Acute Pelvic Pain

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Acute pelvic pain in a woman can be due to gynecologic, gastrointestinal, and urinary tract disorders. This chapter focuses on gynecologic causes of acute pelvic pain. Pregnancy-related disorders, such as ectopic pregnancy, spontaneous abortion, and ovarian hyperstimulation, are not covered, nor are postpartum and postsurgical causes.

Acute pelvic pain, defined as the sudden onset of lower abdominal or pelvic pain lasting less than 3 months [1], is a common urgent clinical presentation. Women frequently present to the emergency department after hours. More than one third of women of reproductive age experience nonmenstrual pelvic pain [2]. Acute pelvic pain can pose a diagnostic challenge because the clinical history, symptoms, and physical examination findings are often nonspecific, and the clinical presentations of the underlying gynecologic, obstetric, urologic, and gastrointestinal conditions often vary widely and can frequently overlap. Although some of the common conditions, such as ruptured or hemorrhagic ovarian cysts, are self-limiting, it is imperative that urgent conditions that may necessitate intervention or surgery, such as ovarian torsion, pelvic inflammatory disease (PID), and appendicitis, be considered when a premenopausal woman has acute pelvic pain.

The American College of Radiology Appropriateness Criteria list pelvic sonography as the preferred first-line imaging modality in the evaluation of acute pelvic pain in pregnant women and nonpregnant women of reproductive age when an obstetric or gynecologic condition is suspected and in the initial assessment of a suspected nongynecologic condition in a pregnant patient [3]. This can be attributed to its ready availability, cost-effectiveness, noninvasive nature, and lack of ionizing radiation. Sonography can also prove helpful in the assessment of suspected gastrointestinal or urinary tract abnormalities in a nonpregnant woman; however, CT is typically the preferred first-line imaging modality for those patients [3].

Adnexal Torsion

The term adnexal torsion broadly refers to torsion of the ovary, fallopian tube, or both. It most commonly involves both [4], because the ipsilateral fallopian tube usually twists with the ovary [5]. Adnexal torsion can, however, occur with isolated torsion of the ovary and even more rarely involve only the fallopian tube [4]. Given the rarity of isolated fallopian tube torsion (an incidence of 1 in 1.5 million women), this diagnosis is rarely made preoperatively [6].

Ovarian torsion occurs when the vascular pedicle of the ovary twists along its suspensory ligament and causes initial obstruction of venous and lymphatic outflow and eventual arterial compromise with resultant ischemia and hemorrhagic infarction [7]. Ovarian torsion can occur at any age but most frequently occurs in women of reproductive age [4]. The characteristic clinical presentation of ovarian torsion is acute onset of sharp, intermittent pain localized to a lower quadrant, often with associated nausea and vomiting [8]. A tender adnexal mass may also be palpated at physical examination [8–10]. In 50–81% of cases of ovarian torsion, an underlying lesion is seen in the ipsilateral ovary [8, 9, 11, 12].

The most consistent gray-scale sonographic finding in ovarian torsion is unilateral ovarian enlargement [5, 13–15] with variability in the internal ovarian architecture (Fig. 1). In a premenopausal woman, the ovary is considered enlarged if the greatest ovarian dimension is more than 4 cm [7, 15] or the volume is larger than 20 cm^3 [7]. An underlying cystic, solid, or mixed solid and cystic mass may be seen within the affected ovary [8, 9, 12, 15–17], or the enlarged ovary may have a heterogeneous internal echotexture, reflecting intraovarian edema and hemorrhage. Multiple small, uniform, peripherally located cysts displaced to the cortex of the engorged ovary are seen in as many as 74% of cases [5, 13, 15]. This finding is sometimes referred to as the string-of-pearls sign [15]. Free fluid may be present owing to transudation from the torsed ovary secondary to venolymphatic obstruction [13, 16]. In ovarian torsion, the affected ovary can be found in an unusual location (Fig. 1), such as in the midline or cranial to the uterine fundus [15, 18]. Transducer palpation over the affected ovary may elicit local tenderness at transvaginal sonography [15].

A specific finding of ovarian torsion that may be seen with gray-scale ultrasound imaging with or without color Doppler

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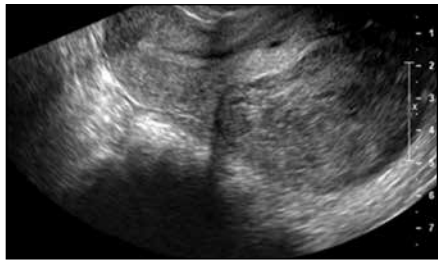
technique is the swirling appearance of the vessels within the twisted vascular pedicle (Fig. 1), sometimes called the whirlpool sign [7, 19]. This sign has the appearance of a round hyperechoic structure with a target appearance characterized by several concentric hypoechoic bands. The twisted vascular pedicle was found to have sensitivity of 88% and specificity of 87% (93% positive and 76% negative predictive values) in one study [9] but was seen in only 13% of cases in another series [16]. Although it may be technically challenging to identify, when seen in conjunction with ovarian enlargement, the finding of a twisted vascular pedicle is considered diagnostic of ovarian torsion [7].

Color Doppler findings can be highly variable and are related to the degree and chronicity of vascular compromise [7]. Lack of arterial and venous Doppler flow is helpful as a supporting finding, but the presence of detectable arterial and venous flow does not exclude ovarian torsion [7]. In one series [20] Doppler sonographic findings were normal in 60% of patients with surgically confirmed ovarian torsion (Fig. 1). In a study in which color Doppler findings were abnormal in 93% of patients, the most common (40%) abnormal flow pattern was complete absence of both arterial and venous flow [16]. In order of decreasing frequency, the other flow patterns were decreased venous and absent arterial flow (33%), decreased venous and arterial flow (13%), decreased arterial and absent venous flow (7%), and normal arterial and venous flow (7%). The ovary can even appear hyperemic in instances of intermittent torsion-detorsion [21]. Given the wide range of technical settings, comparison images of the color Doppler appearance of both ovaries is helpful in evaluations for asymmetric vascularity.

Although ultrasound is the preferred imaging modality for ovarian torsion, CT and MRI can also be helpful in assessment. Like sonography, CT and MRI can also reveal an enlarged ovary with or without an associated underlying ovarian mass, peripherally located follicles, the twisted vascular pedicle, and ascites [7, 15, 22] (Fig. 2). Additional CT findings include a mass in the adnexa, which is sometimes located in the midline, engorged vessels on the affected side, uterine deviation toward the side of the torsion, and fallopian tube thickening [7, 15, 22]. Associated findings of subacute ovarian hematoma and abnormal or absent ovarian enhancement are better delineated with CT or MRI than with ultrasound [7].

Pelvic Inflammatory Disease

PID is a frequent cause of acute pelvic pain, affecting as many as 1.5 million women per year in the United States [5, 23]. PID is an ascending sexually transmitted infection from the cervix to the upper genital tract with subsequent infection that can involve the endometrium, fallopian tubes, ovaries, and peritoneum. It is most frequently caused by *Chlamydia trachomatis* or *Neisseria gonorrhoeae* [24]. Encompassed under the umbrella term of PID are tuboovarian abscesses, endometritis, salpingitis, and peritonitis. Chronic pelvic pain, infertility from scarring, and increased risk of ectopic pregnancy may result



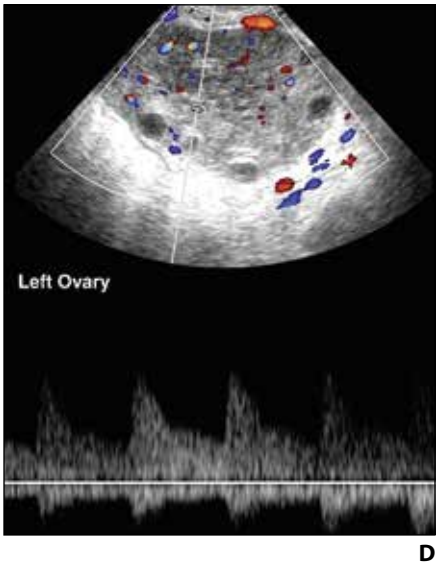


Fig. 1—29-year-old woman in emergency department with acute left-sided pelvic pain.
A, Transvaginal long-axis ultrasound image of left ovary shows enlargement of ovary (*asterisk*) with follicles displaced to periphery.
B, Long-axis transvaginal image of uterus shows relative location of ovary in cul-de-sac.
C, Transvaginal longitudinal ultrasound scan through left adnexa shows round hyperechoic structure with swirling appearance compatible with twisted vascular pedicle (*arrow*).
D, Color and spectral Doppler images of left ovary show presence of arterial flow. This finding does not exclude diagnosis of ovarian torsion, which was found at surgery.

[25]. Known risk factors for PID include young age (15–24 years), numerous sexual partners, history of sexually transmitted infections, bacterial vaginosis, and history of surgical instrumentation via the cervix [26].

The clinical presentation of PID is variable, the most common symptom being lower abdominal pain. Patients may also report fever, malaise, vaginal discharge, vaginal bleeding, dysuria, or dyspareunia; PID may even be asymptomatic [27]. Physical examination may reveal abdominal tenderness, cervical motion, and adnexal tenderness. The patient may also have a fever, leukocytosis, elevated erythrocyte sedimentation rate, positive result of endocervical Gram stain, positive results of culture for *C. trachomatis* or *N. gonorrhoeae,* purulent cervical exudate on culdocentesis or laparoscopy, or the finding of pelvic abscess during bimanual examination or pelvic ultrasound examination [28].

Early in the course of PID, ultrasound findings may be normal. As the infection progresses, some of the reported early sonographic features of PID include increased echogenicity and prominence of peritoneal fat in the pelvis, loss of normal tissue planes, ill definition of uterine serosal contours, increased uterine size, and endometrial thickening or fluid [5, 13, 15]. Nonspecific free pelvic fluid, which may be echogenic, is commonly seen in PID [27].

Normal fallopian tubes are not typically visualized during routine pelvic sonography, but in patients with salpingitis, swelling of the fallopian tube results in thickening of the tubal wall and endosalpingeal folds [29]. Given the absence of intraluminal pus in salpingitis, the endosalpingeal folds are difficult to delineate. The ultrasound appearance is an ill-defined, elongated, solid-appearing mass adjacent to, but separate from, the ovary. If there is distal luminal occlusion of the fallopian tube, pyosalpinx will result and be seen as a tubal structure with purulent echogenic material [13, 29] (Fig. 3). Fluid-debris levels are often visualized within the dilated fallopian tube with the less frequent finding of intraluminal gas or air-fluid levels

Fig. 2—32-year-old woman with acute right lower quadrant pain and torsed right ovary.
A, Coronal reconstructed contrast-enhanced CT image shows swirl of vessels (*arrow*) in right pelvic region.
B, Coronal contrast-enhanced CT image shows enlarged right ovary (*arrowheads*) with relatively less enhancement than normal-sized left ovary (*arrow*).

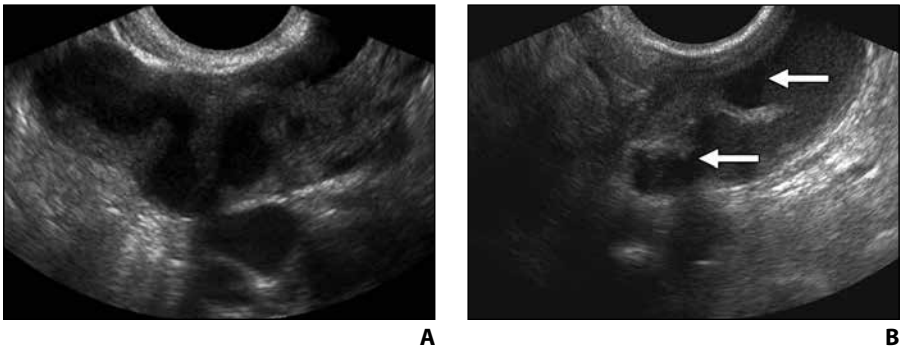


Fig. 3—22-year-old woman with pelvic pain due to pelvic inflammatory disease.
A, Longitudinal transvaginal ultrasound image shows thick-walled tubular structure in right adnexa distended with echogenic material.
B, Longitudinal transvaginal ultrasound image shows fluid-debris levels (*arrows*) in distended left fallopian tube.

[29] (Fig. 3). When viewed in cross-section, redundant folding of the fallopian tube on itself results in an appearance of incomplete septa, which in addition to thickened endosalpingeal folds accounts for the cog wheel sign [13, 29]. Power or color Doppler examination of the fallopian tube may show hyperemia of the fallopian tube walls or endosalpingeal folds [13, 29].

In more advanced cases of PID, exudation of pus from the fallopian tube into the peritoneum leads to involvement of the ovary, initially causing ovarian enlargement, with indistinct ovarian borders [5], sometimes with numerous small cysts [13]. In later stages, an inflammatory mass involving the fallopian tubes and adjacent ovary may develop. When a separate ovary can still be identified, the condition is referred to as tuboovarian complex. Once the architecture of the ovary and the fallopian tube have broken down such that separate structures can no longer be delineated, the condition is referred to as a tuboovarian abscess [13] (Fig. 4). Without intervention, a tuboovarian abscess may rupture and cause peritonitis or multiple intraabdominal abscesses.

Although ultrasound is the preferred imaging modality for patients with PID, CT may have been ordered if a nongynecologic cause of abdominal pain was initially suspected. CT can also be a useful supplement for delineating the extent of disease, evaluating for associated complications, and follow-up in cases refractory to antibiotic therapy. CT findings are usually normal in uncomplicated acute salpingitis; however, some cases reveal nonspecific fluid in the cul-de-sac [30]. With progression to pyosalpinx, serpiginous tubular structures representing a fallopian tube distended with pus

are seen. Tuboovarian abscess appears as unilateral or bilateral hypodense adnexal masses with thick, enhancing walls and thick septations [30] (Fig. 4). Associated CT findings in PID include uterosacral ligament thickening, thickening and anterior displacement of the broad ligament, edema of the parapelvic and presacral fat with resultant hyperattenuation and fat stranding, ill definition of the uterus and nearby bowel wall, inflammatory paraaortic lymphadenopathy, and hydronephrosis [30, 31]. Internal gas bubbles are an infrequent finding in tuboovarian abscesses [31].

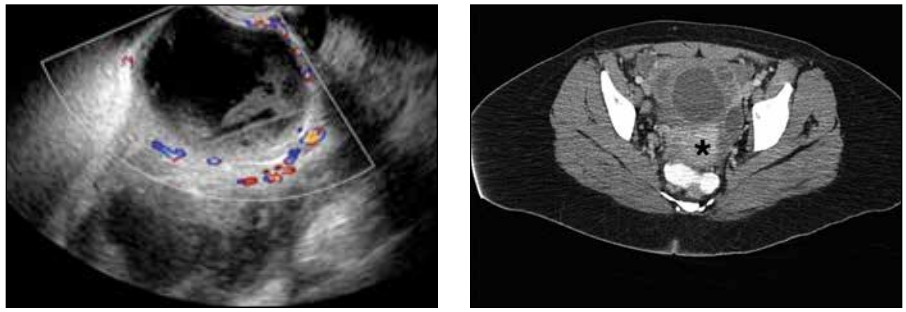


Fig. 4—33-year-old woman with pelvic pain and cervical motion tenderness.
A, Transvaginal sonogram of right adnexa shows complex cystic mass. Ovary cannot be separated from cystic adnexal mass, compatible with tuboovarian abscess.
B, Axial contrast-enhanced CT image shows complex mass with thick, enhancing walls and septations. Hyperattenuation of ill-defined uterus (*asterisk*) is evident.

Functional Ovarian Cysts

Failure to regress of an incompletely developed follicle may result in a follicular cyst. Likewise, the corpus luteum may not resorb after ovulation. Enlargement of either due to accumulation of fluid, rupture, internal hemorrhage, or resultant torsion can cause acute pain and is among the most common reasons that afebrile nonpregnant women of reproductive age present to the emergency department with acute pelvic pain [5]. The hemorrhagic cysts in premenopausal women are typically hemorrhagic corpora lutea. The clinical presentation is acute onset of severe but self-limited pain localized to one side of the pelvis [24]. The WBC count should be normal [24, 32], and correlation should be made with the patient's menstrual cycle, because temporal relation of a symptomatic cyst to the appropriate phase of the menstrual cycle is supportive.

Functional follicular cysts are thin-walled and contain anechoic fluid. Corpora lutea have thick hypoechoic walls, sometimes with internal crenulation, or may appear solid. Peripheral vascularity is present during color Doppler imaging (Fig. 5). When an ovarian cyst ruptures, the involved ovary may have a normal sonographic appearance if the rupture is complete. The ruptured fluid may resorb or diffuse throughout the peritoneal cavity [24]. An ovarian cyst that has not completely ruptured may have a crenate appearance, with internal low-level echoes or blood clot [24]. There may or may not be adjacent free fluid.

Comprehension of the natural evolution of the sonographic appearance of blood is helpful in the evaluation of both hemoperitoneum and hemorrhagic ovarian cysts. Fresh blood is characteristically anechoic and turns hyperechoic when clot forms in the subacute stages (Fig. 6). Over time, as the RBCs hemolyze, the echogenicity of blood progressively decreases in proportion to the hematocrit, and the blood may be entirely anechoic after 96 hours [33]. Hyperechoic acute blood clot may be differentiated from nearby bowel by its avascularity, nontubular shape, and absence of peristalsis during real-time imaging [24].

As they evolve, hemorrhagic ovarian cysts display a wide spectrum of sonographic appearances depending on when they are imaged as the cyst progresses through stages of acute hemorrhage, formation and retraction of clot, and eventual resolution [34]. Typically, a hemorrhagic cyst appears as a complex cystic mass containing internal echoes. For this reason, posterior through-transmission and absence of internal vascularity should be confirmed to establish the basic cystic nature of the mass [34]. In the acute phase, a hemorrhagic cyst has a thin wall with an internal pattern of diffuse low-level echoes [24]. With subsequent lysis of RBCs and the formation of strands of fibrin, the hemorrhagic cyst develops an internal architecture, which has been described as a lacelike or fishnet reticular pattern of internal echoes [24] with avascular linear strands that should be smooth and thin (Fig. 6). With continued evolution, coalescence of the thrombus occurs within the cyst, and retractile clot develops, which must be avascular and often forms angular margins (Fig. 6). This retractile clot is often dependent within the cyst but at times is adherent to the cyst wall [24]. Doppler ultrasound is not infallible in showing tumor vascularity. If features cause concern about a focal tumor nodule within a cystic structure (such as adherence to the wall, rounded shape, poor posterior through-transmission secondary to dense internal architecture), follow-up ultrasound should be performed in 6–8 weeks to document expected evolution or resolution of the hemorrhagic cyst and exclude a tumor nodule within a cystic ovarian neoplasm [24, 34].

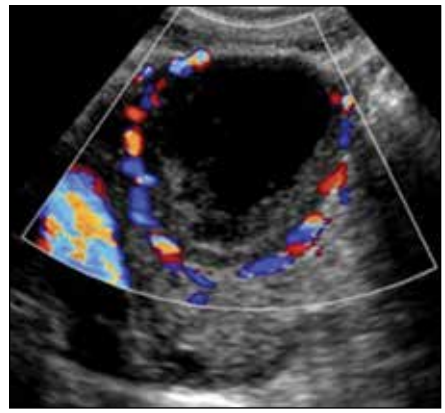


Fig. 5—22-year-old woman with acute right pelvic pain. Coronal transvaginal sonogram of right ovary shows thick-walled cyst. Wall is relatively hypoechoic. Few echoes within cyst represent hemorrhage. Color Doppler imaging shows peripheral vascularity typical of corpus luteum.

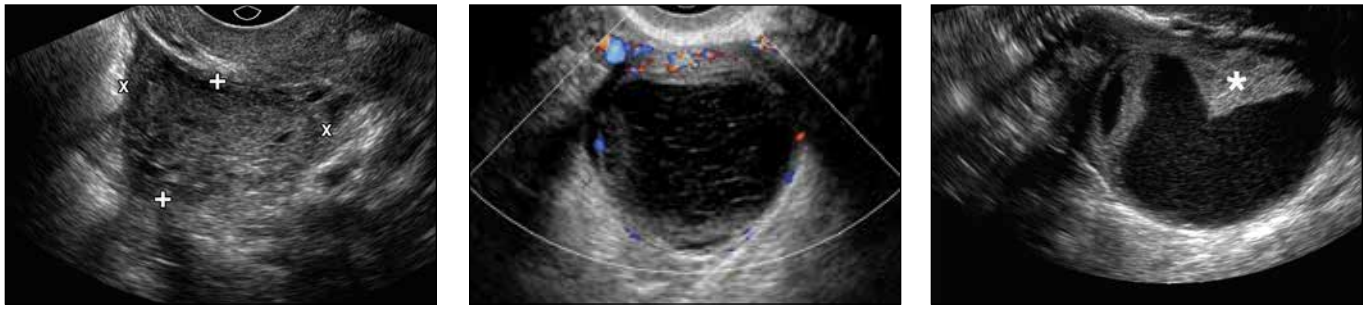


Fig. 6—Evolution of hemorrhagic cysts.
A, Ultrasound image shows hyperechoic clot within subacute hemorrhagic cyst (*calipers*).
B, Ultrasound image shows fine linear echoes with lysis of RBCs and formation of fibrin strands.
C, Ultrasound image shows retractile clot (*asterisk*) with characteristic angular margins.

When hemoperitoneum is present and the ovaries appear normal, CT can be a useful adjunct for excluding other intraabdominal processes, such as a ruptured hepatic adenoma, which can cause hemoperitoneum in a young woman [30]. The CT attenuation within a hemorrhagic cyst and of the hemoperitoneum will be increased, typically to 25–100 HU [19].

Endometriosis

Endometriosis is characterized by ectopic endometrial tissue, primarily within the ovaries and pelvic peritoneum [35]. As much as 80% of endometriosis occurs within the ovaries [19]. Endometriosis affects approximately 10% of premenopausal women [19]. The pathogenesis of endometriosis is a controversial subject with multiple proposed theories and has yet to be fully elucidated. The most widely accepted theory involves ectopic implantation of endometrial tissue by retrograde menstruation [36]. Other theories include hematologic or lymphatic dissemination. Ectopic endometrial tissue is hormone sensitive and can cause cyclic bleeding, pain, and infertility [37]. Although most of the pain is chronic, endometriomas can cause acute on chronic pain, which also can occur in association with secondary infection or rupture [19].

Although the definitive diagnosis of endometriosis is made with surgical and histologic evaluation, imaging can play an important role in the care of patients with suggestive clinical signs and symptoms. Ovarian endometrial implants must be large enough to be detected at sonographic evaluation. Many cases of endometrioma involve microscopic ovarian implants, too small to be detected with imaging [30]. In a study by Mais et al. [38], transvaginal ultrasound was found to have a sensitivity of 88% and specificity of 90% for differentiating endometrioma from other ovarian lesions [38].

Endometriomas can be solitary or multiple and are present in both ovaries in as many as 50% of cases. They appear as hypovascular cystic lesions most often with homogeneous low-level echogenicity (Fig. 7). Other characteristics, such as internal fluid-fluid levels, peripheral nodules, and echogenic foci, can also be seen [39] (Fig. 7). Endometrioma rupture results in the formation of fibrous adhesions, which can have the appearance of a complex mass. This appearance can mimic tuboovarian complex or abscess, hemorrhagic cysts, and ovarian malignancy [40].

Although not feasible in the emergency setting, MRI is believed to be superior to ultrasound in the diagnosis of endometrioma (specificity as high as 98%) owing to its ability to depict old blood products [41]. On MR images endometriomas have increased T1-weighted signal intensity from blood products and often have low T2-weighted signal intensity, the so-called shading sign, which is unique to endometrioma.

Nongynecologic Disorders

In the setting of acute pelvic pain, especially when findings of evaluation of the uterus and ovaries are normal, nongynecologic causes should be considered. Many of the nongynecologic causes of pelvic pain are amenable to sonographic evaluation. These include distal ureterolithiasis and appendicitis. Distal ureteral stones are identified as shadowing echogenic foci within the ureter. Laing et al. [42] found that compared with a transabdominal approach, transvaginal ultrasound is the optimal modality for the diagnosis of distal ureteral stones. This may

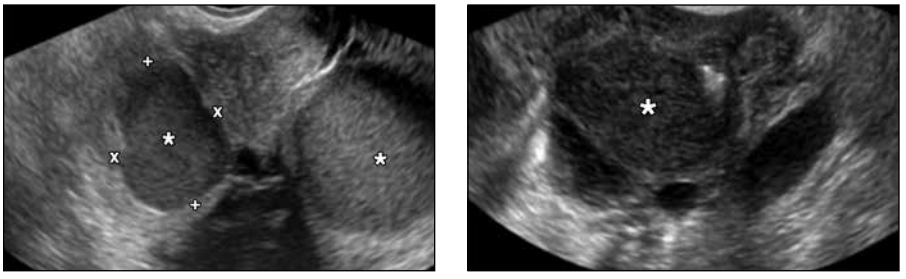
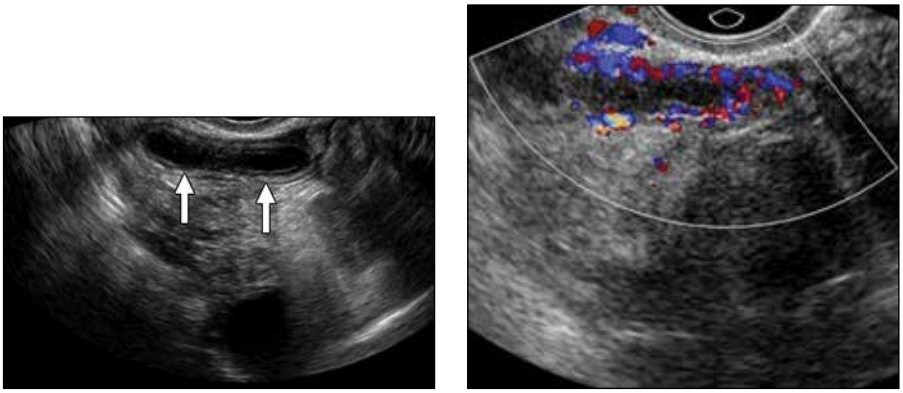


Fig. 7—28-year-old woman with acute pelvic pain and history of endometriosis.
A, Coronal transvaginal sonogram of uterus shows bilateral cystic ovarian lesions with internal homogeneous echoes (*calipers, asterisks*).
B, Coronal transvaginal sonogram of left ovary shows multiple cysts in ovary. Largest cyst (*asterisk*) contains peripheral echogenic foci typical of endometriomas.



A **B**

Fig. 8—24-year-old woman with acute right pelvic pain.
A, Transvaginal sonogram in region of tenderness shows blind-ending tubular structure (*arrows*) compatible with distended appendix.
B, Color Doppler image shows increased vascularity. Acute appendicitis was found at surgery.

be due to the higher-frequency transducer used, the endovaginal approach, and the absence of variability in urinary bladder distention that is often unavoidable with a transabdominal approach.

Transabdominal ultrasound has a reported sensitivity of 80–94% in the diagnosis of acute appendicitis [43]. The findings consist of a dilated, noncompressible, tubular, blind-ending appendix (Fig. 8). Pelvic appendicitis, which involves an appendix that extends toward the pouch of Douglas, is most optimally detected and diagnosed by use of transvaginal sonographic evaluation [44].

Conclusion

One of the most common clinical problems in women presenting to the emergency department is acute pelvic pain. Imaging is essential in the evaluation of these patients, and ultrasound is the primary initial modality. Thorough knowledge of the sonographic features of the most common causes of pain, including ovarian torsion and PID, may obviate additional imaging and result in prompt diagnosis and treatment.

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