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Gynecologic Emergencies: Findings Beyond US and Advances in Management

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Abstract Ovarian torsion, ectopic pregnancy, and retained products of conception are the most common gynecologic emergencies encountered routinely. Ultrasound is almost always the first line in imaging due to universal access and rapid image acquisition. However, increased use and availability of CT and MRI in the emergency setting make it such that the radiologist must recognize these common gynecologic emergencies on multiple modalities. Knowing a patient's pregnancy status can help narrow the broad differential diagnostic considerations. It is also important to be aware of less common, though life-threatening causes of acute pelvic pain including uterine rupture, placental abruption, and uterine arteriovenous malformation. Accurate imaging diagnosis is imperative in appropriate patient management and may be critical in preserving fertility.

Keywords Urogenital imaging · Ovarian torsion · Ectopic pregnancy · Ultrasound · Imaging

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Introduction

The purpose of this article is to review imaging findings in gynecologic emergencies and advances in management. While ultrasound (US) is usually the first-line modality in emergent gynecologic imaging, this review will describe imaging findings across modalities. The pertinent clinical history elements that allow the radiologist to make an accurate diagnosis are highlighted. The differential diagnostic considerations are organized by pregnancy status. Updates in management as impacted by imaging diagnostic accuracy are emphasized.

The Pregnant Patient

Identifying the cause of vaginal bleeding or pain in a pregnant patient depends on the stage of pregnancy. In the first trimester, ectopic pregnancy (EP) must be excluded, while maintaining suspicion for other causes of bleeding, including subchorionic hemorrhage and spontaneous abortion. In the third trimester, placental abruption and rarely uterine rupture could be considered emergently. Clinical and imaging evaluation of both mother and fetus is usually required to rule out life-threatening processes. In many cases, close clinical and imaging follow-up are needed to sort out pregnancy outcomes.

Ectopic Pregnancy

Diagnosis of first trimester pregnancy has evolved with advances in serum markers and imaging technology. Since the Society of Radiologists in Ultrasound changed the first trimester diagnostic criteria for nonviable to 7 mm for embryos without a heartbeat and mean sac diameter of

25 mm for empty sacs, approximately 12 % of patients with first trimester findings will require additional follow-up imaging [1, 2••].

An EP is a pregnancy that implants outside of the endometrial cavity, most commonly within the fallopian tube [3]. The incidence of EP has increased since the 1970's, likely due to better early diagnosis as well as in vitro fertilization, embryo transfer, and microsurgical techniques [3]. Mortality from EP has been declining, but significant age and racial disparities remain significant risk factors for maternal mortality [4, 5]. The best imaging tool for diagnosing EP is transvaginal US which is both highly sensitive (87–99 %) and specific (94–99.9 %) [6].

Pregnancy of unknown location (PUL) is a particular conundrum in the 1st trimester imaging as it is found in 5–42 % of patients on initial imaging [6]. PUL is defined by a positive pregnancy test, β-hCG >2000, and an empty endometrium [6, 7]. Only 6–20 % of PUL are subsequently diagnosed with EP, 20.4 % go onto have a viable IUP, and <1 % of patients with PUL will experience a critical clinical outcome like acute rupture [6, 8•]. Factors that contribute to nonvisualization of a normal IUP include obesity, uterine fibroids, adenomyosis, and endometrial polyps [8•]. One study of over 1000 pregnancies characterized as PUL on initial US found that over 80 % were found to have viable IUPs on follow-up [9] supporting the trend toward expectant management [6, 9]. In a randomized controlled trial of patients with PUL or EP with plateauing β-hCG of 2000 or 1500 UI/l, respectively, there was no difference in treatment success with a single-dose methotrexate compared to expectant management [10••]. Expectant management using a combination of serial serum markers and US for PUL is rapidly becoming the norm.

If CT is performed, high-attenuation clot may be seen surrounding an adnexal mass in EP. Although MRI is rarely used, this modality may be helpful in complicated cases, such as abdominal, cervical, interstitial, or C-section scar EP, and is preferred to CT due to the lack of ionizing radiation [11]. On MR, a gestational sac outside of the endometrial cavity with associated blood products that are T1 hyperintense and heterogeneous on T2 is characteristic [12] (Fig. 1). The gestational age at which an IUP should be seen on MR has yet to be established [12].

MRI may be particularly useful if a cervical, interstitial, or cesarian section scar EP is suspected [11, 13, 14]. Multiplanar T1- and T2-weighted sequences depict the EP implanted outside of the uterus (Fig. 1), illustrate pelvic anatomy for operative orientation, and help clarify the relationship of the EP to adjacent structures [13, 14]. MR can also be used to measure the lesion volume which may predict an indication for and success of local methotrexate treatment [12].

Placental Abruption

In the second and third trimesters, placental abruption should be considered as a cause of vaginal bleeding, particularly in the setting of trauma. Abruption occurs rarely but carries a high risk of premature delivery, maternal morbidity, and fetal death [15, 16•]. US sensitivity is only 24 % [17]. A positive test will demonstrate subchorionic or retroplacental hematoma of varying echogenicity depending on age (Fig. 2). The acute hematoma will be hyperechoic; however, the blood products decrease in echogenicity over time accounting for the low sensitivity in subacute or chronic abruption.

If the US is negative, but clinical suspicion remains high, MR is the next best step. The lack of ionizing radiation and dramatically increased sensitivity, nearly 100 %, are ideal in imaging a stable pregnant patient [18••]. MR can also age the blood products, particularly DWI- and T1-

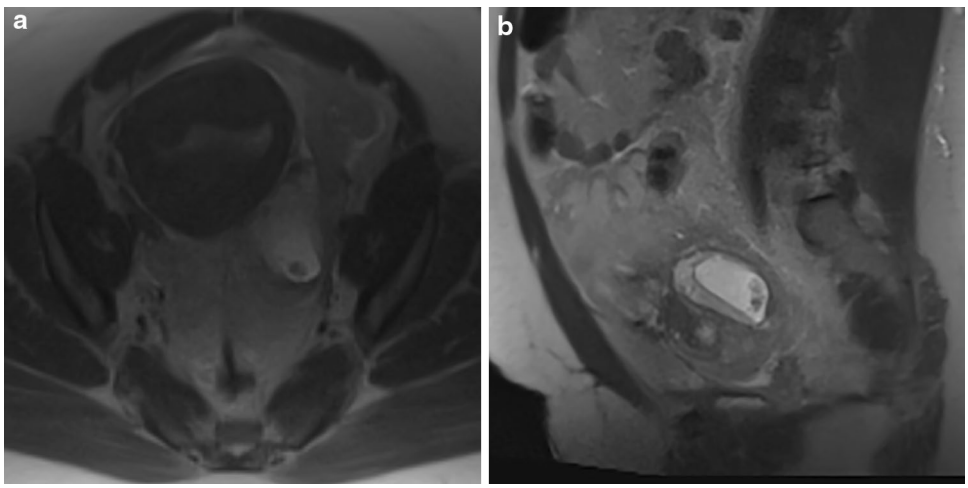

Fig. 1 MRI for ectopic pregnancy. Axial T2WI (**a**) shows a normal thickness endometrium without a gestational sac. Sagittal T2WI (**b**) shows the gestational sac posterior to the fallopian tube with a well-visualized placenta and embryo. Images courtesy of Cary L. Siegal, MD, Mallinckrodt Institute of Radiology

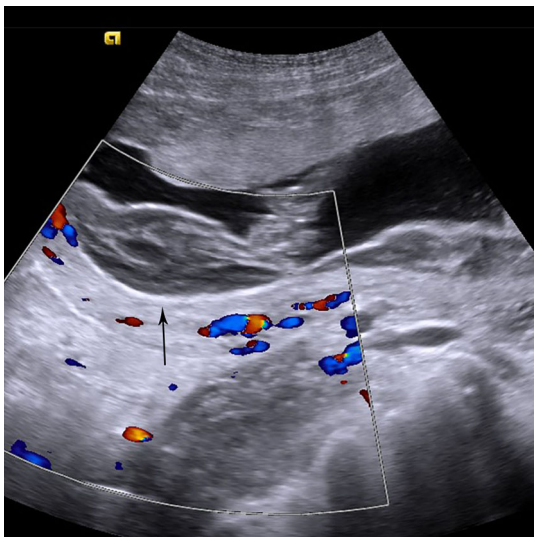

Fig. 2 US for placental abruption. Transabdominal US demonstrates retroplacental abruption, with avascular hypoechoic material (*arrow*) separating the placenta from the uterus

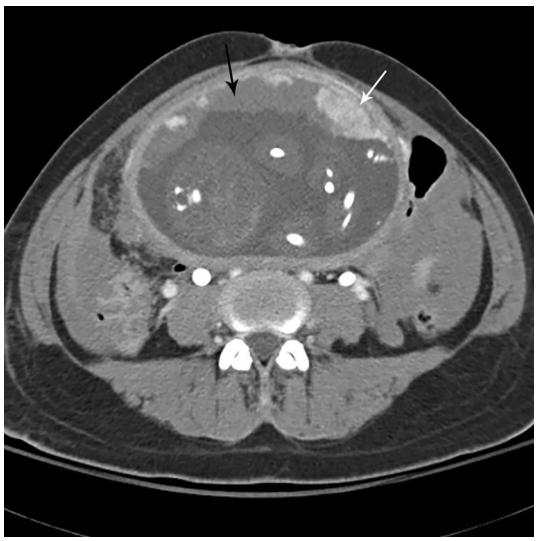

Fig. 3 CT for placental abruption. Axial contrast-enhanced CT image in a patient after motor vehicle accident and fetal demise shows hyperdense blood products (*white arrow*) dissecting under the placenta (*black arrow*)

weighted sequences, aiding in prognosis. Hematoma with hyperacute or acute MR findings has been shown to correlate with rapid clinical deterioration to maternal and fetal distress, often requiring prompt delivery [18••, 19]. With hyperacute or acute bleeds, hypointense blood products relative to the placenta on diffusion imaging may be the best clue. Early or late subacute demonstrate blood products are more easily identified with T1 and diffusion hyperintensity [18••].

Although less commonly performed, CT is often obtained with trauma during pregnancy, in which setting placental abruption and infarction are the most common uterine injuries [20]. CT shows high-attenuation hemorrhage in the typically low-attenuation amniotic fluid and areas of placental devascularization (Fig. 3).

Peri-Partum

Hemorrhage after delivery can occur for a variety of reasons. Uterine atony is the most common, diagnosed and treated clinically. Imaging plays a role in distinguishing retained products of conception (RPOC) from a uterine arteriovenous malformation or fistula (UAVM/UAVF), or simply normal post-partum bleeding [21].

Retained Products of Conception

RPOC refer to persistent fetal or placental tissue in the uterus after delivery [22••]. A thickened endometrial echo complex ranging from 8 to 13 mm is the most sensitive finding [23, 24]. Sensitivity is 80 % with a 10-mm thickness, but specificity is only 20 %, as there are many causes for a thickened post-partum endometrium [24, 25•]. The negative predictive value is 100 %, if endometrial thickness is less than 10 mm without focal endometrial thickening or an endometrial mass [26]. Adding Color Doppler US nearly doubles the likelihood of a diagnosis of RPOC, since both blood clots and RPOC can appear as a thickened endometrial echo complex or mass on grayscale US [27]. Blood clots are typically avascular, with RPOC demonstrating color and pulse wave vascularity [22••] (Fig. 4).

A system of standardized grading, from 0 to 3, has been proposed to unify diagnosis and management [25•]. With increasing grade, there is an increased positive predictive value of RPOC; 90 % with grade 1 and 100 % with grades 2 and 3. Recently, it has been demonstrated that increased vascularity on US reflects the increased vascularity of the chorionic villi. Conversely, avascular or hypovascular RPOC correlates with involution of villi, and thus supports a more expectant management approach [25•].

RPOC is a mimic for many other post-partum findings [22••]. Vascularity extending from the myometrium to the endometrium should help distinguish UAVM from -Grade 3 RPOC (Fig. 6). Endometrial polyps or submucosal fibroids may appear as vascular endometrial masses, similar to RPOC. β-hCG levels can be helpful to distinguish RPOC from gestational trophoblastic disease. If US is inconclusive and clinical management would be altered, CT and MRI with contrast may be used. These modalities will show an endometrial soft tissue

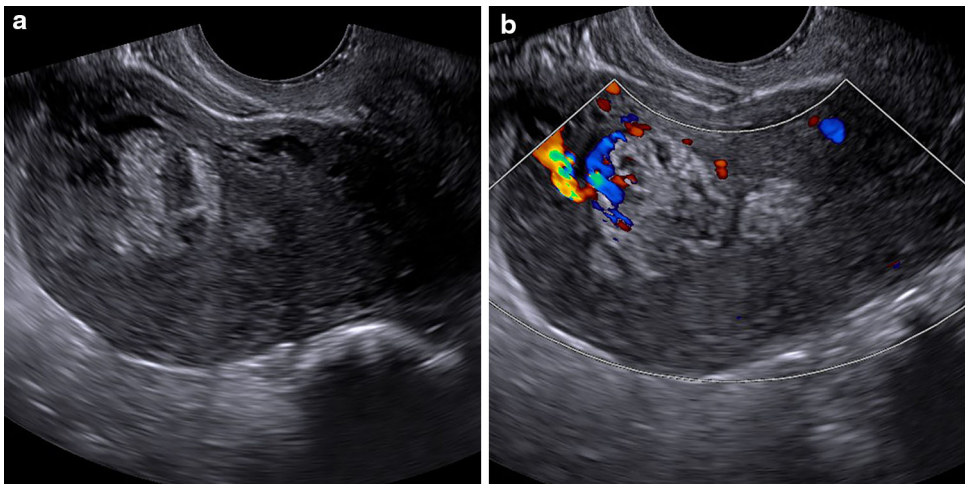

Fig. 4 RPOC on US. Longitudinal US demonstrates a heterogenous, hyperechoic endometrial mass (**a**) with focal Doppler flow (**b**)

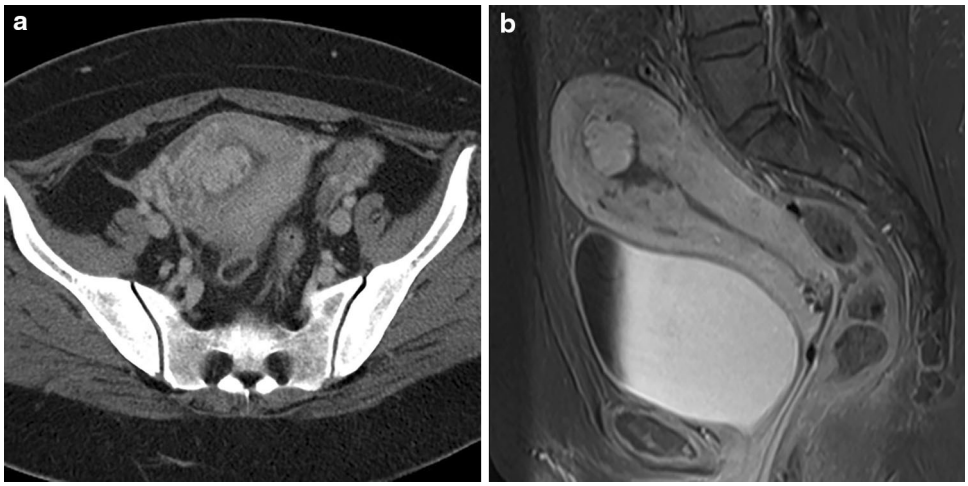

Fig. 5 RPOC on CT and MRI. On axial CT (**a**) a complex-enhancing endometrial mass is noted. On sagittal T1WI post-contrast MRI (**b**), the endometrial mass is enhancing homogeneously

mass with partial or delayed enhancement relative to adjacent endometrium (Fig. 5) [28, 29].

Uterine Arteriovenous Malformation (AVM)/ Arteriovenous Fistula (AVF)

UAVM/UAVF are rare causes of vaginal bleeding in women of reproductive age. These are most often acquired after dilation and curettage, but can be seen after any disruption of the myometrium related to delivery, cesarean section, IUD placement, or RPOC. The abnormal weakened vasculature in these lesions makes them susceptible to bleeding with minimal trauma. As emergent hysterectomy is the treatment for catastrophic bleeding, it is important to consider and recognize UAVM/UAVF.

On US, UAVM/UAVFs are hypoechoic vascular channels centered in the myometrium, typically without mass effect. With Doppler, these channels have avid multidirectional flow and aliasing from high flow velocities (Fig. 6). The velocity waveforms are low resistance with

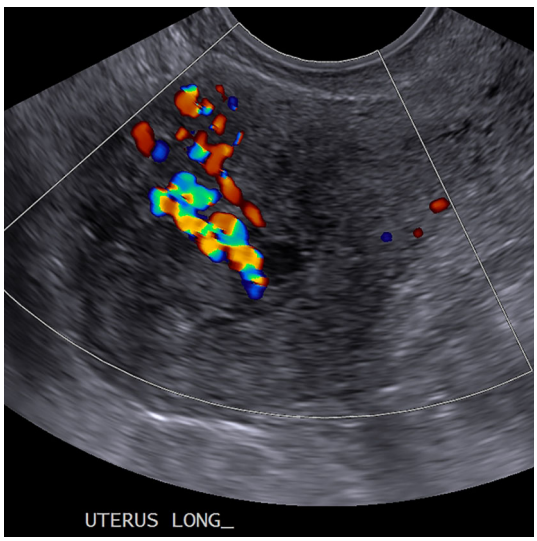

Fig. 6 UAVM/UAVF on US. Transvaginal US shows the mass-like tangle of vessels with multidirectional flow in the anterior myometrium

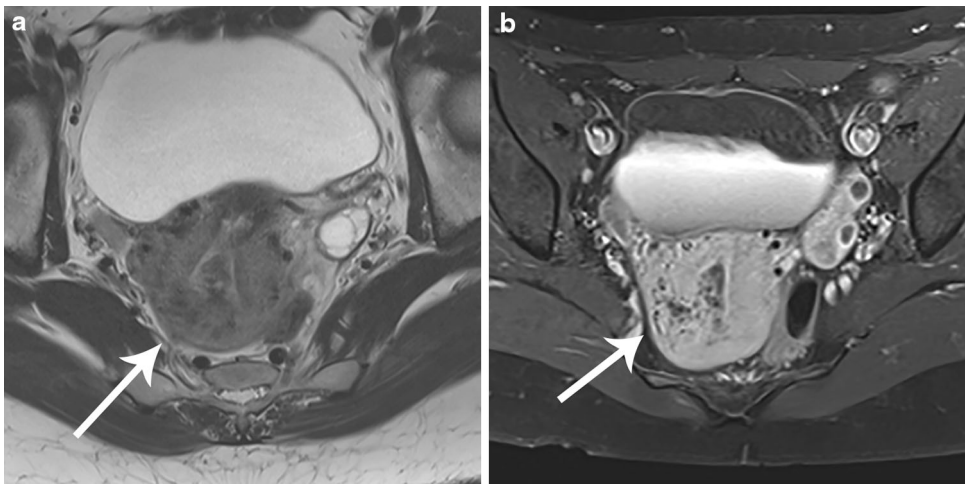

Fig. 7 UAVM/AVF on MRI. Axial T2WI (**a**) shows multiple flow-voids (*arrow*) in the anterior myometrium suggesting vascular malformation. Axial post-contrast T1WI (**b**) with fat saturation demonstrates heterogeneous enhancement (*arrow*) of the vascular malformation, with less signal intensity than adjacent myometrium

RIs typically well below 0.6 due to the shunt physiology created by the lack of a normal capillary bed [30, 31]. The myometrial location helps to differentiate UAVM/UAVF from other endometrial abnormalities, like RPOC.

MR or CT angiography is both useful for treatment planning, although it is not usually required for diagnosis [32]. CT angiography is a fast imaging modality that can be used to confirm a suspected uAVM/uAVF seen on ultrasound [31]. MRI shows serpiginous signal voids with prominent parametrial vessels and irregularity of the junctional zone (Fig. 7) [32]. Findings of unilateral or bilateral hypertrophied uterine arterial vasculature in a vascular tangle with early venous drainage are seen across all angiographic modalities, including conventional digital subtraction angiography.

A recently published retrospective review of 19 women with UAVM who underwent bilateral uterine artery embolization showed a technical success rate of 90 % using a single-treatment session [33••]. Patients had normal menstruation within 2 months, and uncomplicated births have been documented in two of the women [33••]. Technical success is independent of the type of embolization material used. The most common intervention tends to be particulate agents such as gelfoam pledgets and polyvinyl alcohol particles, with microcoils used rarely [33••, 34]. Conventional transcatheter angiography is the best option for treatment with the potential to preserve fertility, while also providing a definitive diagnosis, typically after CTA or MRA planning [33••, 34, 35].

Ovarian Vein Thrombosis

Ovarian vein thrombosis (OVT) is classically associated with pregnancy, thrombophilic states such as sepsis, malignancy, hormone stimulation, inflammatory bowel disease, or recent surgery [36, 37]. OVT affects approximately 0.5–3 per 1000 pregnancies in the post-partum period [38••]. OVT is bilateral in 11–14 % of cases and involves the right ovarian vein up to 90 % of the time [36, 39].

Although US sensitivity is around 50 % because of patient factors that limit the ability to find and image the vein, the study is highly specific [40]. On color Doppler US, OVT will look like acute venous thrombosis in other areas of the body with central hypoechoic thrombus, vein distention, noncompressibility, and lack of flow [41].

Sensitivity and specificity for CT and MRI in the diagnosis of OVT are reported as high as 100 % for both [36, 40–43]. Contrast-enhanced CT is often the first line of imaging and will show an intraluminal filling defect with the enhancement of the distended ovarian vein walls and surrounding inflammation, when OVT is complicated by thrombophlebitis (Fig. 8). Pseudothrombosis on the right due to mixing artifact from delay of contrast opacification compared to the left should be recognized. Delayed imaging in the renal excretory phase can help distinguish the ovarian vein from an adjacent ureter in difficult cases.

MR without IV contrast techniques exist for imaging the pregnant patient. The complex intraluminal thrombus with areas of central low intensity from retracted clot and mixed areas of T1 and T2 hyperintensity [41]. MR venography using 2-dimensional time of flight gradient echo flow is just as sensitive as contrast-enhanced venography [38••]. The addition of diffusion-weighted images can show restricted diffusion in the thrombus also negating the need for IV contrast (Fig. 9) [44•]. Both CT and MR are superior to US in delineating the extent of thrombosis.

Anticoagulation and antibiotic regimens are the most often used to avoid mortality and morbidity associated with sepsis and venous thromboembolism [45]. However, caution should be used when reporting the incidentally discovered OVT in a low risk, asymptomatic post-partum woman. In a 2012 prospective study of 30 women after spontaneous vaginal delivery, over half had definitive or probable ovarian and iliac vein thrombosis identified by MR

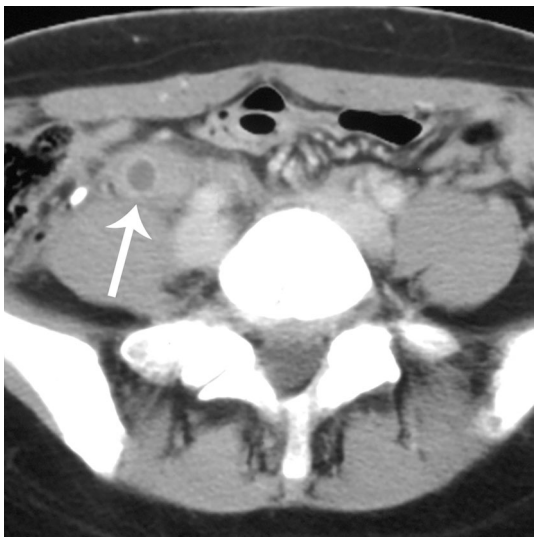

Fig. 8 OVT on CT: Axial contrast-enhanced CT in a post-partum patient shows thrombus in the distended right ovarian vein. The vascular wall enhances with surrounding inflammatory stranding (*arrow*) consistent with thrombophlebitis

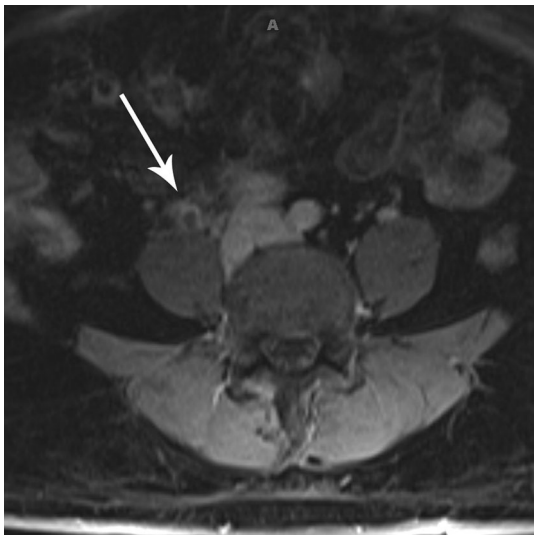

Fig. 9 OVT on MRI. T1WI post-contrast fat saturation image shows intraluminal filling defect with the enhancement of the distended ovarian vein wall and surrounding inflammation indicating thrombophlebitis. Images courtesy of Cary L. Siegal, MD, Mallinckrodt Institute of Radiology

venography on post-partum day 1 [38••]. These findings suggest that deep pelvic thrombosis may actually be a normal finding in the early post-partum period, bringing into question the appropriateness of anticoagulation and antibiotics.

Uterine Rupture and Dehiscence

Uterine rupture and uterine dehiscence are rare causes of acute pelvic pain, but are critically important to recognize

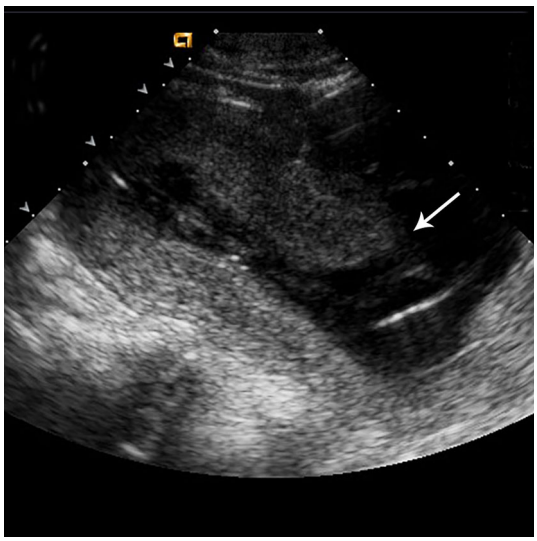

Fig. 10 Uterine rupture on US. Longitudinal US of uterine rupture demonstrates a focal disruption of the myometrium (*arrow*), with echogenic-free fluid in the pelvis, and an abnormal communication to the endometrial cavity

because of the associated high maternal and peri-partum morbidity [46]. Rupture and dehiscence are most often seen after Cesarian-section or trauma, but may be encountered as a complication of minimally invasive contraceptives, including intrauterine devices (IUD) and hysteroscopically placed tubal occlusion devices [47••, 48–50].

Sonographic findings of rupture include an abnormal communication to the endometrial cavity, or a focal disruption in the myometrium with echogenic-free fluid in the pelvis (Fig. 10). Dehiscence may appear as thin tapering of the anterior myometrium containing only an intact echogenic uterine serosa [51•]. If US findings are inconclusive, CT or MR imaging can be used to confirm this diagnosis as future fertility may be threatened if the uterine cannot be repaired (Fig. 11).

The Nonpregnant Patient

In the nonpregnant patient, imaging is almost always used to help the clinician with diagnosis as management considerations widely vary in patients with ovarian torsion tubo-ovarian abscess (TOA) or hemorrhagic cysts.

Ovarian Torsion

Ovarian torsion is defined as partial or complete rotation of the ovary on its vascular pedicle resulting in obstruction of venous and arterial blood flow to the ovary [52]. In over half of all cases, an underlying ovarian mass acts as a lead point [53–55].

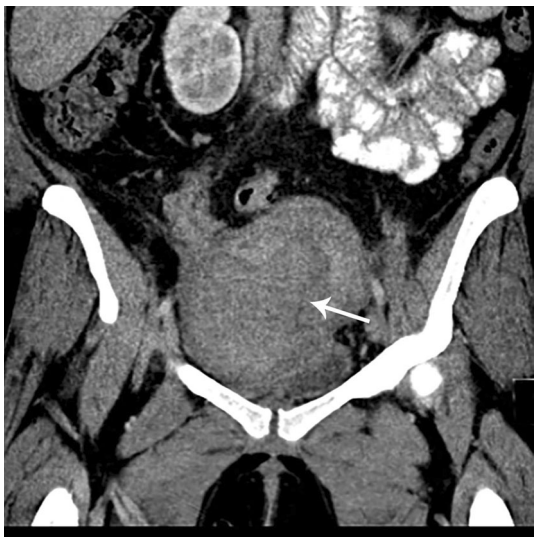

Fig. 11 Uterine rupture on CT. Coronal CT shows a large area of complete myometrial disruption (*arrow*) with heterogenous hypodense material extending from the endometrial cavity to the peritoneal space

Sonographic findings for torsion include unilateral enlargement of the ovary that may or may not be associated with a mass, peripherally displaced follicles, free fluid, and a twisted vascular pedicle. The presence of arterial and venous flow does not exclude torsion, but may indicate ovarian viability and can also be seen in torsion–detorsion [56]. In one study of 21 cases, the absence of blood flow on US was associated with a nonviable ovary at the time of surgery in 100 % of cases [57]. Although US is the initial imaging of choice for suspected torsion, MRI should be considered when sonographic findings are inconclusive, torsion is suspected in a pregnant patient, or for further characterization of the lead point mass causing the torsion [56].

Findings on both CT and MRI include an enlarged ovary with or without a mass and a twisted vascular pedicle. Ascites, engorged vessels on the torsed side, and thickening of the fallopian tube can also be seen [52, 56, 58, 59]. T2-weighted MRI and contrast-enhanced CT best show the enlarged edematous ovary with peripherally displaced follicles (Fig. 12). CT and T1 fat saturation images with IV contrast show abnormal enhancement, twisted, and engorged vessels, and may characterize the underlying mass [56]. Enhancement evolves from heterogeneous to minimal and finally to an absence of enhancement as the ovary infarcts. Due to ovarian dual blood supply, arterial flow does not become compromised until late in the course of torsion [52]. Subacute ovarian hemorrhage is associated with infarction and necrosis and occurs later than ovarian edema [52]. On MRI, a T1 hyperintense rim of a hematoma in an enlarged ovary should lead the radiologist to suspect torsion [56]. Diffusion restriction correlates with hemorrhagic infarction [60•].

Laparoscopic detorsion is the treatment of choice. Just as with imaging, the intra-operative appearance of the ovary may be misleading. The ovary often has a bluish-black appearance that persists the following detorsion [61••]. In the setting of ovarian mass leading to torsion, mass resection or cystectomy with ovarian preservation remains the treatment of choice. If malignancy is suspected, frozen sections should be obtained as oophorectomy should be performed rather than detorsion [55]. After detorsion, most affected ovaries will demonstrate physiologic follicles and normal Doppler flow after only 6 weeks [62]. If the ovary appears atrophic on follow-up US or there is lack of blood flow on Doppler ultrasound, a concern for necrosis should be raised. Additional imaging such as MRI or CT may be used to confirm the observation. A lack of enhancement on CT or MRI, a rim of T1 hyperintensity, or diffusion restriction are all findings that suggest ovarian necrosis. Necrosis should be confirmed by frozen section as oophorectomy is required for treatment [63].

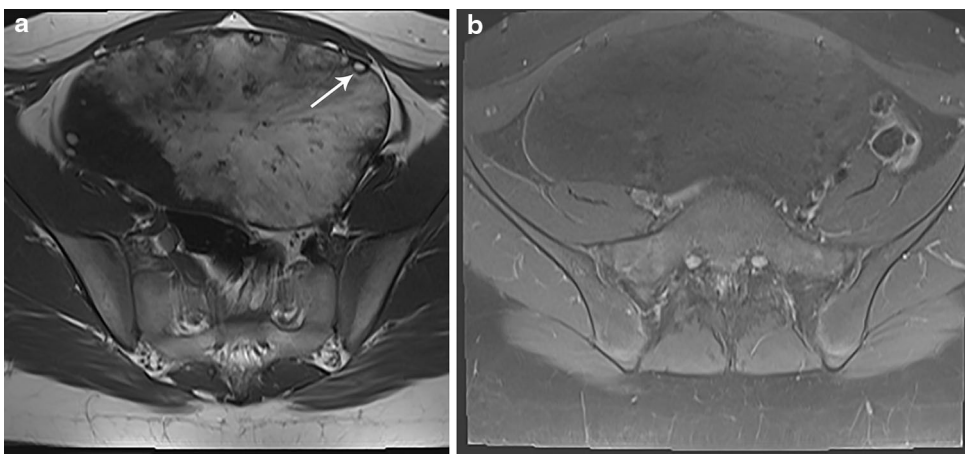

Fig. 12 Ovarian torsion on MRI. Axial T2 (**a**) MRI of the pelvis shows an enlarged ovary with peripherally displaced T2 hyperintense follicles (*arrow*). Post-contrast T1 MRI (**b**) demonstrates no enhancement, raising concern for infarction

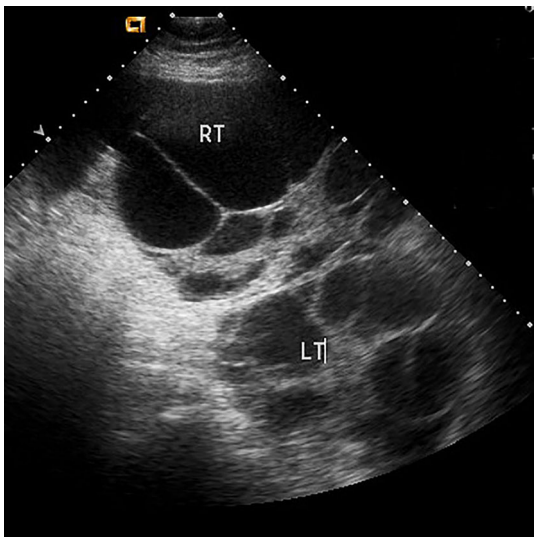

Fig. 13 OHSS on US. Transabdominal images of the adnexa demonstrates enlarged cystic follicles occupying the majority of the ovary with a small central stromal portion, giving a bilateral classic "spoke-wheel" appearance

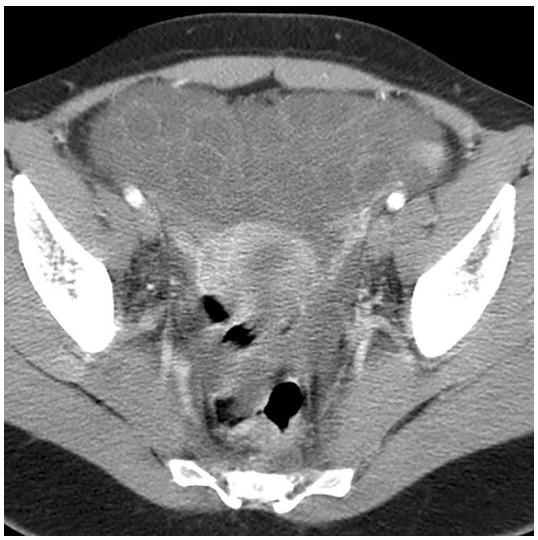

Fig. 14 OHSS on CT. Axial contrast CT shows bilateral symmetric enlargement of both ovaries. Numerous enlarged cystic follicles occupying most of the ovary with scant central stroma

Ovarian Hyperstimulation Syndrome

One entity that is important to distinguish from ovarian torsion is the enlarged ovarian follicles that occur as a consequence of assisted reproductive technology (ART) or ovarian-stimulating pharmacotherapy, ovarian hyperstimulation syndrome (OHSS) [64•]. OHSS classically demonstrates bilateral symmetric enlargement of the ovaries with multiple large thin-walled cysts surrounding a small area of central ovarian stroma, creating a "spoke-wheel" appearance on all modalities (Figs. 13, 14). The large cystic follicles in OHSS may act as lead points for concurrent ovarian torsion. Mild and moderate OHSS commonly presents with nausea and vomiting. Severe OHSS presents with symptoms including ascites, pleural effusions, acute respiratory distress, hemoconcentration, hypovolemia, hypercoagulability, thromboembolism, organ failure, and shock. Thromboembolic complication from severe OHSS, while rare, can result in catastrophic injury or death [64•]. More recently, it is recognized that the risk of OHSS is increased when more that 15 oocytes are targeted for retrieval, suggesting that less aggressive ART stimulation protocols will reduce the likelihood of diagnosing this syndrome in the future [65].

Hemorrhagic Ovarian Cyst

Hemorrhagic ovarian cysts are usually nonemergent causes of acute pelvic pain and resolve spontaneously without intervention. On rare occasions, hemorrhagic cysts present as shock from acute blood loss. These patients usually have large volume hemoperitoneum on imaging [66•]. Ruptured hemorrhagic cysts usually occur in nonpregnant, premenopausal women [67]. Since hemoperitoneum can also be seen in ruptured ectopic pregnancies, β-hCG testing is imperative for accurate imaging diagnosis.

Findings suggestive of a ruptured hemorrhagic cyst on US include a cyst with scalloped borders and point tenderness when the probe is placed on the cyst [68]. In an emergent situation with acute blood loss, a large volume of echogenic fluid or hyperdense hemoperitoneum will be seen on ultrasound or CT, respectively. The attenuation of blood can be quite variable on CT ranging from 30 to 45 HU in unclotted blood to 45–70 HU in clotted blood [69]. Large volume hemoperitoneum may extend into Morrison's pouch, the most dependent part of the body (Fig. 15). These patients may be hemodynamically unstable due to hypovolemic shock and resuscitation algorithms should be employed. This is a critical imaging finding that warrants physician-to-physician communication.

Tubo-Ovarian Abscess

Pelvic inflammatory disease (PID) is ascending infection of the upper female genital tract, which may result in a salpingitis, pyosalpinx, or TOA [70]. This diagnosis is often made clinically; however, imaging can be helpful to evaluate for complications as progression of infection to

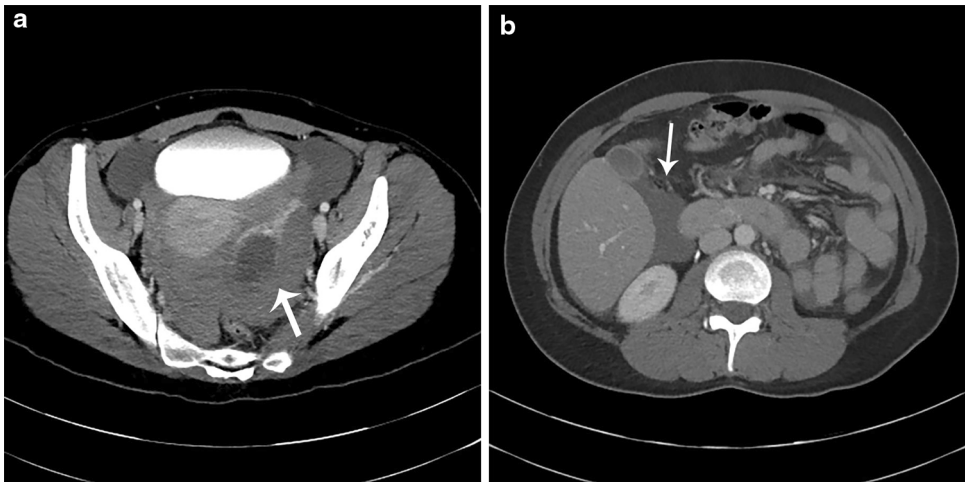

Fig. 15 Hemoperitoneum from rupture hemorrhagic ovarian cyst on CT. Axial contrast-enhanced CT (**a**) through the pelvis shows a fluid attenuating left adnexal mass with rim enhancement (*arrow*) with a large volume of hyperattenuating fluid in the rectouterine pouch. The fluid measured 55 HU consistent with hemoperitoneum. Axial CT through the abdomen (**b**) shows that the hemoperitoneum dissects to Morrison's pouch (*arrow*)

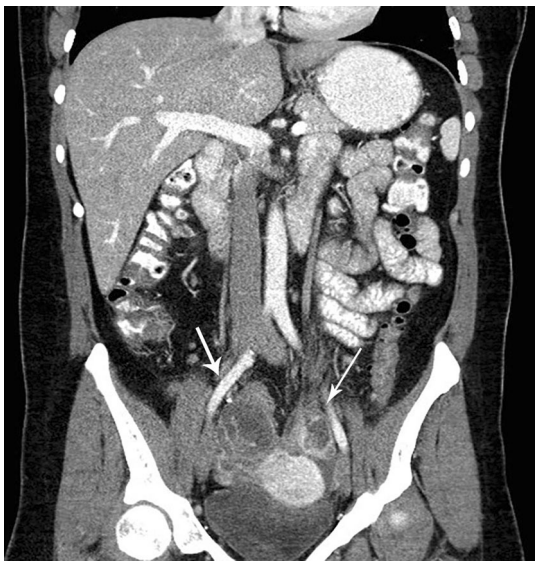

Fig. 16 TOA on CT. Coronal contrast-enhanced CT through the pelvis shows bilateral irregular adnexal masses (*arrows*) with rim enhancement consistent with TOA

the ovary can lead to TOA. Rupture of the abscess into the peritoneal cavity can result peritonitis and sepsis [70].

Findings of pyosalpinx and TOA include a complex adnexal mass, often with cystic and solid components. The fallopian tube and ovary cannot be separated, although the fallopian tube can be identified by its characteristic short axis cog-wheel appearance with its thickened endosalpingeal folds, hyper vascularity, and possible fluid-debris level [70, 71]. TOA may be found on the CT that is performed for nonspecific pelvic pain [70–72]. Contrast-enhanced CT of TOA shows a complex cystic-sold adnexal mass with enhancing walls and septae (Fig. 16). Inflammation spreads from the adnexa into the paracolic gutters and into Morrison's pouch [70]. Spread from the right paracolic gutter to the liver capsule can lead to Fitz-Hugh-Curtis syndrome or perihepatitis [73]. On contrast-enhanced CT and MRI, perihepatitis is seen as thickening and enhancement of the anterior liver capsule with variable perfusion sometimes seen in the subcapsular liver.

If US is indeterminate, MRI should be considered to identify the ovaries and surrounding pelvic structures due to excellent soft tissue contrast [70, 74]. MRI of pyosalpinx will show a dilated T2 hyperintense tubular structure with thick enhancing walls (Fig. 17). T1 signal may be variable depending on the protein content of the fluid. Enhancement of the wall will help to differentiate pyosalpinx from hydrosalpinx [75]. MRI of TOA depends on the hemorrhagic and protein content of the abscess. Usually, the abscess is T1 hypointense with a hyperintense internal rim. T2 imaging will show a heterogeneous mass with low signal septa, and septal enhancement after contrast administration [76]. Diffusion-weighted imaging can be used to confirm abscess.

Management of TOA has evolved in recent years. US-guided transvaginal drainage with concurrent IV antibiotics is favored [75, 77]. In a study by Gjelland et al. [75], transvaginal US drainage in combination with antibiotics performed in 302 women with TOA resulted in a 93.4 % success rate. The other 20 women (6.6 %) went on to surgery due to diagnostic or therapeutic uncertainty. No treatment complications occurred. The high success rate of image-guided US drainage indicates that it should be considered a first-line treatment. Fertility preservation rate with US-guided drainage and antibiotics is approximately 50 % [78•].

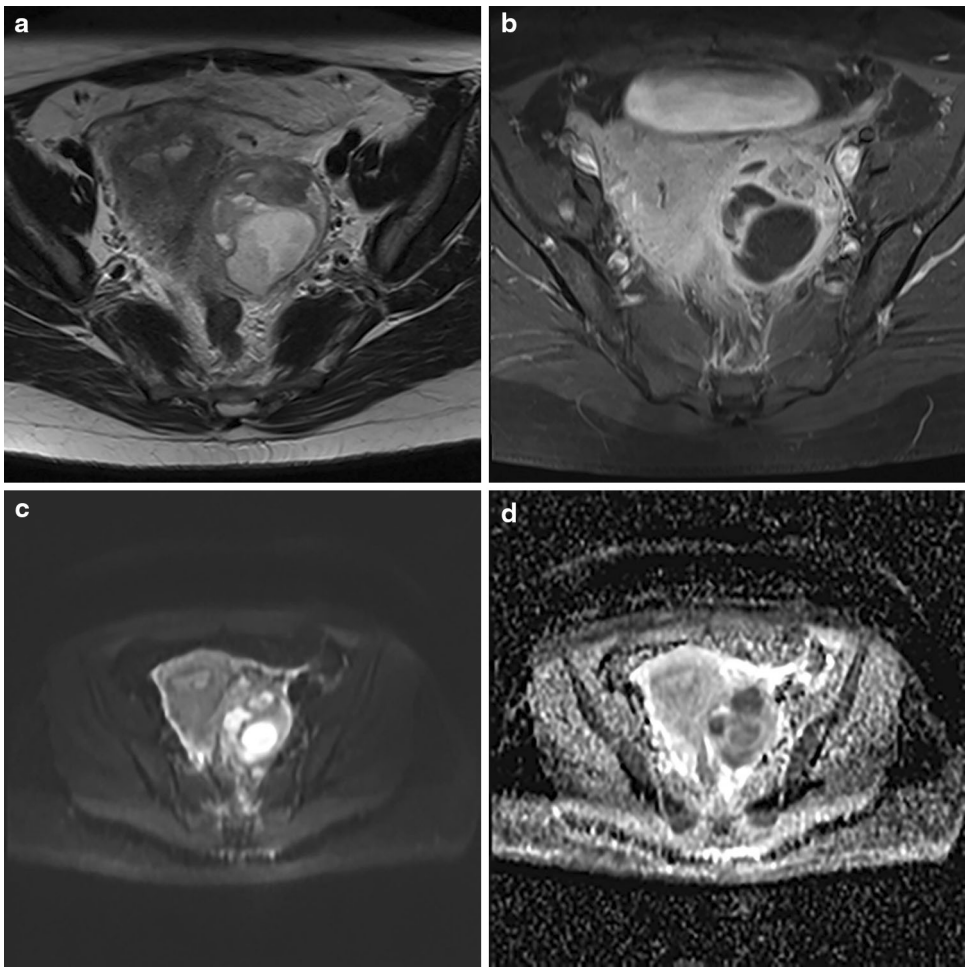

Fig. 17 TOA on MRI. Axial T2 (**a**), T1 post-contrast (**b**), DWI (**c**), and ADC (**d**) images through the pelvis demonstrate a rim enhancing, multiloculated T2 hyperintense mass arising from the left adnexa. The mass demonstrates diffuse restriction (hyperintense on DWI and hypointense on ADC) consistent with a tubo-ovarian abscess

Conclusion

A woman who presents with acute abdominal or pelvic symptoms requires a clinical and imaging evaluation. The first imaging test will almost always be a transabdominal and transvaginal ultrasound. Correct interpretation and subsequent advanced imaging recommendations are highly specific to the clinical context, especially pregnancy status. Insight into management of various acute gynecologic diagnoses helps guide providers and patients to the imaging tests that will improve patient outcomes.

Compliance with Ethics Guidelines

Conflict of Interest Kaerli M. Christensen, Logan A. McLean, Bryn Putbrese, Elaine Pigman, and Marta E. Heilbrun each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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