Gynecologic Causes of Acute Pelvic Pain: Spectrum of CT Findings¹

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Although ultrasound (US) is the primary imaging modality of choice in the radiologic evaluation of the female patient with acute pelvic pain, the role of computed tomography (CT) in the evaluation of abdominal and pelvic pain continues to expand. CT may be performed if a gynecologic disorder is not initially suspected, if US findings are equivocal, or if the abnormality extends beyond the field of view achievable with the endovaginal probe and further characterization of pelvic disease is required. Many gynecologic disorders that cause acute pelvic pain (eg, uterine disorders, ovarian disorders, endometriosis, pelvic inflammatory disease, postoperative or postpartum complications) demonstrate characteristic CT findings. Familiarity with these CT appearances is important: It will allow the radiologist to guide appropriate treatment of affected patients and may eliminate the need for further imaging evaluation.

Abbreviations: HCG = human chorionic gonadotropin, HELLP = hemolysis, elevated liver enzymes, and low platelets (syndrome), IUD = intrauterine device

Index terms: Endometriosis, 85.3192 • Leiomyoma, 854.318 • Ovary, cysts, 852.3117 • Ovary, torsion • Pelvic organs, abscess, 85.211 • Pelvic organs, CT, 85.1211 • Pelvic organs, diseases, 85.211, 85.217, 85.3192 • Pelvic organs, inflammation, 85.217


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**Introduction**

Although ultrasound (US) is the primary imaging modality of choice for the evaluation of pelvic pain in the female patient and magnetic resonance (MR) imaging has proved to be a valuable adjunct, the role of computed tomography (CT) in the evaluation of abdominal and pelvic pain continues to expand. CT may be performed if US findings are equivocal or if the abnormality extends beyond the field of view achievable with the endovaginal probe and further characterization is required. Although clinical findings and correlation with β–human chorionic gonadotropin (HCG) levels frequently indicate a gynecologic disorder, it may be unclear whether the cause of symptoms is primarily gynecologic or is related to the gastrointestinal or genitourinary tract. CT plays a particularly important role in (a) the evaluation of patients with suspected pelvic abscess or hematoma, postpartum complications, or complications related to pelvic inflammatory disease and (b) the exclusion of bowel disease.

In this article, we review CT technique in the evaluation of female patients with acute pelvic pain. We also discuss and illustrate the spectrum of CT findings in various acute gynecologic disorders, including uterine disorders, ovarian disorders (ovarian torsion, hemorrhagic ovarian cyst, ovarian hyperstimulation syndrome), endometriosis, pelvic inflammatory disease, and postoperative or postpartum complications (ovarian vein thrombosis, endometritis, HELLP [hemolysis, elevated liver enzymes, and low platelets] syndrome). In addition, we correlate these findings with US and MR imaging findings to demonstrate the complementary roles of these modalities in this setting.

**CT Technique**

For evaluation of suspected disease in the female pelvis, it is important to administer contrast material both orally and intravenously whenever possible. Oral administration of contrast material (2% iodinated water-soluble contrast material or 2.1% wt/vol barium sulfate suspension) will help distinguish normal bowel from abnormal bowel and adnexal structures. Rectal administration of contrast material is not routinely performed but may in some circumstances help differentiate an adnexal process from a primary disorder of the rectosigmoid colon. Intravenous contrast material enhancement allows better delineation of the uterus and adnexal structures. In single-section helical CT, we administer 100–145 mL of 60% iodinated intravenous contrast material at a rate of 1.5–2 mL/sec with a scan delay of 80–90 seconds. Images are obtained with 5-mm collimation from the level of the iliac crests to the pubic symphysis with a reconstruction interval of 4 mm and a pitch of 1.5. Typically, imaging through the upper abdomen is also performed, with 7-mm collimation and a reconstruction interval of 6 mm. More recently available multi–detector row CT scanners allow thinner collimation, which further increases z-axis resolution and allows improved multiplanar reformattting. In multisection helical CT, we obtain images of the abdomen and pelvis with a 4 × 2.5-mm detector configuration and a pitch of 6 to 7. With a rotation time of 0.5–0.8 seconds, this allows coverage of 30 mm/sec and a nominal section thickness of 2.5 mm. With either technique, delayed images provide better delineation of the ureters. The possibility of pregnancy must be excluded prior to the CT evaluation of any female patient of reproductive age.

**Uterine Disorders**

Fibroids, or leiomyomas, are the most common disorder of the uterus, having been reported in over 20% of women over the age of 30 years (1,2). US findings are usually diagnostic, with sonohysterography (3,4) and MR imaging (5–7) playing supplemental roles for further characterization as needed. CT is not the primary modality for diagnosing or evaluating fibroids; however, fibroids are often found incidentally at CT. Therefore, familiarity with their various CT appearances is important. Although patients with fibroids do not usually present with severe pain, they may present with acute pelvic pain if there is degeneration or torsion (8), prolapse of a pedunculated submucosal fibroid, or severe vaginal bleeding. Uterine enlargement with associated focal masses, which may be submucosal, intramural, or subserosal in location, and uterine contour deformity are the most common CT findings. Intravenous contrast material enhancement is often heterogeneous and depends in part on the timing of imaging with respect to the phase of the contrast material bolus. Hyaline degeneration is the most common secondary change seen in fibroids and may be accompanied by varying
degrees of liquefaction. Fibroids that have undergone hyaline degeneration or necrosis have a more cystic appearance, with diminished contrast material enhancement and areas of low attenuation (Fig 1). Degeneration may be so extensive that the leiomyoma appears predominantly cystic and may become quite large, thereby suggesting primary ovarian disease (Fig 2). Solid “mass-type” calcifications in a uterine mass are the most specific sign for a leiomyoma; however, these occur
in only 10% of cases (Fig 3) (9). Fibroids that are subserosal in location may be confused with adnexal masses, and MR imaging can help confirm a uterine rather than an adnexal origin (5). MR imaging may demonstrate normal ovaries not visualized at US, thereby eliminating the possibility of an adnexal origin. MR imaging may also help confirm that a mass is a fibroid by demonstrating characteristic low signal intensity or a feeding vessel on T2-weighted images (6). When a leiomyoma is submucosal in location, endometrial disease may be suspected, and either US or MR imaging may allow delineation of the distorted but otherwise normal endometrium (Fig 1). Subserosal and submucosal leiomyomas may become pedunculated and may undergo torsion of the pedicle with subsequent infarction, degeneration, necrosis, and, potentially, infection (Fig 3).

**Ovarian Disorders**

**Ovarian Torsion**

In the setting of acute pelvic pain, ovarian torsion is often a leading diagnostic consideration, and Doppler US is the study of choice. The US findings in ovarian torsion have been well described (10–12) and include an enlarged ovary with peripherally distributed follicles, an associated cyst or mass, and lack of vascularity. Because of the variable pain characteristics and frequent lack of definitive clinical findings, the diagnosis of ovarian torsion is often delayed, thereby limiting the possibility of ovarian salvage (13). Affected patients may be evaluated with CT for possible alternate diagnoses, particularly if torsion is subacute or intermittent. Ovarian torsion may occur in the absence of ovarian disease, usually in children (14), and has been attributed to excessive mobility of the adnexa. In adults, there is usually a concurrent ovarian cyst or mass (Fig 4), frequently the mature cystic teratoma (15). CT findings in ovarian torsion have been described previously (16,17) and include deviation of the uterus.
to the twisted side, ascites, obliteration of fat planes, and an enlarged ovary displaced from its normal location in the adnexa. Intravenous contrast-enhanced CT may reveal surrounding enhancing blood vessels, a finding that is consistent with congestion (Fig 5) (14). In lesions with hemorrhagic infarction, a beaked or serpentine protrusion at the periphery of the twisted ovary, lack of enhancement, hematoma, or gas (18) may be observed (Figs 4, 6). Another indicator of ovarian

**Figure 5.** Twisted left ovarian mucinous cystadenoma in a 23-year-old postpartum woman who presented with fever. (a) Axial contrast-enhanced CT scan of the pelvis shows a left adnexal complex cystic mass (arrow). (b) Repeat CT scan obtained 1 week later after the patient returned with acute onset of right-sided pelvic pain shows the cystic mass in the right lower quadrant (solid arrow) with an adjacent enhancing solid tubal mass (open arrow) representing the engorged, twisted vascular pedicle. Pathologic analysis showed a twisted left ovarian mucinous cystadenoma.

**Figure 6.** Twisted left ovarian cyst in a 16-year-old girl who presented with pelvic pain. (a) Axial contrast-enhanced CT scan shows a large left ovarian cyst (c) in the right aspect of the pelvis. At pathologic analysis, the cyst was seen to act as a fulcrum for torsion. (b) CT scan obtained slightly more inferiorly again demonstrates the cyst (c). The associated left ovary (arrow) is enlarged and edematous, with small, peripheral follicles and diminished contrast enhancement. The left ovary is displaced anterior to the uterus. (c) Corresponding US image shows an enlarged, edematous ovary with a high-resistance arterial waveform with reversal of diastolic flow.
torsion is rotation of the adnexal mass to the contralateral side of the pelvis. This can best be appreciated on sequential scans obtained before and after torsion (Fig 5).

Hemorrhagic Ovarian Cyst
Significant hemorrhage of an ovarian cyst often manifests with abrupt onset of pelvic pain. There may be hemorrhage into a corpus luteal cyst or follicular cyst. If there is cyst rupture, it can be life-threatening due to associated hemoperito-
neum and hypotension, the latter usually dominating the clinical picture (Fig 7) (19). This can be particularly severe in patients who are undergoing anticoagulation therapy (Fig 8) (20). The cause of luteal cyst rupture is not clearly understood, although the increased vascularity of the ovary in the luteal phase may predispose to cyst rupture (21). At US, depending on cyst size and the time interval since the onset of hemorrhage, hemorrhagic ovarian cysts can mimic a variety of solid and mixed solid-cystic masses (22). At CT, there is usually a mixed-attenuation mass with a high-attenuation component (45–100 HU) in the adnexa. A fluid-fluid level may also be observed (Fig 8b). If there is cyst rupture, hemoperitoneum will also be present (Fig 8a). Contrast-enhanced CT may delineate the cyst wall, and delayed CT may be useful in demonstrating the site of pooling of contrast-enhanced blood in the pelvis (Fig 8c) (23). CT is helpful in excluding other intraabdominal diseases (eg, ruptured hepatic adenoma) that can lead to hemoperitoneum in the young female patient. A ruptured ectopic pregnancy could manifest with a similar clinical picture, and correlation with β-HCG levels prior to imaging to exclude this possibility is essential. If the disease is correctly diagnosed, patients with hemorrhagic ovarian cysts often do well with conservative treatment and supportive therapy.

**Ovarian Hyperstimulation Syndrome**

Ovarian hyperstimulation syndrome is usually iatrogenic secondary to ovarian stimulant drug therapy for infertility (24) but may occur as a spontaneous event in pregnancy. The syndrome consists of ovarian enlargement with extravascular accumulation of exudates leading to weight gain, ascites, pleural effusions, intravascular volume depletion with hemoconcentration, and oliguria in varying degrees. Pain, abdominal distension, nausea, and vomiting are frequently seen. The imaging findings are similar at US, CT (25), and MR imaging (26) and reflect ovarian enlargement by distended corpora lutea cysts of varying sizes. Because the enlarged follicles are often peripheral in location, a “wheel spoke” appearance has been described, with stromal ovarian tissue located centrally with surrounding cysts (26). This appearance has been described at MR imaging but may also be seen at CT (Fig 9). Familiarity with ovarian hyperstimulation syndrome and the appropriate clinical setting should help avoid the incorrect diagnosis of an ovarian cystic neoplasm.

**Endometriosis**

Endometriosis results from functional endometrial glands and stroma located outside the endometrium and myometrium and affects 5%–10% of women (27). Small implants and adhesions are not well evaluated radiologically, and laparoscopy is performed for diagnosis and staging. Larger implants and endometriotic cysts, or endometriomas, may be evaluated with US, MR imaging, or CT. CT is not considered the primary imaging modality for evaluation of endometriomas because findings are nonspecific. The CT manifestation of endometriomas is variable and can range from a predominantly solid to a predominantly
cystic mass (Fig 10) (28,29). A focal hyperattenuating area representing clot in a cystic mass has been described as a CT finding suggestive of endometrioma but was seen in only a minority (15%) of cases in a study by Buy et al (30). This finding may also be observed in other masses with hemorrhage such as hemorrhagic ovarian cyst. Therefore, CT findings are often nondiagnostic, and other complex cystic adnexal masses must be considered. Bilaterality (Fig 11) and multiple lesions are ancillary diagnostic findings that support the diagnosis with any imaging modality. There may be implantation in extraovarian sites such as the serosal surface of the uterus, urinary bladder, ureters, and fallopian tubes. Involvement of the intestinal tract is not uncommon and has diverse clinical manifestations (31). Occasionally, endometriosis may result in obstruction of the appendix, resulting in acute appendicitis (Fig 11b). In patients who have previously undergone abdominal surgery or amniocentesis, there may be implantation in the region of the scar with an endometrioma in the abdominal wall (32). At clinical examination, a peri-incisional abdominal wall hernia may be suspected. At CT, an enhancing soft-tissue mass is visualized (Fig 12). Differential considerations would include other soft-tissue masses (eg, desmoid tumor or some other mesenchymal tumor) or possibly hematoma. Although generally considered a disorder of patients of reproductive age, endometriosis may be reactivated in postmenopausal women undergoing hormone replacement therapy and may manifest clinically as a mass accompanied by pelvic pain (Fig 13) (33).

The imaging features of endometriomas are somewhat more specific at US, which is usually the first-line imaging study of choice. At US, an endometrioma usually appears as a complex cystic mass with uniform low-level echoes and irregularity of the wall (34). Endometriomas may occasionally be multilocular with thin or thick septations as well as nodularity of the wall, and other cystic masses cannot be excluded. MR
Adenomyosis is a benign uterine disease in which endometrial glands and stroma are found within the myometrium. Symptoms include abnormal uterine bleeding and dysmenorrhea. Imaging findings have been well described at both US and MR imaging (36–39) and include an enlarged, globular uterus with small cystic areas.
corresponding to dilated glands. MR imaging is the diagnostic study of choice because it offers greater specificity for this diagnosis by demonstrating diffuse or focal thickening of the junctional zone (>12 mm), which is pathognomonic for this disorder. Occasionally, an enlarged, globular uterus with small myometrial cysts may be visualized at CT, findings that suggest the diagnosis (Fig 14). Approximately 11% of patients with adenomyosis also have endometriosis (40).

Pelvic Inflammatory Disease
Pelvic inflammatory disease is one of the most common causes of acute pelvic pain in women, and imaging findings vary with the stage of disease. Most cases result from ascending infection, usually caused by a mixture of anaerobic and aerobic organisms. Although US is the primary imaging modality, CT can be a helpful adjunct in determining the extent of disease, identifying associated complications, and further assessing patients who do not respond to antibiotic therapy. In noncomplicated acute salpingitis, CT findings are most often normal or demonstrate a small amount of fluid in the cul-de-sac. With progression to tubo-ovarian abscess, CT findings include bilateral thick-walled, low-attenuation adnexal masses with thick septations and often with an associated serpiginous structure corresponding to a dilated, pus-filled fallopian tube (Fig 15). Clinical findings of fever, leukocytosis, and cervical motion tenderness are very important in suggesting this diagnosis because there is overlap in the CT appearance of tubo-ovarian abscesses with that of other complex cystic masses, including neoplasm. The tubular nature of the mass may be better appreciated on reformatted images, which may also help distinguish a tubo-ovarian abscess from other complex cystic masses. Internal gas bubbles are the most specific radiologic sign of abscess but are unusual in tubo-ovarian abscess (41). Associated findings include thickening of the uterosacral ligaments, increased attenuation of the presacral fat secondary to edema, hydronephrosis, and indistinct margins of adjacent bowel loops. The inflammatory process may extend to involve the appendix or colon and greater omentum (Fig 16). Anterior displacement of a thickened broad ligament and loss of definition of the

Figure 14. Adenomyosis and endometriosis in a 34-year-old woman who presented with pelvic pain. The patient had a history of menorrhagia. (a) Axial contrast-enhanced CT scan demonstrates an enlarged uterus with posterior thickening of the myometrium and multiple small cystic areas (arrows). (b) Endovaginal US image demonstrates an enlarged, globular uterus with diffusely heterogeneous echotexture of the myometrium and small myometrial cysts, findings that are consistent with adenomyosis. A complex cystic mass with low-level echoes (not shown) was also seen in the adnexa, a finding that is consistent with endometrioma.
uterine border are suggestive of an adnexal origin for the inflammatory process and help distinguish a tubo-ovarian abscess from other causes of pelvic abscess such as diverticulitis.

Pelvic inflammatory disease is uncommon in postmenopausal women but is occasionally encountered (42). It is usually polymicrobial, is often associated with the formation of tubo-ovarian abscess, and may manifest clinically as postmenopausal bleeding and a palpable pelvic mass.

**Figure 15.** Bilateral tubo-ovarian abscesses in a 38-year-old woman who presented with fever and pelvic pain. (a) Axial contrast-enhanced CT scan shows bilateral, peripherally enhancing, thick-walled complex cystic structures with an adjacent serpiginous component (arrow). (b) Coronal oblique reformatted image helps confirm the tubular nature of these structures, which proved to be bilateral tubo-ovarian abscesses at surgery. u = uterine fundus.

**Figure 16.** Tubo-ovarian abscesses in a 42-year-old woman. (a) Axial contrast-enhanced CT scan demonstrates secondary inflammatory involvement of the appendix (arrow). (b) CT scan obtained cephalad to a demonstrates thickening of the cecal wall (black arrows). Note the infiltration of the greater omentum (white arrow).
A particular type of pelvic inflammatory disease is encountered in patients with an intrauterine device (IUD) in place. These patients are prone to infection with *Actinomyces israelii*, an invasive organism, which leads to chronic suppurative infection (43,44). It can often be difficult to differentiate infection with this organism from pelvic neoplasm with carcinomatosis (Fig 18) (45). Another condition that may mimic ovarian neoplasm at radiologic examination is genitourinary tuberculosis with associated tuberculous peritonitis (Fig 19) (46).
Postoperative or Postpartum Complications

CT is the initial imaging modality of choice for postoperative complications such as pelvic abscess (Fig 20) and hematoma (Fig 21). Bladder flap hematoma is a common complication following cesarean section (Fig 22) (47). Uterine perforation may result from dilatation and curettage or occur after delivery and may appear as an enhancing parametrial fluid collection and discontinuity of the uterus (Fig 23) (29).
Ovarian Vein Thrombosis

Ovarian vein thrombosis, or thrombophlebitis, occurs most commonly in postpartum patients but may occur following pelvic surgery (48) or pelvic trauma, complicate other disorders such as pelvic inflammatory disease, or complicate treatment of tumors with chemotherapy (49). In 80%–90% of cases, the right ovarian vein is involved (50). This predilection for right-sided involvement is possibly due to retrograde flow in the left vein preventing stasis and ascending infection. The characteristic CT findings consist of a tubular structure with an enhancing wall and low-attenuation thrombus in the expected location of the ovarian vein (Fig 24) (51). This finding should not be confused with hydroureter, acute appendicitis, or a thrombosed inferior mesenteric vein. Thrombosis of an ovarian vein collateral vessel that is retrocecal in location, continues cephalad in the retroperitoneum, and terminates anterior to the kidney may be particularly difficult to distinguish from an inflamed appendix (Fig 25) (52). However, careful assessment on multiple CT scans should facilitate diagnosis.

Endometritis

Discrete endometritis occurs most often after parturition or instrumentation and is the most common cause of postpartum fever. It also occasionally occurs in the setting of cervical stenosis. The diagnosis of endometritis is often based on clinical findings: The normal postpartum uterus is enlarged and may contain small amounts of blood or fluid within the endometrial cavity (47,51). Also, a small amount of air can be seen within the endometrial cavity up to several weeks after a normal vaginal delivery (53). In endometritis, the endometrial cavity is usually thickened and distended with fluid at CT (Fig 25c). The diagnosis should usually not be considered solely on the basis of the presence of air within the endometrial cavity. This finding can support the diagnosis, unless there has been recent instrumentation or...
the patient recently gave birth. The advantage of CT over US is that associated inflammation in the parametrial soft tissues and extrauterine pelvic abscess may be identified. The visualization of enhancing soft tissue within the endometrial cavity suggests the presence of retained products of conception (51).

**HELLP Syndrome**

HELLP syndrome is one of the hypertensive disorders of pregnancy, occurring in 4%–12% of preeclamptic patients (54). This syndrome most likely results from vascular endothelial injury, which results in intravascular deposition of fibrin with end organ damage and can occur prior to or after delivery. Disseminated intravascular coagulation is seen in 20%–40% of cases (55). Other major complications of HELLP syndrome include placental abruption, acute renal failure, pulmonary edema, pleural and pericardial effusions, hepatic infarction, hematoma (Fig 26),

**Figure 25.** Postpartum endometritis in a 30-year-old woman after spontaneous vaginal delivery. (a) Contrast-enhanced CT scan obtained at the level of the right lower quadrant shows an enhancing tubular structure with low attenuation centrally (arrows), a finding that in isolation could mimic appendicitis. (b) CT scan obtained cephalad to a demonstrates a continuous serpiginous collateral vessel from a thrombosed ovarian vein (arrowheads). This vessel terminated anterolateral to the kidney. (c) CT scan of the pelvis demonstrates an enlarged postpartum uterus with an endometrial cavity expanded by fluid, debris, and a moderate amount of air. A small amount of associated ascites is also seen. These findings helped confirm the clinical suspicion for endometritis.

**Figure 26.** HELLP syndrome in a 34-year-old postpartum woman who presented with right upper quadrant pain, pelvic pain, and hypotension. Contrast-enhanced CT scan shows a large, subcapsular liver hematoma (arrows). CT scans obtained more inferiorly (not shown) demonstrated associated hemoperitoneum within the abdomen and pelvis.
and rupture. Pelvic pain may occur in the setting of hemoperitoneum. Spontaneous intrahepatic hemorrhage and rupture likely result from toxemia-related vasculopathy with endothelial damage, vasospasm, and ischemia, leading to hemorrhage. Supportive therapy is usually offered initially, with capsular rupture necessitating surgery. Embolization of the hepatic artery may also be attempted. CT is important in initial diagnosis and for serial follow-up. Findings may include subcapsular or intrahepatic hemorrhage, capsular rupture, and areas of confluent necrosis secondary to infarction. Intravenous contrast-enhanced CT allows identification of active arterial extravasation, which cannot be demonstrated at US.

Conclusions

Many gynecologic disorders that cause acute pelvic pain demonstrate characteristic CT findings. Therefore, CT is an important diagnostic tool in the assessment of female patients who present with pelvic pain. Familiarity with the spectrum of CT findings in these disorders will allow the radiologist to guide appropriate treatment of affected patients and may eliminate the need for further imaging evaluation.

References


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