURRENT APPROACH TO DIAGNOSTIC IMAGES

APENDICITIS AGUDA: HALLAZGOS RADIOLÓGICOS Y ENFOQUE ACTUAL DE LAS IMÁGENES DIAGNÓSTICAS

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SUMMARY

Acute appendicitis is the most common cause of acute abdominal pain which requires surgery. Before the advent of modern diagnostic imaging techniques, the diagnosis of acute appendicitis was exclusively performed by clinical findings; however, the negative appendectomy rates decreased significantly after the introduction of sectional images such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Ultrasonography (U.S.), as well as the morbidity and mortality associated with this disease. In this paper, we review the anatomy of the appendix, the clinical manifestations of acute appendicitis and the findings of this entity in different diagnostic imaging modalities based on available evidence.

RESUMEN

La apendicitis aguda es la causa más frecuente de dolor abdominal agudo que requiere cirugía. Antes de la aparición de las modernas técnicas en imágenes diagnósticas, el diagnóstico de apendicitis aguda era exclusivamente clínico; sin embargo, después de la introducción de imágenes seccionales como la tomografía computarizada, la resonancia magnética y la ultrasonografía, las tasas de apendicectomías negativas se redujeron de forma significativa, y con ellas disminuyeron la morbilidad y mortalidad asociadas a esta enfermedad. En el presente artículo se revisa la anatomía del apéndice cecal, las manifestaciones clínicas de la apendicitis aguda y los hallazgos de esta entidad en las diferentes modalidades de imágenes diagnósticas, a la luz de la evidencia disponible.

KEY WORDS (MeSH)

Appendicitis
Appendectomy
Ultrasonography
Magnetic resonance imaging
Tomography, X-ray computed

PALABRAS CLAVE (DeCS)

Appendicitis
Apendicectomía
Ultrasonografía
Imagen por resonancia magnética
Tomografía computarizada por rayos X

Introduction

Acute appendicitis is the most common cause of abdominal pain which requires surgery. Literature indicates that appendicitis affects between 7-12% of the general population throughout their life. The global risk of suffering appendicitis is 8.6% for men and 6.7% for women in all age groups (1-4). This pathology occurs more frequently during the second and third decade of life, with a peak age of 22 years (3).

250,000-280,000 new cases a year are documented in the United States, with a mortality of 0.0002%

and a morbidity of 3% when timely diagnosis and treatment occurs (3,5-7).

Before the appearance of modern techniques in diagnostic imaging, the diagnosis of acute appendicitis was exclusively clinical. The objective was to reduce the rate of perforated appendicitis as much as possible (3). 20% of resected cecal appendices with a clinical diagnosis of acute appendicitis were normal. However, when trying to reduce this number of false positives as the diagnosis criteria became stricter, the cases of perforation became more common. To summarize,

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the rate of false positives was inversely proportional to the rate of perforated appendicitis (1,3,8).

After introducing sectional images such as Computed Tomography (CT), Magnetic Resonance (RM) and Ultrasonography (U.S.) as a part of the diagnostic routine in this entity, the rates of negative appendectomies were significantly reduced to percentages ranging between 1.7-3%, without an increase in the cases of perforated appendicitis (9-12).

Anatomy of the cecal appendix

The cecal appendix is a cecal intestinal loop which measures between 3-20 cm and has a transverse diameter of less than 6 mm. It originates in the posteromedial wall of the cecum, 2-3 cm inferior to the ileocecal valve (3,13,14), Much has been written about the position of the cecal appendix in relationship with the colon (3,13,14); nevertheless, authors suggest adopting the classification published by Verduga, et al. (14), which was made based on a study of a Latin American population which is similar to ours (figure 1).

Physiopathology

The inflammatory process starts when the only permeable end of the appendix is obstructed (1,3,5). The most frequent causes of appendicular obstruction are:

- Fecalith
- Feces
- Lymphoid hyperplasia
- Seeds
- Parasites
- Tumors

Said obstruction conditions the accumulation of liquid and the secretions in the lumen of the appendix, with posterior bacterial proliferation and inflammation of the wall and the surrounding tissue (1,5). The increase in endoluminal pressure, secondary to the accumulation of fluids, puts great pressure force on the wall of the appendix and also reduces blood perfusion which triggers ischemia, gangrene, and lastly, perforation (1,3,5).

Appendicular perforation is one of the final stages of said inflammatory process. The purpose of therapeutic intervention in patients is to avoid it. Once perforation occurs, mortality increases to 3% and morbidity becomes as high as 47% (3,5). Even if diagnosed early, up to 26% of appendicitis are perforated at the moment of diagnosis (5).

Clinical manifestations

Symptomatology which occurs due to appendicitis can be grouped in typical and atypical symptoms according to what is described in the literature. Typical symptoms are present on only 50-70% of patients (15,16). These symptoms have been classically grouped into clinical evaluation tables which seek to determine the pretest possibility for diagnosis (1,3,15,17-20) (table 1).

Atypical symptoms appear in between 20-30% of patients. These symptoms appear due to variants in the anatomical position of the cecal appendix and due to differences in the perception and description of pain by the patient (1,3,15). The age of occurrence is a very important factor. It is said that up to 47% of appendicitis in

children under the age of 5 and 47% of appendicitis in persons over the age of 65 are perforated at the moment of diagnosis (21-24).

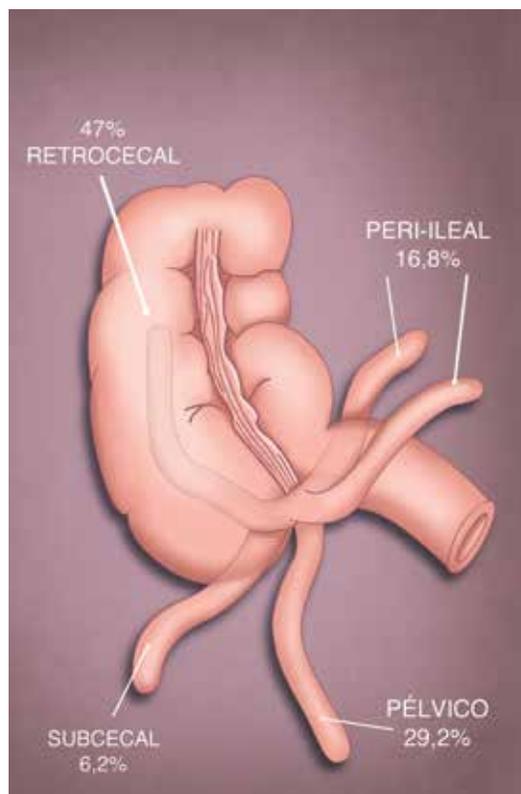


Figure 1. Drawing which shows the most frequent positions of the cecal appendix with respect to the cecum and its respective percentages.

Table 1. Alvarado Scale to calculate the clinical probability (pretest) of acute appendicitis.

Category	Descriptor	Score
Symptoms	Migration	1
	Anorexia – ketonuria	1
	Nausea – vomiting	1
Signs	Pain in the lower right quadrant	2
	Rebound tenderness	1
	Fever (>37.3 C of oral temperature)	1
Lab	Leukocytosis (> 10,000 / mm ³)	2
	Deviation towards the left (Neutrophils > 75%)	1
Score	Interpretación	
1 – 4	Low probability of appendicitis	
5 – 6	Possible appendicitis	
7 – 8	Probable appendicitis	
9 – 10	Very probable appendicitis	

Source: Taken and adapted from Alvarado A. (20)

Diagnostic imaging: Multi-modality approach

As previously mentioned, the diagnostic imaging approach to acute appendicitis has shown a favorable impact in the morbidity and mortality of patients with this entity. We will now proceed to a quick description of the most commonly used imaging modalities, as well as the most relevant findings in each one of them.

Simple imaging of the abdomen

Even through simple imaging of the abdomen is part of the initial diagnostic approach of some pathologies which cause acute abdominal pain (for example: urolithiasis, intestinal obstruction, etc.), it is not recommended for the study of a patient with suspected acute appendicitis, given that the findings are non-specific in 68% of cases, and a sensitivity as low as 0% has been reported for this entity (6,8,12,25,26).

However, classic imaging signs have been described in literature. These are worthy to be mentioned and include the following:

- Ileus reflex (between 51 – 81%) (figure 2).
- Increase in the opacity of the lower right quadrant of the abdomen (between 12-33%).
- Thickening of the walls of the caecum (between 4 – 5 %).
- Bad definition of the fatty line of the psoas muscle on the right side.
- The appendicolith can be seen as a nodular image in at least 5% of cases, with calcium density, projected on the right iliac fossa (figure 2).
- Petroianu et al. (26) described the new sign of the “fecal load on the cecum), which consists of a presence of material with soft tissue density and of radiolucent bubbles in its interior, occupying the cecum (fecal matter) in patients who suffer from pain in the right iliac fossa. It has a sensitivity of 97%, a specificity of 85%, a positive predictive value of 78.9% and a negative predictive value of 98% for the diagnosis of acute appendicitis.

Currently, the main usefulness of conventional imaging of the abdomen in the study of acute abdominal pain is to rule out perforation and intestinal obstruction.

Ultrasound

The use of ultrasound as a tool in the diagnosis of acute appendicitis was first described in 1986 by Dr. Puylaert (2,3,5,8). Since then, it has become one of the main imaging techniques for the diagnosis of this entity, with special relevance in pediatric patients and in pregnant women (29,30).

Technique

The patient must lie down in a supine position on a firm surface. The lower right quadrant is explored with a high-frequency lineal transducer. (3,5,8). The exploration with a transducer must be with a firm and gradual compression.

Said maneuver has two main objectives: first, it seeks to displace the adjacent intestinal loop towards a probable swollen appendix and fixed to the abdominal wall. It also seeks to evaluate the degree of compatibility of the cecal appendix, which is an acute appendicitis criterion as will be seen later (5).

The test must be initiated in the place where the patient presents the most pain, given that in 94% of cases, it is possible

to find a significant finding in this place (5). It is not always easy to visualize the cecal appendix. Therefore, maneuvers have been described which can help the radiologist at the moment of the test, for example: position the left hand of the evaluator in the lumbar region of the patient and try to compress the abdomen against the transducer, or ask the patient to lie down in a left lateral decubitus position and perform a lateral and posterior ultrasound approach (3,5). The radiologist should try to prove the entire length of the appendix, in order to prevent diagnostic errors and not confuse it with the terminal ileum.

Findings

The normal cecal appendix is seen as a tubular, elongated, and cecum structure with a lamellate appearance due to its histological layers; it usually has a diameter of less than 6 mm in its transverse diameter. It has an ovoid or oval shape in the images with compression in its short axis (figure 3). It is important to note that the normal appendix is compressible, mobile, and it does not present an alteration in echogenicity of surrounding fat (3,5). The non-visualization of the cecal appendix in expert hands has a negative predictive value (NPV) of 90% (3,5).

Ultrasound findings of acute appendicitis include:

- Transverse diameter over 6 mm: This parameter has a sensitivity of 98% (18,30). However, up to 23% of healthy adult males have a cecal appendix with a transverse diameter which is larger than this. This is why some authors suggest that when an appendix with a diameter between 6-9 mm is found, it must be considered “undetermined” and other signs of appendicitis must be searched for: for example, non-compressibility, the shape and the alteration of echogenicity of the adjacent tissues (3,5,30) (figure 4).
- Non-compressible appendix: The normal appendix must be mobile and compressible. The loss in compressibility or the fact that the appendix adopts a circular shape in axial images with plain compression is a criterion in order to consider the diagnosis of acute appendicitis (2,5,23) (figure 4).
- Inflammatory changes in the surrounding fat: These changes are seen as an increase in the echogenicity of periappendicular fat associated with an absence of deformation with compression (6,13) (figure 4).
- Increase in vascularization, visualized in the color Doppler: Even though it has a good sensitivity (87%), it is said that this parameter is invalid for the diagnosis of acute appendicitis, given that the stage of the process can be positive or negative (3,5,23) (figure 5).
- Appendicoliths: These structures are recognizable in only 30% of appendicitis cases. However, their finding increases the risk of perforation (3,19,23) (figure 6).
- Signs of perforation: There are three classic examples of appendicular perforation in U.S.: The collection of periappendicular fluid (figure 7), the irregularity of the wall and the presence of a, extra-luminal appendicolith (2,3,5). However, it is common that the appendix is not easily visualized after perforating it (30).

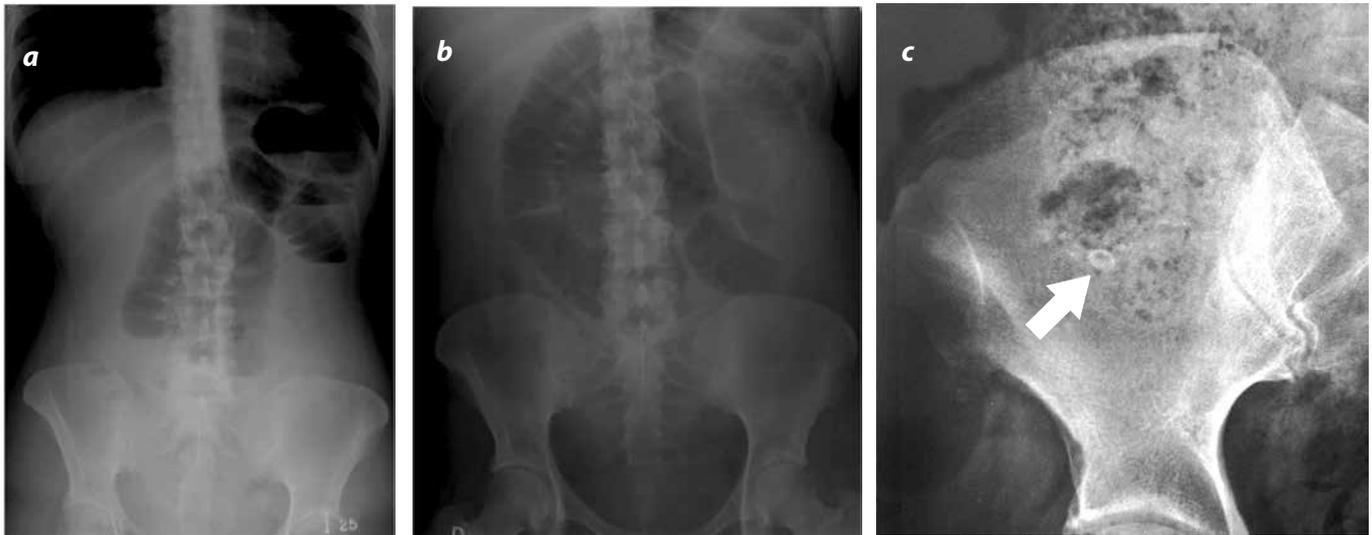


Figure 2. Imaging of the abdomen in frontal projection, a) in a vertical position and b) in a supine position. An abnormal gaseous pattern can be seen, due to the dilatation of the small intestine loops in the superior hemiabdomen, without a configuration of an obstructive pattern in a patient with appendicular plastron; this finding suggests ileum, which is frequently visualized in patients with acute appendicitis. c) Close-up of an imaging of the abdomen in the lower right quadrant, in which an image of oval morphology can be seen, as well as a calcium density which corresponds to an appendicolith (arrow).

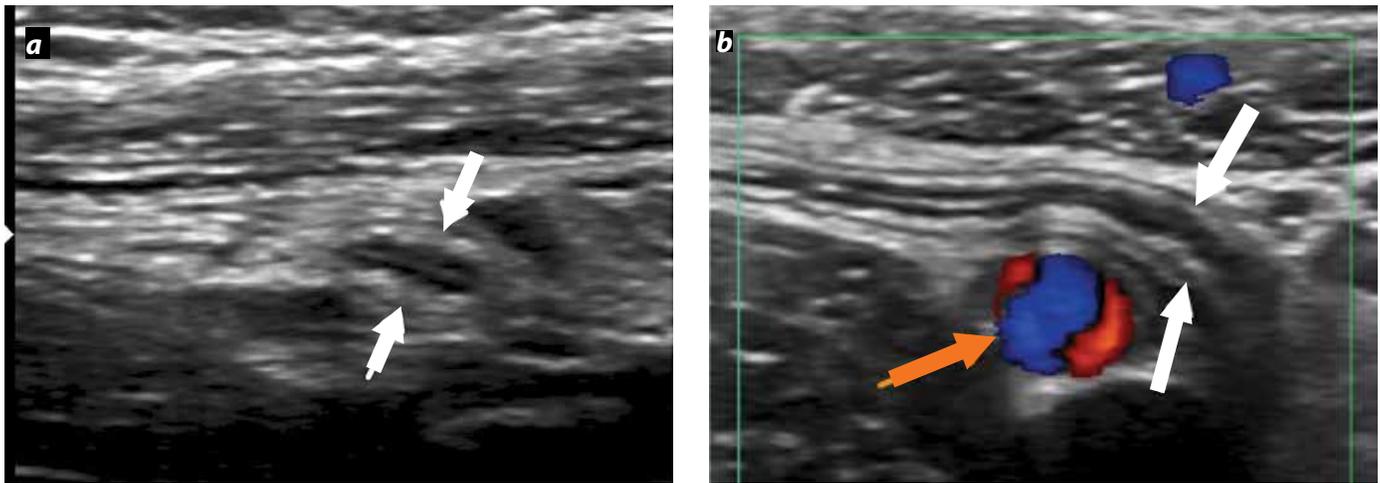


Figure 3. Ultrasound appearance of a normal cecal appendix. a) Axial image which shows the appearance of concentric rings with alternating echogenicity (white arrows), which represent the mucosa, the muscle and serous of the appendix. b) The cecal appendix can be observed in the longitudinal axis, in its most common location (white arrows), at a medial position against the iliac vessels (color Doppler - orange arrow).

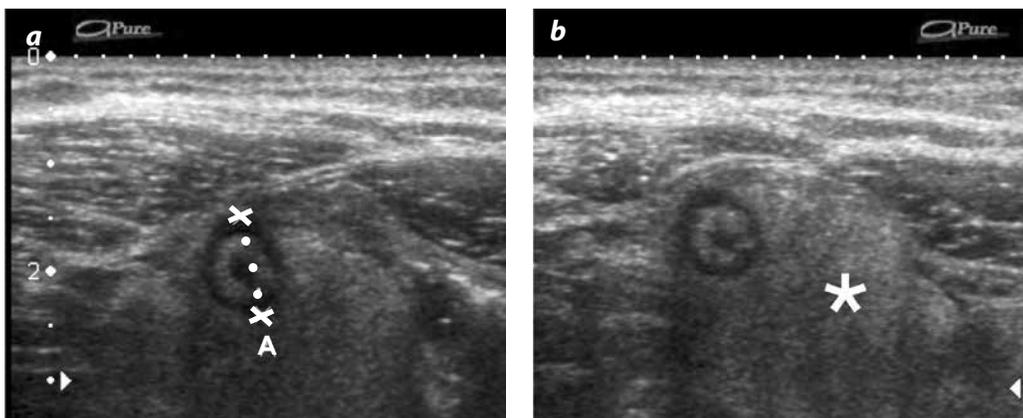


Figure 4. Acute appendicitis, appearance in ultrasound. a) Axial image of the non-compressed cecal appendix, thickened (calipers), with a diameter of 13 mm. b) The diameter of the appendix is not modified with the compression maneuvers. Similarly, an alteration in the echogenicity of adjacent non-compressible fat can be seen (*).

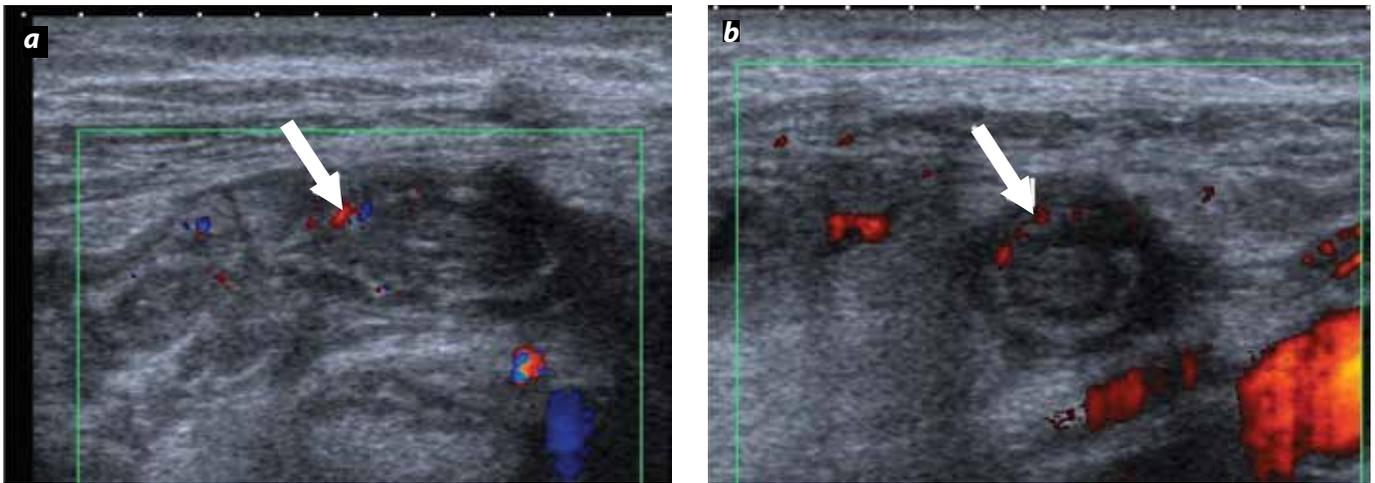


Figure 5. Increase in the vascularization of the appendix due to acute appendicitis. a) Longitudinal image of the appendix with an increase of flow in its walls in the images with color Doppler (arrow). b) In the power Doppler, an increase in flow in the anterior wall of the appendix can be seen (arrow).

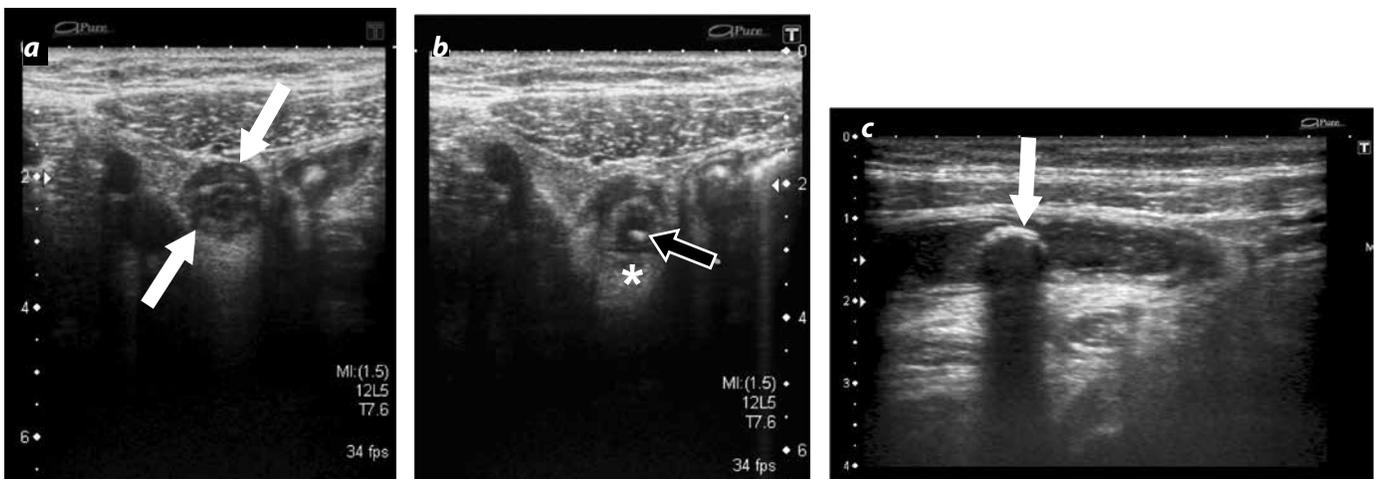


Figure 6. Acute appendicitis associated with appendicolith. a) Axial image of the thickened cecal appendix (white arrows), with a diameter of 11 mm, which is not modified with the compression maneuvers in (b). b) Similarly, an alteration in the echogenicity of adjacent fat can be seen (*), as well as an image of associated fecalith (black arrow). c) Ultrasound in a longitudinal cut of the appendix of another patient, where a round echogenic image (arrow), and a posterior acoustic shadow in its interior can be seen, representing an appendicolith.



Figure 7. Perforated appendicitis. Axial ultrasound image where a distended appendix can be visualized due to an inflammatory process (calipers), associated with a surrounding liquid projection, secondary to perforation (asterisk).

Computed Tomography

CT, along with U.S., are the two most commonly used diagnostic modalities for the diagnosis of acute appendicitis. Several image acquisition protocols in CT images have been described. However, only the most important ones will be described (1,3,5,9,31-34):

- Total abdominal CT: Cuts from the diaphragmatic cupola to the pubic symphysis have been performed. The width of the cut is 5 mm, and 100-150 cm³ of the intravenous (IV) contrast is administered to the patient. In addition, an enteric contrast medium is administered orally or rectally, 1 hour before the study. This protocol has a sensitivity of 96%, a specificity of 89%, and a precision of 94%. The great advantage of this protocol is that it provides a differential diagnosis in 56% of cases of patients with uncommon clinical conditions and without imaging evidence of appendicitis.
- Focalized CT: This protocol was designed for the directed search of appendicitis in patients with a compatible clinical condition. 5 mm cuts are suggested from the inferior pole of the right kidney until the greater pelvis. Images are acquired with an oral contrast

medium, and IV similar to what was described in the former protocol. This protocol showed a sensitivity close to 98%, with 98% specificity and 98% precision. Despite all this, only 39% of cases offer differential diagnosis when the study is negative for appendicitis.

- CT of the abdomen with only an intravenous contrast: A tomographic acquisition of the abdomen from the diaphragmatic cupolas towards the greater trochanters is performed in this protocol, after the endovenous administration of an iodized contrast medium at a standard dosage. A study of a 64-channel multi-detector equipment is suggested, and the images should be acquired during the venous phase. This protocol shows a sensitivity of 100% (confidence interval between 92.9-99.2%) (35,36). According to some authors, omitting the usage of the oral contrast medium reduces the stay of the patient in the emergency service, speeding up diagnosis and treatment (37).
- Simple CT of the abdomen: There is a complete acquisition of the abdomen without administering an oral contrast medium or an IV. What it seeks to prove is an increase in the transverse diameter of the appendix and an alteration of perpendicular fat. One of the advantages of this protocol is that it is cheaper. It also does not require the patient to be prepared and it is quicker. One of its disadvantages include a 7.3% rate of false negatives. However, it is not much greater than other protocols. Informed sensitivity ranges between 85 – 96%. Specificity ranges between 93 – 99%, and precision is closer to 97%. When the test is negative for appendicitis, it offers a differential diagnosis in only 35% of cases.

These same protocols have been suggested in the literature, with a reduction in the radiation dosage, showing the same diagnostic performance, and reducing the exposure of the patient to ionizing radiation (33, 38).

Findings

The normal cecal appendix is only seen between 43-82% of all abdomen CT's (1, 5). As reviewed in the anatomy section, it is visualized as a cecum tubular structure, with a length of 3-20 cm, and with a diameter of less than 6 mm. The presence and/or absence of gas in the lumen of the appendix does not confirm or rule out a diagnosis of appendicitis (3, 5) (figure 8).

There are primary and secondary findings of appendicitis in CT. Primary findings refer to alterations of the appendix proper. Secondary findings

correspond to the alteration in adjacent structures by the inflammatory process (1,3,5).

Primary findings:

- Increase in transverse diameter: There is an increase in transverse diameter when it is greater than 6 mm (18) (figure 9). A sensitivity of 93% is informed, as well as a specificity of 92%. However, Brown, et. al (5) state that up to 42% of healthy adults have an appendix with a diameter greater than this threshold. Because of this, they suggest that an appendix with a diameter between 6-10 mm is called "appendix with an undetermined diameter", and other imaging signs must be sought in order to support the diagnosis of appendicitis (5,8).
- Thickening of the wall of the appendix greater than 1 mm (1,3,5,31), with a sensitivity of 66% and a specificity of 96% (figure 10).
- Abnormal and heterogenous enhancement of the wall. This finding has a sensitivity of 75% and a specificity of 85% (3).
- The submucous edema or stratification which configures the "Target" or "Diana" sign (5,8) (figure 11).
- Appendicoliths are present in 20-40% of cases. However, they increase the risk of perforation when present (3,8) (figure 12).
- Secondary findings:
 - Focal thickening of the walls of the cecum (figure 13): This sign has an estimated sensitivity of 69%, but a specificity close to 100%. Said focal thickening of the wall of the cecum occurs around the insertion of the cecal appendix; because of this, this process forms a "funnel" image which points towards the origin of the appendix and it configures the "arrowhead sign" in tomographies with enteral contrast (5,30). On the other hand, the "sign of cecal bar" appears when the thickened wall of the cecum surrounds an enclaved appendicolith in the root of the appendix (3,5,30).
 - The alteration in the density of periappendicular fat reports a sensitivity between 87-100% and a specificity between 74-80% (3,5,12,39) (figure 14).
 - It is common to find regional adenomegalies (12).
 - At least five signs of perforation have been described: the presence of extra luminal gas, the visualization of an abscess, phlegmon, the presence of an extra-luminal appendicolith or a focal defect in the enhancement of the wall (1,3,5). The co-existence of two of the previously described findings has a sensitivity of 95% and a specificity of 100% for a perforation (figure 15).

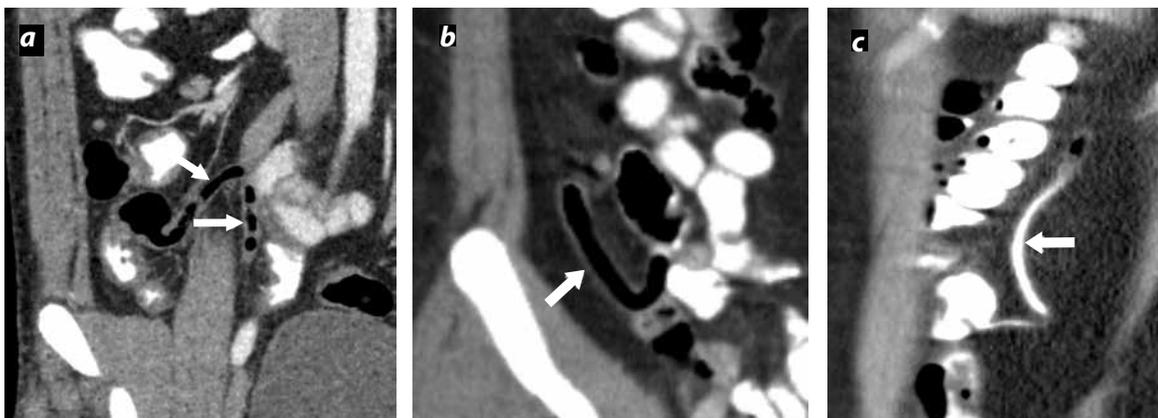


Figure 8. Tomographic appearance of a normal cecal appendix. Gas can be visualized in the interior, as well as thin walls and a diameter under 6 mm. Close-up of a tomography with an oral and intravenous contrast in a coronal plane (a and b), where the location of the peri-ileal and paracecal appendix can be visualized, respectively. c) Close-up of a CT of the abdomen in a sagittal plane, where the cecal appendix is visualized, with normal morphology and caliber in the retrocecal location.

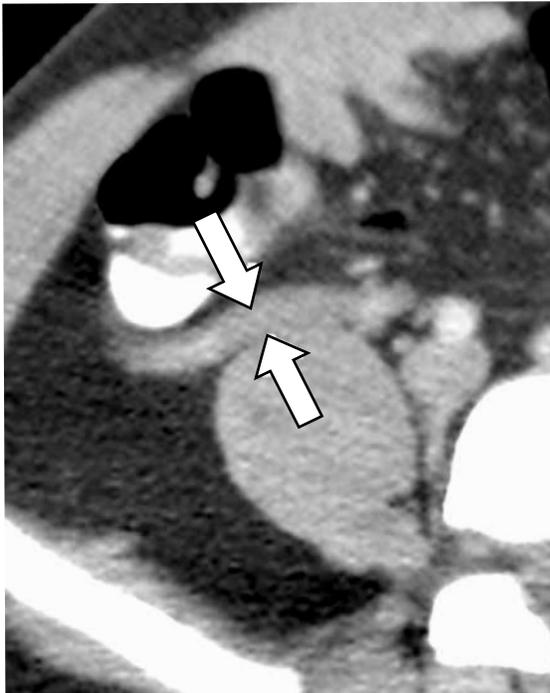


Figure 9. Axial CT cut which shows the thickened cecal appendix, with a diameter of 12 mm (arrows), without significant inflammatory changes in the periappendic mesenteric fat.

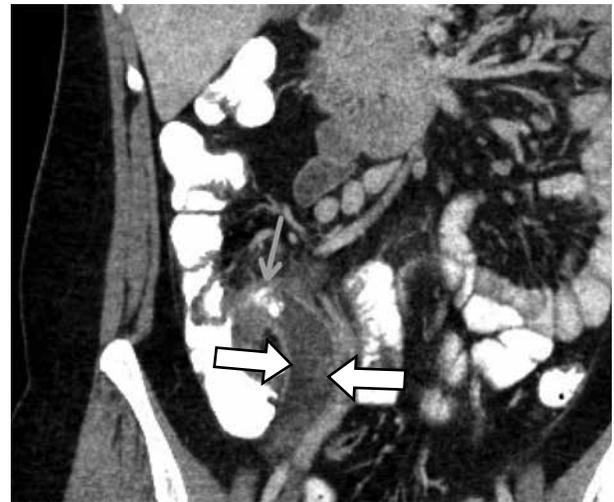


Figure 12. Coronal reconstruction of a CT of the abdomen with a contrast medium where the distended cecal appendix can be seen (white arrows), with enhancement of its walls, and calcified image which corresponds to an appendicolith at its base (orange arrow).

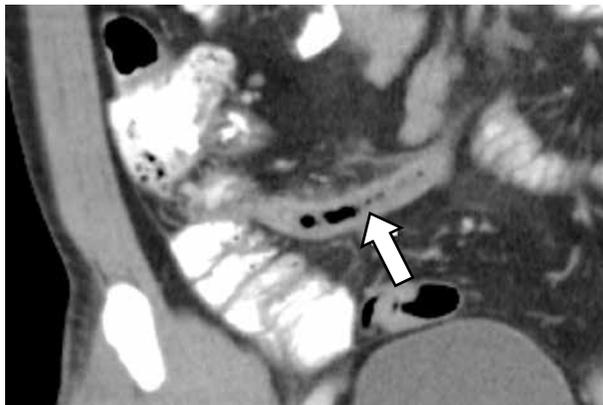


Figure 10. Coronal image of a CT with contrast medium which shows a thickened cecal appendix, with a diameter of 14 mm (arrow), with heterogenous thickening and enhancement of its walls (3 mm) and with inflammatory changes in the periappendic fat.



Figure 13. Contrast CT images in the axial plane (a) and saggital plane (b), showing a focal thickening in the walls of the cecum (white arrow), secondary to an acute appendicitis (orange arrow).

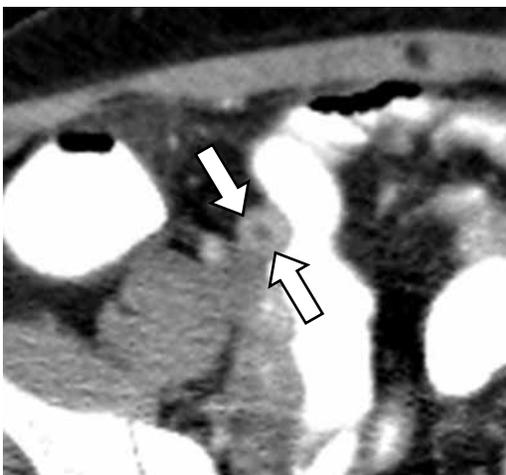


Figure 11. Axial CT cut with a contrast medium, showing the thickened appendix with pseudostratification of its walls, which configures the "Diana" sign (arrows).

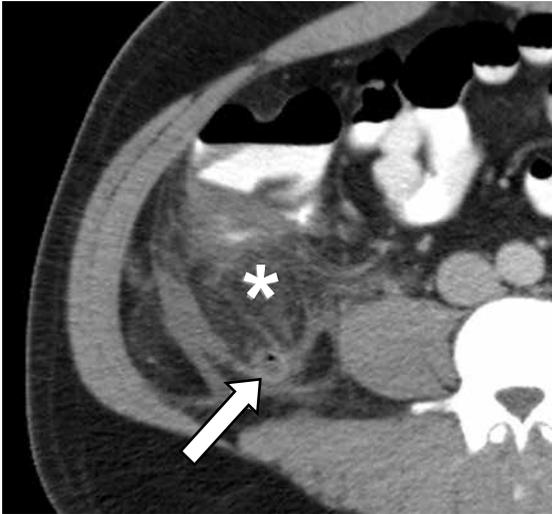


Figure 14. Axial cut of a contrasted CT, which shows an increase in the density and striation of fat (*), adjacent to the appendicular inflammatory process (arrow).

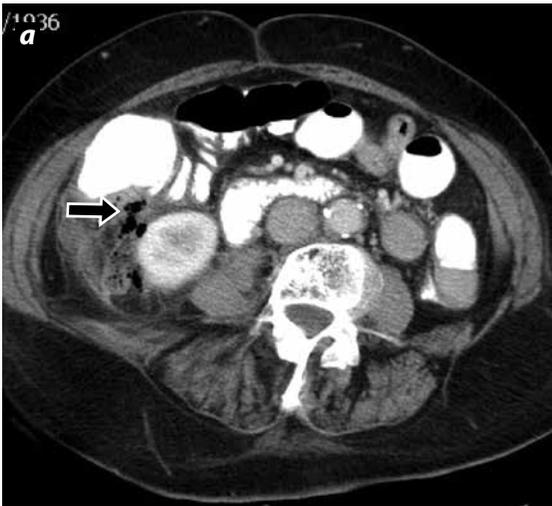


Figure 15. CT image with a contrast medium in the axial plane (a) and coronal plane (b). Extensive inflammatory changes in the fat of ileocecal region and extra luminal gas in the retroperitoneum due to a perforation (black arrow). In addition, this image indicates appendicitis with an appendicolith (white arrow).

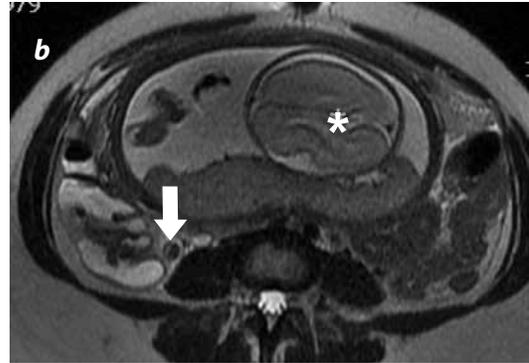
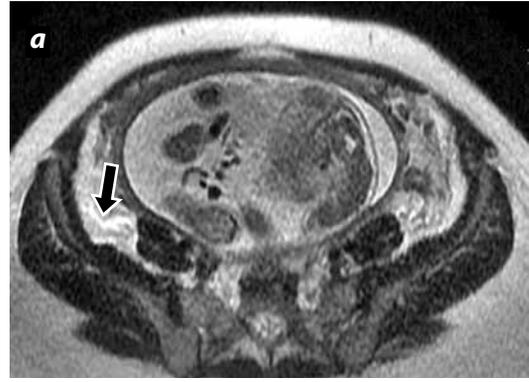


Figure 16. Axial MR images in SSFSE sequences potentiated in T2. a) Scarce free liquid is observed in the image. It has a high signal, in the fossa, the right iliac (black arrow), associated with an increase in the diameter of the cecal appendix (white arrow in image b), secondary to an acute appendicitis. Note the gravid uterus and the fetal head in the images (*).

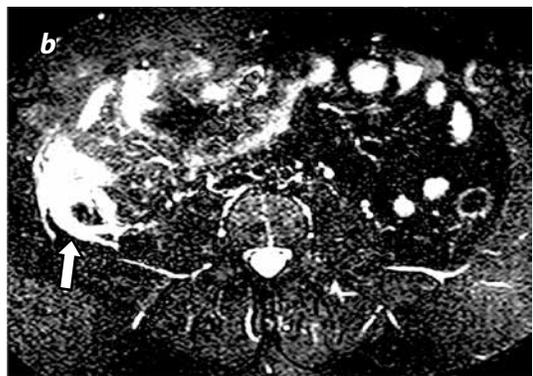


Figure 17. Axial MR images in SSFSE sequences with T1 (a) and T2 with fat suppression (b) information. A cecum tubular loop can be seen, thickened, located in the right iliac fossa, with alteration of a sign of surrounding mesenteric fat (black arrow). b) A free liquid in the cavity can be seen in the sequences with fat suppression (white arrow), adjacent to the cecal appendix, which indicates an inflammatory process.

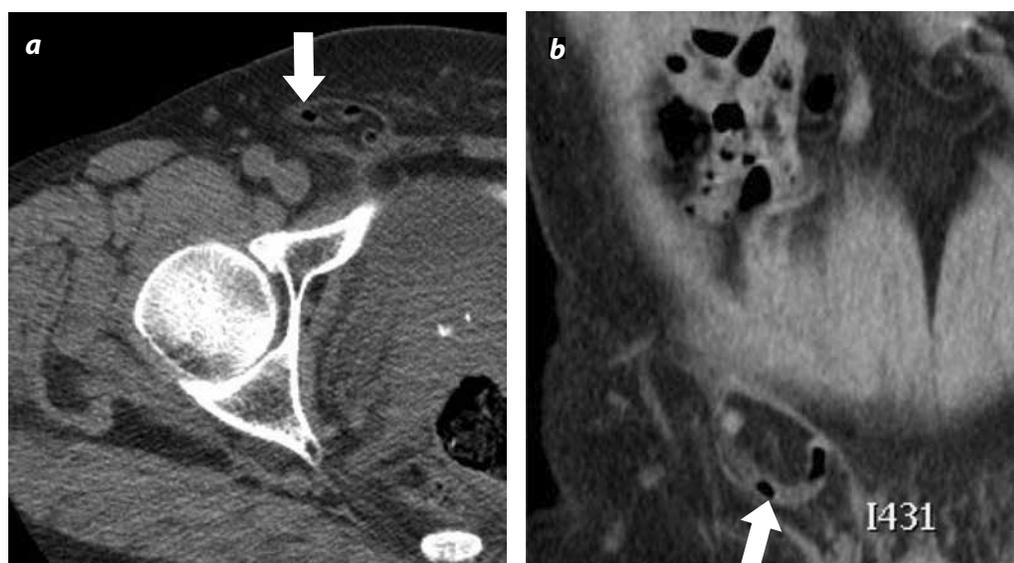


Figure 18. Unusual location of the cecal appendix. Axial cut (a) and coronal cut (b) of a CT which shows a cecal appendix (white arrow) inside of a right inguinal hernia.v

Images due to magnetic resonance

MR provides a high spatial resolution; however, there are some limiting factors for the massive implementation of this type of imaging such as elevated cost, low availability, long acquisition times, and movement artifact. The safety of Gadolinium in pregnant women is still controversial (3,5,19).

There are mainly two MR indications: as an alternative to CT in children with suspicion of appendicitis. However, it is not conclusive in U.S.; or in pregnant women with suspicion of acute appendicitis, but U.S. does not confirm or rule out diagnosis in these cases (2,5,40-45). Singh, et al. (46) suggest that the doctor asks three questions before requesting an MR for a pregnant woman:

- Is the information provided by U.S. not conclusive?
- Will the information provided by MR change the management of the patient?
- Can MR be postponed until the patient is not pregnant?

A doctor can request an MR if he/she believes it is appropriate after answering these three questions.

There are several MR imaging acquisition protocols in order to optimize the time of acquisition, reducing the artifacts or movement, and saving time to prevent the appearance of complications due to an inopportune treatment, without losing spatial resolution or image quality (3,40,46,47). Two of the most well-known protocols are free and sustained breathing (rapid).

The most common protocol is free breathing which has T2 potentiated images, with fat saturation; T1 potentiated images before and after administering an intravenous paramagnetic contrast medium. This protocol has a sensitivity of between 97-100%, a specificity between 92-93% (46); However, as previously mentioned, the safety of Gadolinium during the first semester of gestation is still being discussed.

In MR, the cecal appendix is visualized as a cecum tubular structure, with low T1w and T2w intensity when it has gas or fecal matter, or has the same muscle intensity than when it is collapsed. It is possible to visualize the appendix in up to 62% of normal patients. T2w is the series where this structure can be best visualized (5, 46). The size thresholds are the same than in a U.S. and a C.T., and the most representative

pathological findings have high periappendicular fat intensity in T2w, associated with changes in the wall and an increase in the transverse diameter of the appendix (figures 16 and 17). Periappendicular collections and abscesses can also be observed (3,5,46).

Available evidence

Several articles have been published regarding the performance of different imaging modalities for the diagnosis of acute appendicitis, which depend on variables such as age, sex, and specific clinical conditions. Some authors are in favor of performing diagnostic images to all patients with clinical suspicion of appendicitis (48). Other authors prefer that this inquiry is performed in doubtful cases. Few authors say that diagnostic images are not useful (11).

Despite great controversy on the matter, Dr. Parks, et al. (8), in her article, summarizes available evidence for the three image modalities which are most commonly used for the diagnosis of acute appendicitis (table 2). Therefore, guidelines have been suggested regarding the image modality that must be chosen, depending on the patient and the specific clinical characteristics (42,49-51).

In general terms, U.S. is preferred as an initial approach in children. Clinical findings are given a lot of relevance, as well as the pre-test probability for treatment; CT images are considered a second choice, and only when necessary. It is emphasized that it is better to avoid them. MR is still not included in the routine diagnosis algorithm (2) (chart 1). On the other hand, the most available technique in the institution must be used for adults, whether it is CT or U.S. However, U.S. should be used as a first option with the purpose of preventing patient irradiation as much as possible (30) (chart 2).

Diagnostic difficulties

The imaging diagnosis of acute appendicitis is rarely easy. The diagnostic difficulties of this entity can be grouped into two main categories: difficulties due to the bodily habit of the patient, and difficulties in the anomalous location of the cecal appendix (13,52-54).

Regarding the bodily habit of the patient, one must mention that in slender patients with low peritoneal fat, for example in children, it

Table 2. Staging performance of image modalities routinely used for the diagnosis of acute appendicitis

	S (%)	E (%)	VPP (%)	VPN (%)
Ultrasound	66 – 100	83 – 96	91 – 94	89 – 97
Computed tomography	90 – 100	91 – 99	92 – 98	95 – 100
Magnetic resonance	97 – 100	92 – 98	57 – 98	96 – 100

Source: Taken from Parks NA, Schroepel TJ. (8) (S: sensitivity, Sp: specificity, PPV: Positive predictive value, NPV: Negative predictive value).

Chart 1. Diagnostic algorithm for appendicitis in a pediatric patient. Modified from Strouse P. (2)

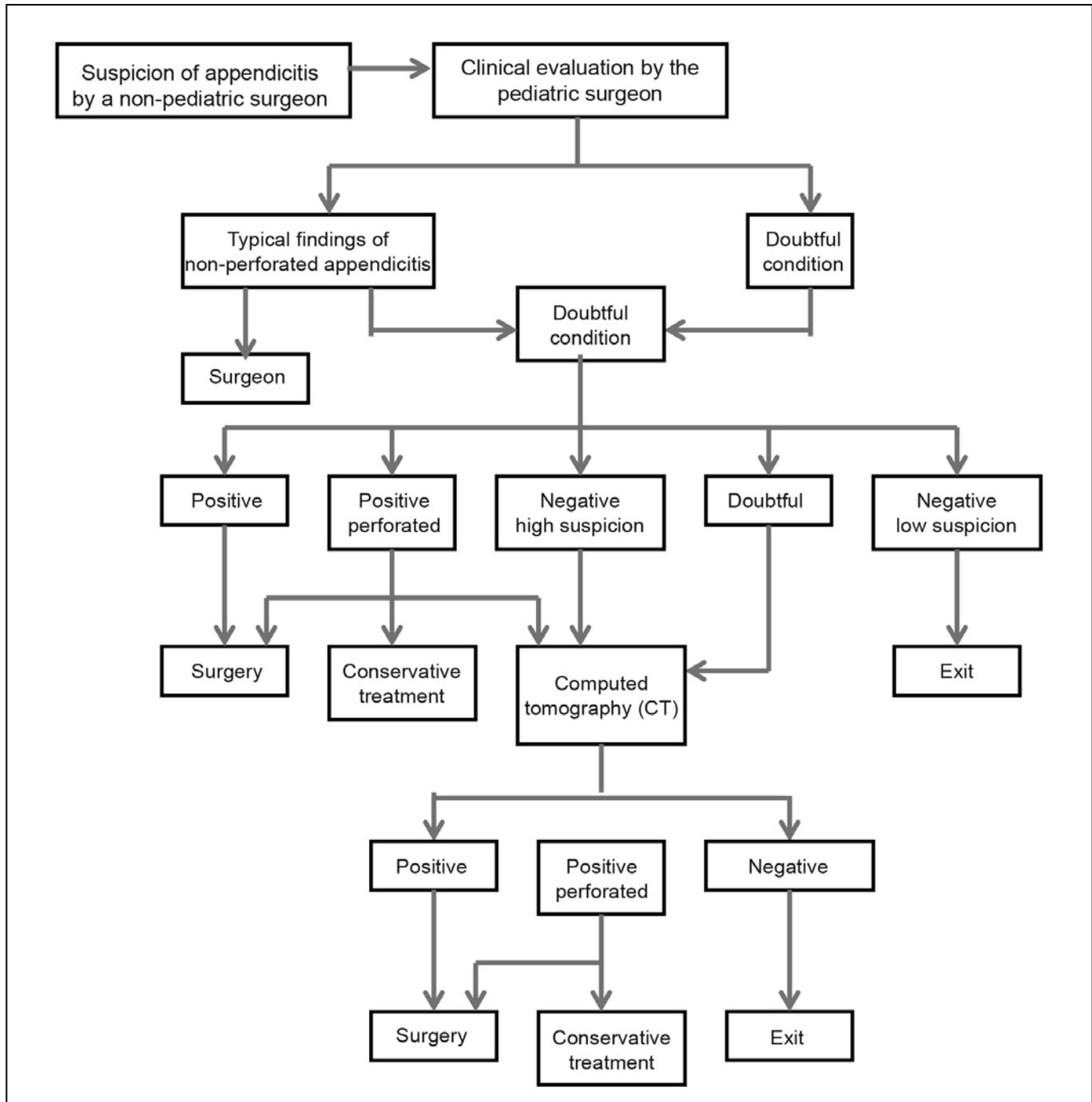
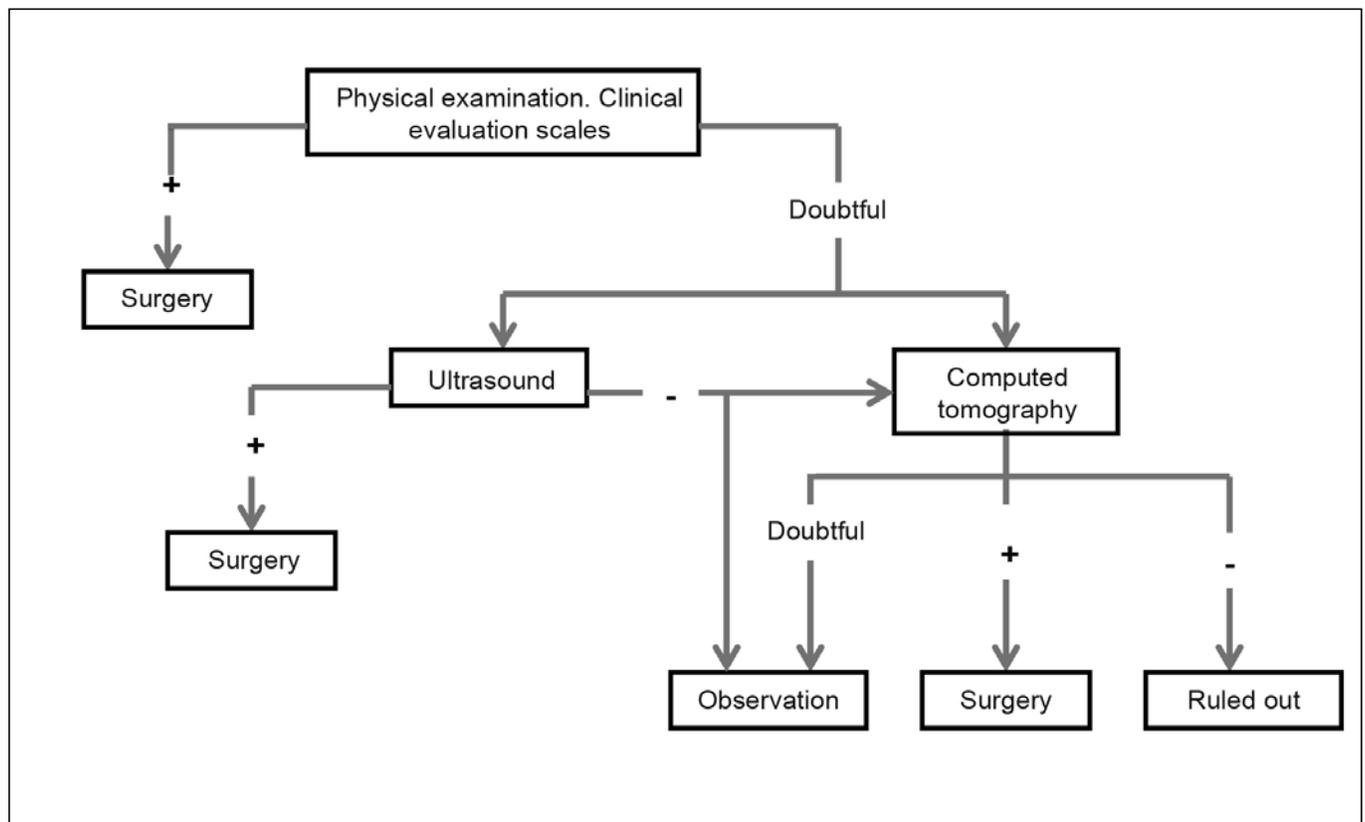


Chart 2. Diagnostic algorithm for appendicitis in an adult patient.

is difficult to differentiate the different CT abdominal structures. On the other hand, it is very difficult to perform an ultrasound in patients with abundant subcutaneous adipose tissue, given that fat limits the propagation of the ultrasound loop and the acoustic window.

Another difficulty in the diagnosis of acute appendicitis is the abnormal position or the anatomical variables of the cecal appendix. It can be located in a retrocecal manner, in the hepatorenal fossa, in an inguinal hernia (figure 18) or even in the left side of the abdomen (50, 53, 54). It is not infrequent that some patients with appendicitis simulate similar clinical conditions due to these atypical locations (for example, cholecystitis, etc.).

Differential diagnoses

There are several differential diagnosis of acute appendicitis, depending on age and sex (1, 3, 55, 56). In women of fertile age, gynecological and obstetrics causes of abdominal pain are the main differential diagnoses. Other causes of abdominal pain in the right iliac fossa are mesenteric adenitis, Crohn disease, diverticulitis, colon cancer, acute gastroenteritis, inflammatory pelvic disease, infection of the urinary tracts, urolithiasis, epiploic appendagitis, ovarian torsion, ectopic pregnancy, and stump appendicitis, among others (57-59).

Conclusion

Acute appendicitis continues to be one of the most frequent pathologies which require emergency attention and surgical treatment, with

associated morbidity and mortality rates which can be significant if a timely diagnosis and treatment are not performed.

Diagnostic images currently play a relevant role in the integral attention of patients with a clinical suspicion of acute appendicitis. Therefore, it is essential that the radiologist knows the imaging findings, the indications, the limitations, the benefits, and the potential risks of each modality in images, from a personalized focus for each patient.

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