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SPECIAL ARTICLE

Diagnostic Imaging of Acute Appendicitis in Reproductive-age Women

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ABSTRACT

Acute pelvic pain is a common presenting symptom in reproductive-age women. This condition may be associated with gynecologic disease such as pelvic inflammatory disease, ruptured ovarian cyst or nongynecologic conditions including gastrointestinal or urinary tract diseases. Acute appendicitis, the most common cause of nongynecologic pain may mimic the more common gynecologic conditions, due to nonspecific signs and symptoms. Therefore, diagnostic imaging is necessary.

Transabdominal and/or transvaginal ultrasound (US) is the preferred imaging modality for initial assessment when an obstetrical or gynecologic etiology is suspected. If the result is inconclusive or normal, computerized tomography (CT) should be performed. Currently CT is the imaging modality of choice for diagnosis of acute appendicitis in adult. The diagnosis of acute appendicitis on both US and CT examination are based on evidence of an inflamed appendix, showing fluid-filled distension, enlarged appendix (greater than 6 mm), appendiceal wall thickening with enhancement and/or appendicolith. Periappendiceal inflammatory change are also seen. In perforated appendicitis, more specific findings are extraluminal air, extraluminal appendicolith, pericecal phlegmon or abscess and defect in enhancing appendiceal wall.

Acute pelvic pain is a common presenting symptom in reproductive-age women. However, diagnosis of acute pelvic pain can be problematic especially pain at the right side. Nonspecific signs and symptoms including pelvic pain, fever and a pelvic mass may be associated with a gynecologic condition, gastrointestinal tract or urinary tract disease. Acute appendicitis, the most common cause of nongynecologic pain, may mimic the more common gynecologic conditions such as pelvic inflammatory disease or ruptured ovarian cyst. Typically, it requires imaging to determine the exact etiology.

Ultrasound (US) is the preferred imaging modality for initial assessment when an obstetrical or gynecologic etiology is suspected in reproductive age women with acute pelvic pain[1]. Therefore, gynecologist should be familiarised with imaging findings of acute appendicitis that often mimic the signs and symptoms of other gynecologic conditions.

Role of US in reproductive-age women with acute appendicitis

US is a widely available, rapid, noninvasive and inexpensive modality. This examination requires no patient's preparation or contrast material administration. The most important advantage of US in reproductive-age women is a lack of ionizing radiation because,

pregnancy-related causes may be one of the etiologies of acute pelvic pain in these patients related causes. So usage of radiation should be avoided. Therefore, US is the best initial imaging modality in women of reproductive age with acute pelvic pain because of its ability to differentiate gynecologic from non-gynecologic conditions.

However, disadvantage of this technique is operator-dependence. Operator's skill is an important factor in all US examinations especially in case of right lower quadrant pain or suspected acute appendicitis. US in experienced hands, has reported sensitivities of 75-90%, specificities of 86-100%, accuracies of 87-96%, positive predictive values of 91-94%, and negative predictive values of 89-97% for the diagnosis of acute appendicitis[2]. However, the inexperienced operator, poor equipment and poor technique, will not provide the excellent results possible with this modality.

US techniques[2-5]

US should be performed through the abdomen and pelvic cavity, for evaluate many causes of right-sided abdominal pain such as acute cholecystitis, obstructive uropathy or gynecologic causes including ectopic pregnancy, ruptured ovarian cyst or pelvic inflammatory disease. This step is examined with a 3.5-5 MHz curve array transducer. Additional transvaginal US is helpful for evaluate gynecologic conditions.

Next step for evaluation of the appendix, a high-resolution or high-frequency (> 5 MHz) linear array transducer must be used with graded-compression technique. This most familiar technique was first introduced by Puylaert in the mid-1980s. It describes the use of gentle, slow and uniform pressure on the region of interest (right lower quadrant region) by the US transducer, resulting in displacement and compression of normal gas-filled bowel loops. Differentiation between the inflamed appendix or abnormal non-compressible bowel loops and normally compressible bowel loops can be easily performed by this maneuver. Adequate compression has been completed, if the iliac vessels and psoas muscle are visualized. The appendix locates anterior to these structures. Sagittal and transverse scanning should be performed. Identification of the ascending colon is the first step. It appears as a non-peristaltic structure containing gas and fluid. Then, the transducer is swept inferiorly to identify the terminal ileum, seen as an active peristaltic and compressible tubular structure. The appendix arise from the cecal tip which locates about 1-2 cm below the terminal ileum.

However, in obese patient, the curve array transducer is more advice, which provide a greater penetration and larger field of view. Furthermore, the operator should ask the patient for the point of maximum tenderness. This is useful to aid in locating an appendix, especially retrocecal and pelvic type. In general, a retrocecal appendix can be seen by coronal scan which the transducer parallel to the iliac wing to optimize visualization posterior to the cecum. A pelvic appendix, one of unusual position, is best visualized by the transvaginal US[6]. The pelvic appendicitis is most frequently confused with gynecologic disease and consequently misdiagnosed. Therefore, transvaginal US is recommended for reproductive-age women with pelvic pain, fever or a pelvic mass whenever gynecologic and gastrointestinal-tract disease cannot be clearly differentiated at routine transabdominal US[6].

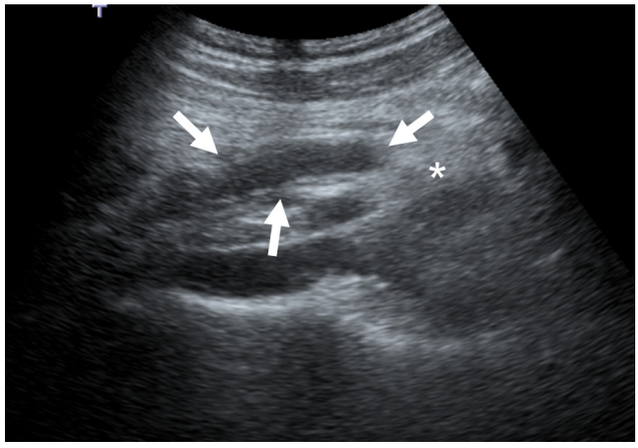

Fig. 1. Longitudinal scan through the appendix of patient with acute appendicitis, showed blind-ending, fluid-filled tubular structure with a laminated wall (white arrow) and evidence of periappendiceal inflammation, seen as echogenic periappendiceal fat (white *)

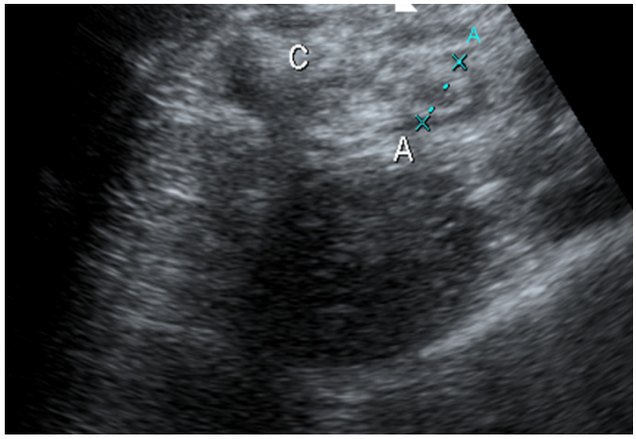

Fig. 2. Transverse scan through the appendix of patient in fig. 1, showed target appearance, characterized by a fluid-filled hypoechoic or anechoic center, surrounded by echogenic mucosa and submucosa, and outer hypoechoic muscular layer (Appendix : A, Cecum : C)

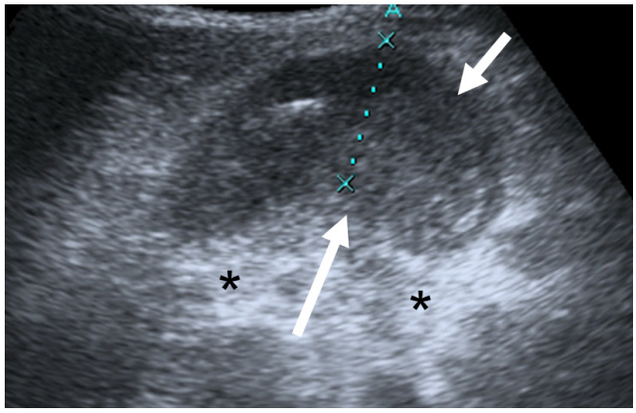

Fig. 3. Longitudinal scan through the appendix of patient with acute gangrenous appendicitis, revealed blind-ending, fluid-filled tubular structure with diffuse loss of definition of the wall layers (white arrow). Echogenic periappendiceal fat inflammation was noted. (black *)

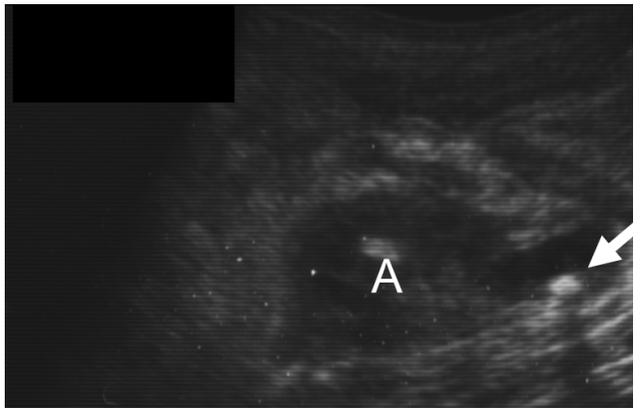

Fig. 4. Oblique scan through the right lower quadrant region of patient with ruptured appendicitis, showed round, echogenic foci with posterior acoustic shadow that indicate appendicoliths in the adjacent periappendiceal fluid collection or abscess (white arrow: appendicoliths, A : Abscess)

US findings of acute appendicitis[2-5]

The inflamed appendix shows a blind-ending, fluid-filled tubular structure with a laminated wall, seen on longitudinal view (Fig. 1). It should be noncompressible and aperistalsis. The maximum diameter is larger than 6 mm, from outer wall to outer wall. On transverse view, the target appearance is visible, characterized by a fluid-filled hypoechoic or anechoic center, surrounded by echogenic mucosa and submucosa, and outer hypoechoic muscular layer (Fig. 2). Focal or diffuse loss of definition of the wall layers indicate ischemic and gangrenous appendicitis (Fig. 3). Localized disruption of the appendiceal wall and extraluminal air bubbles may be present in perforated cases. Appendicoliths appear as rounded, echogenic foci with posterior acoustic shadow (Fig. 4). Their presence within the appendiceal lumen or in the adjacent periappendiceal soft tissue after perforation is highly associated with appendicitis. However, if it is not evidence, appendicitis cannot be excluded.

Periappendiceal findings can help for suggested diagnosis of appendicitis. Evidence of periappendiceal inflammation is usually seen, showing echogenic peri-appendiceal fat (Fig. 1, 3). It may cause mass effect and separate the inflamed bowel segment from adjacent structures. Periappendiceal phlegmon appears as hypoechoic area with poor margination within the inflamed periappendiceal fat. Periappendiceal abscess (Fig. 4) manifests as focal fluid-like collection with well encapsulation, high specificity for perforated appendicitis. Gas bubbles within the collection suggest either perforation or gas-forming organisms. Adjacent cecal and terminal ileal wall thickening may be seen in cases of appendicitis.

Color Doppler examination may add valuable information. Evidence of hyperemia in the inflamed appendiceal wall or adjacent bowel wall including cecum and terminal ileum can be depicted. However, absent or decreased flow may be seen in cases of gangrenous appendicitis. Hyperemia in the inflamed periappendiceal fat is also noted.

Role of computerized tomography in reproductive- age women with acute appendicitis

The recognized and important disadvantage of CT is a lot of ionizing radiation. Pregnant or suspected pregnant patient must be kept away from this imaging modality. US should be primarily performed to exclude pregnancy-related or gynecologic etiologies of acute pelvic pain. CT is a complementary to US and is recommended whenever US results are suboptimal, indeterminate or normal in patients with acute pelvic pain.

Nowadays, CT is the imaging modality of choice for the evaluation of acute abdominal pain as the result

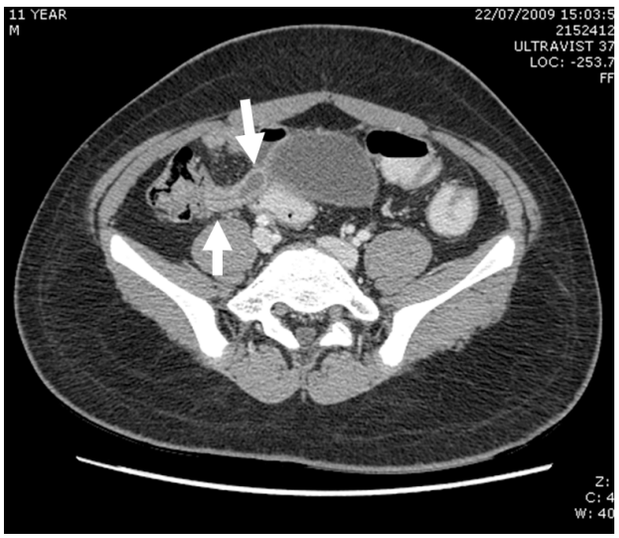

Fig. 5. Axial enhanced CT scan of patient with acute appendicitis, showed fluid-filled distension and enlargement of appendix with homogeneous enhancing thicken appendiceal wall (white arrow)

of suspected appendicitis in adult. CT has reported sensitivities of 88-100%, specificities of 91-99% and accuracies of 94-98%[7]. The advantage of CT over US are operator's independence, superior contrast sensitivity and reduced limited visualization of the appendix in the obese patient. Moreover, CT is more useful than US for evaluating complication of acute appendicitis, such as perforation, phlegmon and abscess formation.

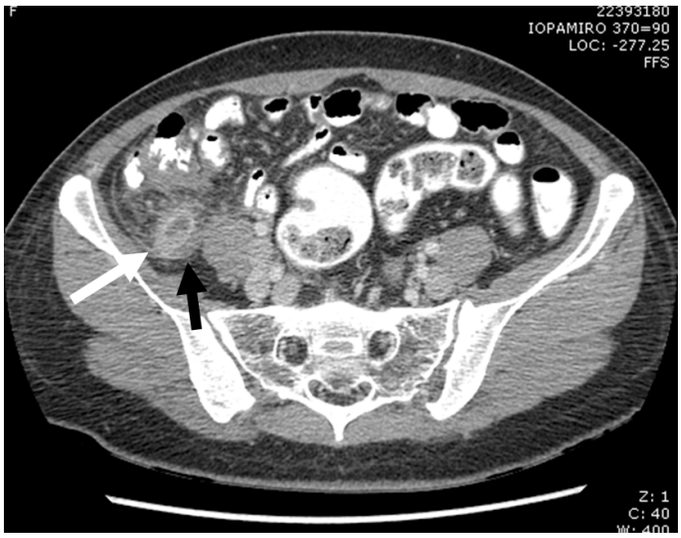

Fig. 6. Axial enhanced CT scan of patient with acute gangrenous appendicitis, showed fluid-filled distension and enlargement of appendix with shaggy appendiceal wall (white arrow). Periappendiceal fat strandings were seen. (black arrow)

Fig. 7. Axial enhanced CT scan of patient with acute gangrenous appendicitis showed appendiceal enlargement (12 mm in diameter), enhancing thicken wall with patchy non-enhancing area (black arrow) and intraluminal appendicolith (white arrow)

Fig. 8a,b. Axial enhanced CT scan of patient with perforated appendicitis and abscess, showed extraluminal appendicoliths (white arrow) and pericecal abscess (A), showing well-circumscribed fluid collection with rim enhancing thicken wall with multiple extraluminal air (black arrow on fig.8b)

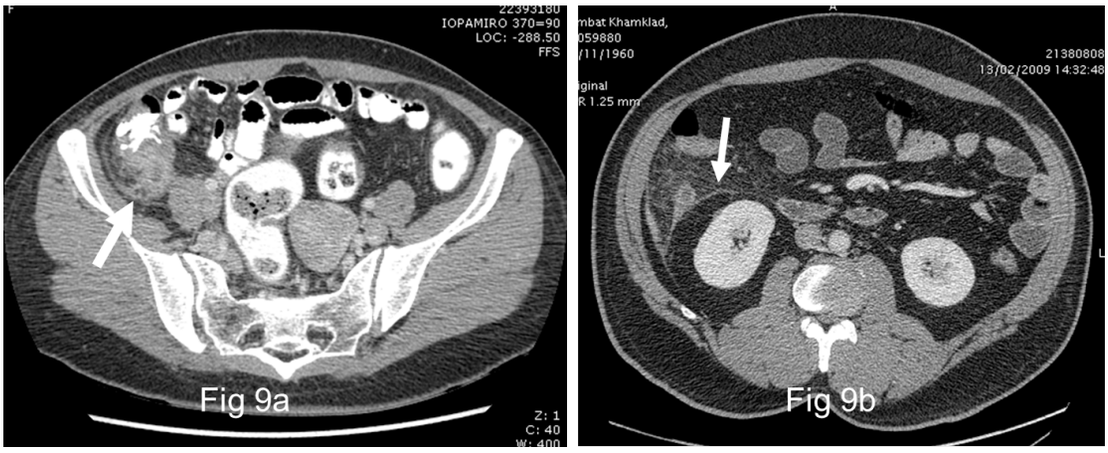

Fig. 9a,b. Axial enhanced CT scan of patient with acute gangrenous appendicitis, showed fluid-filled distension and enlargement of appendix with enhancing appendiceal wall, right lateroconal and right anterior pararenal fascial thickening (white arrow) and periappendiceal fat strandings.

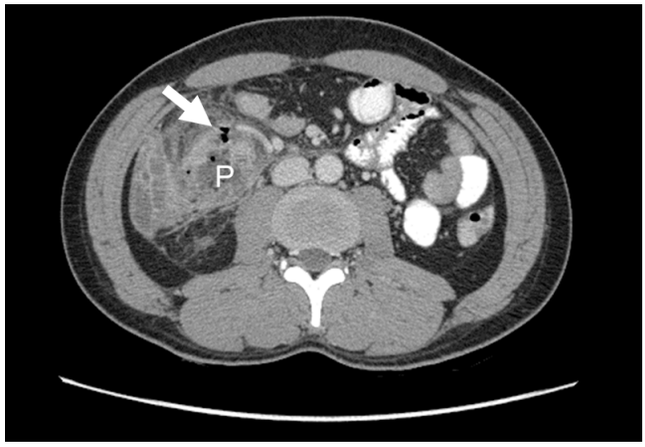

Fig. 10. Axial enhanced CT scan of patient with perforated appendicitis, showed pericecal phlegmon (P), showing marked pericecal fat inflammation with ill-defined fluid collection. Extraluminal air bubbles were present (white arrow).

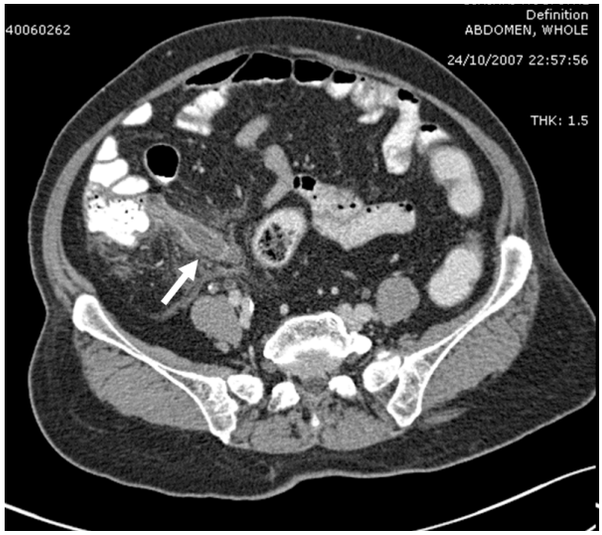

Fig. 11. Axial enhanced CT scan of patient with perforated appendicitis. Dilated appendix was noted, measured 15 mm. in diameter, with defect in enhancing appendiceal wall, seen as disruption of enhancing line (white arrow). Periappendiceal fat standing was seen.

CT findings of acute appendicitis[2,3,7]

Diagnosis of acute appendicitis on CT examination is based on evidence of an inflamed appendix and periappendiceal inflammatory change. The inflamed appendix shows fluid-filled distension and enlargement, typically greater than 6 mm in outer wall to outer wall diameter (Fig.5). This cutoff point is referred from findings of US performed with graded compression technique, whereas CT images are obtained without compression. Therefore, normal appendiceal diameter in CT can be measured at greater than 6 mm especially in air-filled, contrast-filled or bowel content-filled distended appendix. In the study by Charoensak A et al[8], approximately 62% of visualized normal appendices have maximum outer diameter greater than 6 mm and only 2.5% of visualized normal appendices have maximum outer diameter greater than 10 mm, they defined the upper limit of normal as 10 mm.

In general, the inflamed appendix shows circumferential and symmetrical wall thickening. Due to variable in outer diameter of normal appendix, Huwart L et al[9] has suggested that wall thickness of the appendix is a more reliable measurement than appendiceal diameter. From results of previous studies[8,9], they found only 6.6% and 4.2% of visualized normal appendices that had two walls thickness more than 6 mm. Therefore, the threshold of two walls thickness at greater than 6 mm is usually suggested inflamed appendix. The thicken appendiceal wall hyperenhancement (Fig.5) after IV contrast administration should be seen, may be homogeneous or may exhibit a target sign appearance. Patchy non-enhancing areas in thicken appendiceal wall may be seen in gangrenous appendicitis as well as pneumatosis and shaggy appendiceal wall (Fig. 6, 7).

The calcified appendicolith (Fig. 7, 8) is often seen, 43-46% of patients with acute appendicitis[10]. A definitive CT diagnosis of acute appendicitis can be made if a calcified appendicolith is seen in association with pericecal inflammation[2]. However, the presence of an appendicolith alone without surrounding inflammation is not diagnostic for acute appendicitis[7,11], because it can be found in normal subjects. Presence of appendicolith increases the likelihood of appendiceal perforation.

Periappendiceal inflammation is present in majority of cases, about 98% of CT[2] findings of periappendiceal inflammation include periappendiceal linear fat strandings (Fig.6) and/or fluid collections, haziness or thickening of the appendiceal mesocolon and local fascial thickening such as right lateroconal or pararenal fascia (Fig. 9). The inflamed appendix may

cause reactive focal wall thickening at cecal apex and the cecal arrowhead sign, appears as triangular configuration of oral contrast material funneling into the focally thickened cecal apex and pointing toward the occluded appendiceal orifice. The cecal bar sign may be seen, depicting linear inflammatory soft tissue at the base of the appendix that separates the contrast-filled cecum from the appendix.

In perforated appendicitis, more specific CT findings[12-14]) are extraluminal air (Fig. 8b, 10), extraluminal appendicolith (Fig. 8a,b), pericecal phlegmon (Fig. 10) or abscess (Fig. 8a,b) and defect in enhancing appendiceal wall (Fig. 11). Phlegmon is characterized by diffuse and marked periappendiceal or pericecal fat inflammation with ill-defined fluid collection. Abscess is defined as a well-circumscribed fluid collection with rim enhancing thicken wall. The other less specific findings including marked ileocecal wall thickening, localized lymphadenopathy, peritonitis and small bowel obstruction may be present in perforated cases.

Conclusion

Acute appendicitis is the most common cause of nongynecologic condition in reproductive age women with acute pelvic pain. This condition usually mimics the gynecologic diseases such as pelvic inflammatory disease or ruptured ovarian cyst. Transabdominal and/or transvaginal US is recommended for initial evaluation which help for exclude pregnancy-related or gynecologic etiologies of acute pelvic pain. If the result is inconclusive or normal, CT should be performed. Currently, CT is the imaging modality of choice for diagnosis of acute appendicitis in adult. The diagnosis of acute appendicitis on both US and CT examination are based on evidence of an inflamed appendix and periappendiceal inflammatory change.

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ภาพวินิจฉัยทางรังสีวิทยาของภาวะไส้ติ่งอักเสบเฉียบพลันในสตรีวัยเจริญพันธุ์

วรรณวรางค์ สุทธิคีรี

ภาวะปวดท้องน้อยอย่างเฉียบพลันเป็นอาการที่พบได้บ่อยในผู้หญิงวัยเจริญพันธุ์ โดยอาจมีสาเหตุมาจากโรคของระบบสืบพันธุ์ของเพศหญิงเองหรืออาจเป็นจากระบบอื่นก็ได้เช่น ระบบทางเดินอาหารหรือระบบทางเดินปัสสาวะ ซึ่งสาเหตุที่เกิดจากระบบอื่นนั้นที่พบได้บ่อยที่สุดคือ ภาวะไส้ติ่งอักเสบเฉียบพลัน การวินิจฉัยแยกโรคข้างต้นเป็นไปได้ค่อนข้างยากเพราะอาการและอาการแสดงไม่ค่อยจำเพาะ ดังนั้นการตรวจวินิจฉัยทางรังสีวิทยาเพิ่มเติมจึงมีความจำเป็นอย่างมาก

การตรวจด้วยคลื่นเสียงความถี่สูงหรืออัลตร้าซาวน์เป็นการตรวจขั้นแรกที่เหมาะสมที่สุดเพราะสามารถวินิจฉัยโรคในระบบสืบพันธุ์ของเพศหญิงได้เป็นอย่างดี และเนื่องจากเป็นวิธีการตรวจที่ไม่มีรังสีเอกซเรย์จึงเหมาะสมสำหรับผู้ป่วยตั้งครรภ์ที่อาจเกิดภาวะแทรกซ้อนที่ทำให้มีอาการปวดท้องน้อยได้ อย่างไรก็ตามหากการตรวจด้วยคลื่นเสียงความถี่สูงนั้นไม่สามารถให้การวินิจฉัยได้หรือตรวจแล้วไม่พบความผิดปกติอันมีสาเหตุมาจากระบบสืบพันธุ์ของเพศหญิง การตรวจวินิจฉัยเพิ่มเติมด้วยเครื่องเอกซเรย์คอมพิวเตอร์ช่องท้องเพื่อหาสาเหตุอื่นดังเช่น ภาวะไส้ติ่งอักเสบเฉียบพลันก็ควรทำเป็นลำดับถัดไป

การวินิจฉัยภาวะไส้ติ่งอักเสบสามารถทำได้ทั้งจากการตรวจด้วยคลื่นเสียงความถี่สูงหรือตรวจด้วยเครื่องเอกซเรย์คอมพิวเตอร์ช่องท้อง โดยจะพบความผิดปกติคือ ไส้ติ่งจะมีขนาดใหญ่ขึ้น โดยทั่วไปจะมีขนาดใหญ่กว่า 6 มิลลิเมตร ผนังหนาตัวขึ้น บวมมีน้ำคั่งภายในรูของไส้ติ่ง มีการอักเสบของไขมันโดยรอบไส้ติ่ง อาจพบหินปูนอุดภายในรูของไส้ติ่งได้ นอกจากนี้ถ้าการอักเสบรุนแรงมากจนเกิดการทะลุ อาจพบลักษณะฝีหนองโดยรอบไส้ติ่ง มีลมรั่วหรือหินปูนหลุดออกจากรูของไส้ติ่งที่แตก เป็นต้น