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Usefulness of ultrasonography in children with right iliac fossa pain☆

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Abstract Acute pain in the right iliac fossa (RIF) is common in children. It can arise from a wide variety of gastrointestinal and genitourinary processes that make up the differential diagnosis with acute appendicitis (AA). In this article, we describe the most representative findings of these processes on ultrasonography (US). We emphasize the characteristics that enable these processes to be differentiated from AA.

PALABRAS CLAVE
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Utilidad de la ecografía en niños con dolor en la fosa ilíaca derecha

Resumen El dolor agudo en la fosa ilíaca derecha es un cuadro frecuente en la infancia. Su origen puede ser secundario a un amplio abanico de procesos gastrointestinales y genitourinarios que constituyen el diagnóstico diferencial de la apendicitis aguda. En el presente artículo se describen los hallazgos ecográficos más representativos de tales procesos, insistiendo en las características que permiten diferenciarlos de la apendicitis aguda.

Introduction

Acute pain in the RIF is common in pediatric patients. Although AA and intestinal intussusception are the typical causes, RIF pain can also be caused by multiple gastrointestinal and genitourinary disorders that should be considered in the differential diagnosis of AA.

US represents the ideal diagnostic modality in children with abdominal pain. Its excellent anatomic resolution in the pediatric population has helped reduce the negative

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appendectomy rate.[1] Technological advances in US allow examination of the layers of the intestinal wall and surrounding mesentery with high spatial resolution. This provides new clinical applications such as the assessment of acute inflammatory activity, response to treatment and complications of Crohn's disease, US evaluation of acute recurrent appendicitis, follow-up of intestinal involvement in Schönlein–Henoch purpura (SHP), preoperative assessment of the viability in cases of ovarian torsion, or support for the decision of performing a biopsy in celiac disease.

The objective of this study is to describe the US findings and the key diagnostic findings of those conditions that may present with acute RIF pain in children, with an emphasis on AA, since this is the most common disease in children requiring surgery[2,3] and the most common source of diagnostic errors.

Technique

The graded compression technique described by Puylaert in 1986 is based on the fact that gradual compression on the anterior abdominal wall eliminates bowel gas and intraluminal fluid from the bowel loops, reduces the distance between transducer and appendix, and displaces bowel loops out of the RIF.[4] This compression allows visualization of iliac vessels and psoas muscle, since the appendix is anterior to these structures (Fig. 1A). In addition to be ineffective and painful, fast compression may result in rupture of an appendix at risk for perforation.[2]

The exam is performed in the longitudinal and transverse planes. The ascending colon appears as a nonperistaltic structure containing fluid and gas. Inferiorly, the terminal ileum, compressible and peristaltic, can be identified. The cecal base, where the appendix arises, is 2–3 cm below the terminal ileum. While the base of the appendix is at a fairly constant location, its end may move freely, and its location is therefore very variable; however, this does not translate into a statistically significant difference in the rate of appendicitis.[5,6]

The topology of the superior mesenteric vessels and their relationship with the aorta and inferior vena cava should be systematically identified.

Normal right iliac fossa

The digestive tract comprises four concentric layers that can be differentiated histologically. The layers from deep to superficial are the mucosa—consisting of an epithelium with underlying lamina propria and the muscularis mucosa—, the submucosa, the muscularis propria and the adventitia. US shows a penta-stratified pattern where the first (superficial mucosa), third (submucosa) and fifth (adventitia) layers are hyperechogenic, and the second (muscularis mucosa) and fourth (muscularis propria) layers are hypoechoic[6–8] (Fig. 1B).

In adults, the thickness in any segment of the digestive tract is $\leq$3 mm. In children, it ranges between 1.5 and 3 mm in the terminal ileum and <2–3 mm in the colon, depending on the age.[8] Valvulae conniventes are <2 mm in width and 2–5 mm in length, being more numerous in the jejunum (two or three per cm) than in the ileum (two per cm). Given its intestinal origin, the appendix exhibits similar characteristics to the digestive tract, therefore, its maximum diameter should not exceed 6 mm in the transverse plane and its wall should not exceed 3 mm.[3,4,6,9] Nonetheless, histologically normal appendixes > 6 mm can also be found in cases of accumulation of secretions in the lumen, hyperplasia or fecal impaction.[10]

The normal appendix is oval-shaped in the transverse plane and easily compressible. Conversely, in appendicitis, the appendix walls are inflamed, rigid and noncompressible. Its lumen may contain air or fluid, or be collapsed with adhesion of the mucosal layers, giving rise to a central echogenic line.

Lastly, the mesentery appears slightly echogenic.

Acute appendicitis

AA is the most common condition requiring surgery in children and the one leading to more diagnostic errors. Traditionally, AA has been described to occur when fecal matter or appendicoliths obstruct the appendiceal lumen, which is usually followed by infection. However, we know now that AA is not always secondary to obstruction and that several causes may lead to AA: lymphoid follicular hyperplasia obstructing the cecal–appendiceal junction, inflamed follicles in infectious processes, foreign bodies, or trauma. These factors lead to inflammation and an increase in intraluminal pressure. As a result, the appendix enlarges and induces inflammatory changes in the surrounding tissues, such as the pericecal fat and peritoneum.[2] Ultimately, ischemia occurs and the inflamed appendix, eventually, perforates.

Sensitivity and specificity of sonography for the diagnosis of AA vary greatly between studies (up to 100 and 98%, respectively).[2–12] The appendiceal diameter is considered the most relevant morphologic criteria (sensitivity > 98%) and, traditionally, the threshold diameter > 6 mm has been used for diagnosis of appendicitis. On transverse images, the appendix appears fixed, round and noncompressible. Hyperechogenicity of the pericecal fat is common. This fat may increase in volume and surround the appendix, which represents the inflamed omentum that migrates to the appendiceal area in case perforation occurs (Fig. 2A). Free fluid and mesenteric lymph nodes are frequent but unspecific. In up to 30% of cases, appendicoliths are seen in the appendiceal lumen.[2]

Doppler signal varies depending on the stage of the disease. Although it might increase in the acute phase (Fig. 2B), it may diminish in case of appendiceal perforation.[2–4,9] Therefore, Doppler examination alone cannot reliably distinguish between normal and abnormal appendix. Perforation can be suspected in the presence of an irregular contour of the appendix, fluid or collections, and dilated bowel loops with thickened walls[2–4,7,10,13] (Fig. 1E). After perforation occurs, the appendix is usually decompressed and it is visible only in 30–60% of cases.[4,9,13]

Acute pain, gas and severe obesity may complicate visualization of the appendix. Therefore, the nonvisualization of the appendix does not allow us to rule out AA despite the fact that the first studies considered the nonvisualization on US