

**American College of Radiology  
ACR Appropriateness Criteria®  
Acute Pelvic Pain in the Reproductive Age Group**

**Variant 1:** Acute pelvic pain in the reproductive age group. Gynecological etiology suspected,  $\beta$ -hCG positive (either serum or urine). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler adnexa	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
MRI pelvis without and with IV contrast	Usually Not Appropriate	○
MRI pelvis without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕
CT pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

**Variant 2:** Acute pelvic pain in the reproductive age group. Gynecological etiology suspected,  $\beta$ -hCG negative (either serum or urine). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transabdominal	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
MRI pelvis without and with IV contrast	May Be Appropriate	○
MRI pelvis without IV contrast	May Be Appropriate	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
MRI abdomen and pelvis without IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕
CT pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

**Variant 3:****Acute pelvic pain in the reproductive age group. Nongynecological etiology suspected,  $\beta$ -hCG positive (either urine or serum). Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen and pelvis transabdominal	Usually Appropriate	○
US duplex Doppler adnexa	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
MRI abdomen and pelvis without IV contrast	May Be Appropriate (Disagreement)	○
CT abdomen and pelvis with IV contrast	May Be Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	Usually Not Appropriate	○
CT abdomen and pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕
CT pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

**Variant 4:****Acute pelvic pain in the reproductive age group. Nongynecological etiology suspected,  $\beta$ -hCG negative (either urine or serum). Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
US abdomen and pelvis transabdominal	Usually Appropriate	○
US duplex Doppler pelvis	Usually Appropriate	○
US pelvis transvaginal	Usually Appropriate	○
CT abdomen and pelvis with IV contrast	Usually Appropriate	⊕⊕⊕
CT abdomen and pelvis without IV contrast	Usually Appropriate	⊕⊕⊕
MRI abdomen and pelvis without and with IV contrast	May Be Appropriate (Disagreement)	○
MRI abdomen and pelvis without IV contrast	May Be Appropriate	○
CT pelvis with IV contrast	Usually Not Appropriate	⊕⊕⊕
CT pelvis without IV contrast	Usually Not Appropriate	⊕⊕⊕
CT abdomen and pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕
CT pelvis without and with IV contrast	Usually Not Appropriate	⊕⊕⊕⊕

## Acute Pelvic Pain in the Reproductive Age Group

Expert Panel on GYN and OB Imaging: Olga R. Brook, MD<sup>a</sup>; Joseph R. Dadour, MD<sup>b</sup>; Jessica B. Robbins, MD<sup>c</sup>; Ashish P. Wasnik, MD<sup>d</sup>; Esma A. Akin, MD<sup>e</sup>; Matthew P. Borloz, MD<sup>f</sup>; Adrian A. Dawkins, MD<sup>g</sup>; Myra K. Feldman, MD<sup>h</sup>; Lisa P. Jones, MD<sup>i</sup>; Lee A. Learman, MD, PhD<sup>j</sup>; Kira Melamud, MD<sup>k</sup>; Krupa K. Patel-Lippmann, MD<sup>l</sup>; Carl J. Saphier, MD<sup>m</sup>; Kimberly Shampain, MD<sup>n</sup>; Jennifer W. Uyeda, MD<sup>o</sup>; Wendaline VanBuren, MD<sup>p</sup>; Stella K. Kang, MD, MS.<sup>q</sup>

### Summary of Literature Review

#### Introduction/Background

Premenopausal patients with acute pelvic pain often pose a diagnostic dilemma. They may exhibit additional nonspecific signs and symptoms, the most common being nausea, vomiting, and leukocytosis. The differential considerations encompass gynecological and obstetrical causes (eg, hemorrhagic ovarian cysts, pelvic inflammatory disease [PID], ovarian torsion, ectopic pregnancy, spontaneous abortion, or labor and placental abruption), as well as nongynecological etiologies (eg, appendicitis, inflammatory bowel disease, infectious enteritis, diverticulitis, urinary tract calculi, pyelonephritis, and pelvic thrombophlebitis). The choice of imaging modality is determined by the most likely clinically suspected differential diagnosis, because each modality differs in the ability to depict disease in the various pelvic organs. Thus, a thorough clinical evaluation of the patient is required to determine the index of suspicion among the various etiologies. Diagnostic considerations should be based upon the correlation of history, physical examination, and laboratory testing before a radiologic examination is chosen.

*Serum beta-human chorionic gonadotropin:* A serum beta-human chorionic gonadotropin ( $\beta$ -hCG) test is usually performed when a premenopausal patient presents with symptoms of acute pelvic pain. Knowledge of pregnancy is of utmost importance to determine whether pregnancy-related causes of pain should be considered, especially ectopic pregnancy. Concern for fetal exposure to ionizing radiation is an important consideration in determining the appropriate imaging modality. Serum  $\beta$ -hCG test becomes positive approximately 9 days after conception. Thus, a negative serum  $\beta$ -hCG test essentially excludes the diagnosis of an intrauterine or ectopic pregnancy. Note that elevated  $\beta$ -hCG in a nonpregnant patient may be related to miscarriage, ectopic pregnancy, pituitary production, paraneoplastic production, or gestational trophoblastic disease.

Details on risk to the fetus, as well as guidelines on screening for pregnancy, minimizing radiation exposure, and risk assessment, can be found throughout this document.

#### Special Imaging Considerations

Details on risk to the fetus, guideline on screening for pregnancy, minimizing radiation exposure, and risk assessment can be found in the [ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#) [1].

Use of contrast in MRI during pregnancy should be done with caution, because the gadolinium-chelate molecules are excreted in the amniotic fluid and may remain there for an indeterminate amount of time before finally being reabsorbed and eliminated [2].

Gadolinium is considered a pregnancy category C drug (it should be administered only if the potential benefit outweighs the risk) because animal studies have revealed adverse effects. Among 26 patients who had exposure to gadopentetate-dimeglumine in the periconceptional and first trimester period, only one congenital birth anomaly was found (hemangiomas) [3]. However, no well-controlled studies of the teratogenic effects of these media in

---

<sup>a</sup>Beth Israel Deaconess Medical Center, Boston, Massachusetts. <sup>b</sup>Research Author, Centre Hospitalier de l'Université de Montréal, Montréal, Montreal, Quebec, Canada. <sup>c</sup>Panel Chair, University of Wisconsin, Madison, Wisconsin. <sup>d</sup>Panel Vice-Chair, University of Michigan, Ann Arbor, Michigan. <sup>e</sup>The George Washington University Medical Center, Washington, District of Columbia; Commission on Nuclear Medicine and Molecular Imaging. <sup>f</sup>Virginia Tech Carilion School of Medicine, Roanoke, Virginia; American College of Emergency Physicians. <sup>g</sup>University of Kentucky, Lexington, Kentucky. <sup>h</sup>Cleveland Clinic, Cleveland, Ohio. <sup>i</sup>Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania. <sup>j</sup>Virginia Tech Carilion School of Medicine, Roanoke, Virginia; American College of Obstetricians and Gynecologists. <sup>k</sup>New York University Langone Health, New York, New York. <sup>l</sup>Vanderbilt University Medical Center, Nashville, Tennessee. <sup>m</sup>Women's Ultrasound, LLC, Englewood, New Jersey; American College of Obstetricians and Gynecologists. <sup>n</sup>University of Michigan, Ann Arbor, Michigan. <sup>o</sup>Brigham & Women's Hospital, Boston, Massachusetts; Committee on Emergency Radiology-GSER. <sup>p</sup>Mayo Clinic, Rochester, Minnesota. <sup>q</sup>Specialty Chair, New York University Medical Center, New York, New York.

The American College of Radiology seeks and encourages collaboration with other organizations on the development of the ACR Appropriateness Criteria through representation of such organizations on expert panels. Participation on the expert panel does not necessarily imply endorsement of the final document by individual contributors or their respective organization.

Reprint requests to: [publications@acr.org](mailto:publications@acr.org)

pregnant patients have been performed.

Thus, if the information requested from the MRI study with intravenous (IV) contrast cannot be acquired using other modalities and is needed to potentially affect the care of the patient or fetus during the pregnancy, and the ordering physician believes that it is not prudent to wait until the patient is no longer pregnant, IV contrast may be administered and the rationale diligently documented. It is recommended that informed consent be obtained from the patient after discussion with the referring physician [4].

### **Initial Imaging Definition**

Initial imaging is defined as imaging at the beginning of the care episode for the medical condition defined by the variant. More than one procedure can be considered usually appropriate in the initial imaging evaluation when:

- There are procedures that are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care)

OR

- There are complementary procedures (ie, more than one procedure is ordered as a set or simultaneously where each procedure provides unique clinical information to effectively manage the patient's care).

### **Discussion of Procedures by Variant**

**Variant 1: Acute pelvic pain in the reproductive age group. Gynecological etiology suspected,  $\beta$ -hCG positive (either serum or urine). Initial imaging.**

#### **CT Abdomen and Pelvis With IV Contrast**

CT is not commonly used for the evaluation of pelvic pain in the setting of a positive  $\beta$ -hCG given the radiation exposure. CT may be used inadvertently if the patient is inadequately screened for pregnancy. Correlates of "classic" ultrasound (US) signs of ectopic pregnancy can be seen on CT, such as a cystic structure with peripheral enhancement in tubal pregnancy or hemoperitoneum with a hemorrhagic adnexal mass in the case of ruptured ectopic pregnancy. In the rare cases of abdominal ectopic pregnancy, CT can be helpful in confirming the diagnosis, due to its large field of view in determining anatomic relationships and potential vascular supply, and in assessing placental adherence [5].

#### **CT Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Pelvis With IV Contrast**

There is no relevant literature to support the use of pelvic CT with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of pelvic CT without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Pelvis Without IV Contrast**

There is no relevant literature to support the use of pelvic CT without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **MRI Abdomen and Pelvis Without and With IV Contrast**

There is no evidence to support use of MRI abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. However, MRI may serve to evaluate multiple organ systems for signs of complications or pathology related to a positive  $\beta$ -hCG (ie, ectopic pregnancy) in select cases or when the suspected organ system causing pain is clinically unclear.

Generally, MRI of the pelvis may provide sufficient anatomic coverage without including the entire abdomen as with MRI of the abdomen and pelvis and, thus, may be used in selected cases as a second-line imaging modality.

### **MRI Abdomen and Pelvis Without IV Contrast**

There is no evidence to support the use of MRI abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. However, MRI may serve to evaluate multiple organ systems for signs of complications or pathology related to a positive  $\beta$ -hCG (ie, ectopic pregnancy) in select cases or when the suspected organ system causing pain is clinically unclear. Generally, MRI of the pelvis may provide sufficient anatomic coverage without including the entire abdomen as with MRI of the abdomen and pelvis and, thus, may be used in selected cases as a second-line imaging modality or in patients who are unable to tolerate transvaginal US (TVUS).

### **MRI Pelvis Without and With IV Contrast**

MRI pelvis without and with IV contrast is not commonly used as initial imaging for the evaluation of acute pelvic pain in the setting of a positive  $\beta$ -hCG. However, MRI can demonstrate correlates of “classic” US signs of ectopic pregnancy, such as in tubal pregnancies with a cystic structure with peripheral enhancement or hemoperitoneum with a hemorrhagic adnexal mass in the case of ruptured ectopic. In the rare cases of abdominal pregnancy, MRI can help confirm the diagnosis with its larger field of view (compared to US), help determine anatomic relationships and potential vascular connections, and assess placental adherence. Other cases of interstitial, cornual, ovarian, cervical, or cesarean scar pregnancies can also be visualized with MRI [5].

Cesarean scar pregnancy was accurately diagnosed in 95.5% of cases using contrast-enhanced MRI compared with 88.6% using US in a retrospective analysis of 44 patients with cesarean section scar pregnancy. This suggests that contrast-enhanced MRI could be used as a reliable adjunct for diagnosing cesarean scar pregnancy in select cases or if US is inconclusive or nondiagnostic. The typical findings of a gestational sac embedded in the anterior lower part of the uterus in the sagittal T2-weighted views were identified in all the patients. However, MRI examinations were performed approximately 5 days after the US examinations, which may have resulted in some bias, and same-day studies might have yielded similar sensitivity between both modalities [6]. Please refer to the Special Imaging Considerations section above for a discussion about the use of gadolinium-based contrast in the setting of pregnancy.

### **MRI Pelvis Without Contrast**

MRI pelvis without IV contrast is not commonly used as initial imaging for the evaluation of acute pelvic pain in the setting of a positive  $\beta$ -hCG, unless TVUS is not tolerated. MRI could be used as a second-line modality in the evaluation of complicated cases with unusually located ectopic pregnancy or if US is inconclusive or nondiagnostic. Sequences such as T1-weighted imaging are performed with and without fat suppression to identify bloody ascites and to determine stage of hemorrhage, as well as T2\*-weighted imaging that facilitate the identification of both hemorrhage and air bubbles can be performed [7]. Multiplanar T2-weighted MRI (usually half-Fourier single-shot fast spin-echo [ss-FSE or HASTE] sequences) can help with the detection of cystic structures, edema, and inflammation (especially if fat suppressed). Multiplanar balanced steady-state free precession (FIESTA or True FISP) sequence can help in confirming vessels and differentiating them from linear structures, like the appendix, due to bright blood effects [8].

In a small study with 8 patients with ectopic pregnancies (ovarian, tubal, parauterine, and cesarean section locations), diffusion-weighted imaging (DWI) showed diffusion restriction of the thick-walled cyst-like gestational sac in all patients, described as the “ring of restriction sign” by the authors [9].

### **US Duplex Doppler Adnexa**

Although labeled under a separate imaging procedure per ACR methodology, this document considers Doppler imaging to be a standard component of pelvic US. Doppler imaging is an integral imaging procedure along with pelvic US in the setting of acute pelvic pain and positive  $\beta$ -hCG. A prospective study of 32 patients by 4 gynecological sonologists with varying levels of experience demonstrated moderate to substantial interobserver reproducibility of Doppler US for diagnosis of incomplete miscarriage with substantial to almost perfect intraobserver reproducibility [10].

In the early 1990s, Doppler imaging was suggested as a tool allowing for increased detection rate of ectopic pregnancy, increasing sensitivity from 71% to 87% [11]; however, a recent study evaluating the correlation between adnexal sonographic findings and tubal rupture found no statistically significant correlation. Nonspecific adnexal

findings allows earlier detection of ectopic pregnancy than previously reported findings of detection of a yolk sac or embryonic heartbeat [12].

### **US Pelvis Transabdominal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. A transabdominal-only approach could serve as an alternative if a transvaginal approach is not feasible. TVUS and transabdominal US (TAUS) of the pelvis are the most useful imaging modalities for initial assessment when an obstetrical or gynecological etiology is suspected [13].

Diagnostic criteria for nonviable pregnancy in the first trimester require transvaginal assessment of the uterus and adnexa. However, transabdominal imaging without transvaginal scanning may be sufficient for diagnosing pregnancy failure when an embryo's crown-rump length is >15 mm without visible cardiac activity [14]. A combined transabdominal and transvaginal approach allows for assessment of adnexa situated in a high position that may be not be visible by the TVUS approach due to a position distant from the US probe. Visualization with TAUS may also be better than TVUS in select other circumstances.

### **US Pelvis Transvaginal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. TVUS is the most useful method to evaluate the endometrium, early pregnancy, and adnexa [14]. TVUS is currently considered the single best diagnostic modality to assess for ectopic pregnancy [15].

Literature from the 1980s correlated the presence of a gestational sac using TVUS with  $\beta$ -hCG levels of 1,000 to 2,000 mIU/mL [16]. However, the sonographic detection of a normal intrauterine pregnancy at  $\beta$ -hCG levels >2,000 mIU/mL can be complicated by obscuration of the endometrial cavity by fibroids, hemorrhage, intrauterine devices, or vaginal bleeding [11,17].

Doubilet et al [14] suggested that in some cases, the gestational sac may not be visible on TVUS until the  $\beta$ -hCG level reaches >3,000 mIU/mL. Therefore, in a stable patient, the diagnosis of failed or ectopic pregnancy should not be made at  $\beta$ -hCG level at or below 3,000 mIU/mL, and repeat sonographic evaluation and  $\beta$ -hCG levels should be obtained. The absence of an intrauterine pregnancy when the  $\beta$ -hCG level is >3,000 mIU/mL should be strongly suggestive (but not diagnostic) of an ectopic pregnancy. The high specificity of adnexal findings suggestive of ectopic pregnancy includes the classic "tubal ring" [12]. The sensitivity and positive predictive value (PPV) for ectopic pregnancy in cases evaluated with TVUS and when serum  $\beta$ -hCG level was <2,000 mIU/mL was 34.3% and 80.4% compared with definite diagnosis at follow-up by gynecology service (sensitivity of 75.9% and PPV of 91.5%) [18].

TVUS as a screening test for ectopic pregnancy demonstrated a 99% sensitivity and 84% specificity in a prospective study of 1,427 patients with  $\beta$ -hCG levels >1,500 IU/L [11].

In a retrospective study of 1,880 patients presenting to the emergency department with first trimester pain or vaginal bleeding, an overall accuracy of TVUS diagnosis was 78%, with a specificity above 90% but a low sensitivity of 35%. The sensitivity for ectopic and intrauterine pregnancy diagnosis is even lower in the absence of a yolk sac, 13% for ectopic pregnancy and 4% for intrauterine pregnancy. However, specificity is preserved in the absence of the yolk sac and remains above 90% [18].

A meta-analysis of 14 studies with 12,101 patients with ectopic pregnancy showed a positive likelihood ratio of 111 for the finding of adnexal mass without an intrauterine pregnancy on TVUS. This makes TVUS the single best diagnostic modality for evaluating patients with suspected ectopic pregnancy. A lack of adnexal abnormalities on TVUS decreases the likelihood of ectopic pregnancy with a negative likelihood ratio of 0.12 [15].

In a retrospective study of 591 cases of pregnancy of unknown location, no normal intrauterine pregnancy was found in patients with endometrial thickness <8 mm. An endometrial thickness of  $\geq 25$  mm virtually excludes the possibility of ectopic pregnancy because it was only present in 4 cases [19].

### **Variant 2: Acute pelvic pain in the reproductive age group. Gynecological etiology suspected, $\beta$ -hCG negative (either serum or urine). Initial imaging.**

#### **CT Abdomen and Pelvis With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG with the exclusion of ovarian vein thrombosis or postoperative complications after gynecological surgery. CT abdomen and

pelvis with IV contrast could be a consideration if a life-threatening diagnosis is considered (please refer to the ACR Appropriateness Criteria<sup>®</sup> topic on “[Major Blunt Trauma](#)” [20] for the initial evaluation in cases of abdominal trauma) or if US and MRI are inconclusive. Gynecological etiologies of acute pelvic pain may be seen on CT despite an initial indication focused on bowel or other adjacent organs (eg, appendicitis, acute diverticulitis, or kidney stones). An asymmetrically enlarged ovary with or without an underlying mass and a twisted pedicle are suggestive of adnexal torsion (with multiplanar CT reformations helpful for better detection of the twisted vascular pedicle). Other findings may include subacute ovarian hematoma (better assessed with nonenhanced acquisitions), abnormal or absent ovarian enhancement, ascites, deviation of the uterus to the side of the twist, engorged vessels on the twisted side, and fallopian tube thickening [21]. CT evaluation has a sensitivity of 74% to 95% and a specificity of 80% to 90% based on 2 case-control studies and 1 cohort study (n = 3,232) for the diagnosis of adnexal torsion [22].

CT findings of tubo-ovarian abscess (TOA) include a thick-walled fluid density in adnexal location, septations within the mass, indistinct borders between the uterus and adjacent bowel loops, and gas bubbles within the mass. Other findings include thickening and anterior displacement of the round ligament, which suggest adnexal origin rather than gastrointestinal tract origin. Findings of a tubular cystic lesion with multiple satellite lesions were pathologically proven to be pyosalpinx in 10 of 14 cases [23]. The presence of a right ovarian vein entering a right pelvic abscess had a 100% specificity and 94% sensitivity to TOA and may help differentiate from peri-appendiceal abscess [24].

In the setting of endometriosis, CT evaluation may demonstrate secondary signs of architectural distortion, thickening of bowel serosa, or even bowel obstruction, although the imaging findings may not be specific to deep pelvic endometriosis. Findings of irregular peripherally enhancing adnexal cyst usually accompanied by hemorrhagic pelvic free fluid might also indicate a ruptured hemorrhagic cyst.

#### **CT of Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG.

#### **CT Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG.

#### **CT Pelvis With IV Contrast**

There is no relevant literature to support the use of CT pelvis with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

#### **CT Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT pelvis without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

#### **CT Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT pelvis without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

#### **MRI Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the routine use of MRI abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Generally, MRI pelvis without and with IV contrast is performed rather than MRI abdomen and pelvis in this clinical setting.

#### **MRI Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the routine use of MRI abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG.



### **MRI Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of pelvic MRI without and with IV contrast as the initial imaging modality for the evaluation of acute pelvic pain. However, MRI can be useful for equivocal cases of ovarian torsion, PID, TOA, and other gynecological causes of acute pelvic pain in patients of reproductive age such as fibroid torsion or necrosis or in patients that are unable to tolerate TVUS.

For MRI evaluation of adnexal torsion, a meta-analysis including 18 studies (1,654 patients, 665 cases) reported a pooled sensitivity of 81% and specificity of 91% [22]. An enlarged ovary with or without an underlying mass and a twisted pedicle suggest adnexal torsion (with multiplanar MRI acquisitions potentially necessary for better detection of the twisted pedicle). Other findings may include subacute ovarian hematoma (better assessed with T1-weighted sequences with fat saturation), abnormal or absent ovarian enhancement, ascites, deviation of the uterus to the side of the twist, engorged vessels on the twisted side, and fallopian tube thickening [21].

A prospective cohort study with 187 patients evaluated with MRI for PID showed a sensitivity, specificity, PPV, negative predictive value (NPV), and accuracy with conventional MRI findings (T1-weighted, T2-weighted with fat saturation, postcontrast sequences) of 90.7%, 93.3%, 98.3%, 70.0%, and 91.2%, respectively. Adding DWI yielded a sensitivity, specificity, PPV, NPV, and accuracy of 98.4%, 93.3%, 98.4%, 93.3%, and 97.5%, respectively, with overall increased accuracy, sensitivity, and NPV [25].

MRI with DWI and contrast-enhanced sequences showed a sensitivity of 83.3% for ovarian torsion, 100% for endometriotic cysts, 100% for hemorrhagic cysts, 83.3% for TOA, and 87.5% for dermoid cysts in a prospective study on 74 patients evaluated with TVUS and MRI. Overall sensitivity of MRI in these pathological entities was 94.6% [26].

A TOA is characterized by an ill-defined adnexal mass with thick regular or irregular enhanced walls containing fluid. The signal intensity was variable from low signal intensity on T1-weighted images to intermediate or high signal intensity on T2-weighted images. The solid component (if present) may include thickened septa or wall, papillary projection, and various degrees of solid portions, which enhance after contrast injection. The sensitivity, specificity, PPV, NPV, and accuracy of MRI findings for predicting TOA were 47.1%, 91.4%, 84.2%, 64%, and 69.6%, respectively, in the absence of DWI and apparent diffusion coefficient (ADC) values [27].

The fluid component in TOA demonstrated significantly lower ADC values in comparison with fluid components of adnexal malignancies (mean ADC values of  $1.04 \pm 0.41 \times 10^{-3} \text{ mm}^2/\text{s}$  in TOA versus  $2.42 \pm 0.38 \times 10^{-3} \text{ mm}^2/\text{s}$  in tumors). Solid enhancing components was found 46% of the time in TOA, with high-intensity signal on DWI but higher ADC values than for malignancies (mean ADC values of the solid component in TOA of  $1.43 \pm 0.16 \times 10^{-3} \text{ mm}^2/\text{s}$  versus  $1.18 \pm 0.36 \times 10^{-3} \text{ mm}^2/\text{s}$  in tumors). When DWI was added to MRI protocols, the sensitivity, specificity, PPV, NPV, and accuracy of MRI findings for predicting TOA were 100%, 97.1%, 97.1%, 100%, and 98.6%, respectively, which may help distinguish TOA from ovarian malignancy [27].

Deep pelvic endometriosis may be identified as T2 hypointense fibrosis, most commonly seen at the torus uterinus and along the uterosacral ligaments, which may or may not contain T1 hyperintense hemorrhagic foci or T2 hyperintense glands. Other findings may include T2 hypointense obliteration of the fat planes anteriorly to the rectum/sigmoid colon, posteriorly to the vaginal wall or cervix, and obliteration the pouch of Douglas. The sensitivity, specificity, PPV, NPV, and accuracy of MRI for deep pelvic endometriosis were 90.3%, 91%, 92.1%, 89%, and 90.8%, respectively [28].

### **MRI Pelvis Without IV Contrast**

There is no relevant literature to support the use of pelvic MRI without IV contrast as the initial imaging modality for clinically suspected gynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG.

### **US Duplex Doppler Pelvis**

Doppler US imaging is integral for evaluation of abnormal vascularity (in case of inflammation) or lack of vascularity (in case of ovarian torsion). This document considers Doppler imaging to be a standard component of pelvic US. A meta-analysis reported a similar pooled sensitivity and specificity in diagnosing adnexal torsion using Doppler US (7 studies, 845 patients, sensitivity 80% and specificity 88%) compared with the grayscale US only (12 studies, 1,187 patients, sensitivity 79% and specificity 76%) [22].

Ovarian torsion may lead to adnexal necrosis and infertility, so early detection is essential. A prospective study on 159 patients showed that all patients with adnexal torsion had absent flow or abnormal flow pattern in the ovarian



vein. In 13 patients whose only abnormality was absent or abnormal ovarian venous flow with normal grayscale US appearance and normal arterial blood flow, 8 of those patients (62%) had adnexal torsion or subtorsion [29].

In cases of adnexal torsion, a whirlpool sign can be located either lateral or medial to the affected ovary. A larger volume of the ovarian or paraovarian mass was associated with a greater probability of a lateral whirlpool sign in a small retrospective study of 30 patients [30]. A retrospective study of 22 patients evaluated for adnexal torsion with whirlpool sign on US, 90.0% of whom had adnexal torsion confirmed on laparoscopy [31].

Power Doppler TVUS was 100% sensitive and 80% specific in PID diagnosis (overall accuracy 93% in a study of 30 patients with PID and 20 patients with hydrosalpinx as a control group) [32]. Specific US signs of PID, including wall thickness >5 mm, cogwheel sign, incomplete septa, and the presence of cul-de-sac fluid, discriminated patients with acute PID from the control group of patients with hydrosalpinx. Doppler US findings of hyperemia and lower pulsatility index allowed further discrimination between PID and hydrosalpinx with a high level of significance ( $P < .01$ ) [32].

### **US Pelvis Transabdominal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. A transabdominal-only approach could serve as an alternative if the transvaginal approach is not feasible. TVUS and TAUS of the pelvis is the most useful imaging modality for initial assessment when an obstetrical or gynecological etiology is suspected [13]. A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, allowing for assessment of the adnexa situated in a high position that may not be visible by the TVUS approach due to position distant from the US probe and free fluid. Visualization TAUS may also be better than TVUS in select other circumstances (patient discomfort, large fibroids, surgical changes) or when TVUS is uncomfortable or inappropriate (post-treatment vaginal stenosis/fibrosis, juvenile age, sexually naïve patient).

### **US Pelvis Transvaginal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. TVUS and TAUS of the pelvis is the most useful imaging modality for initial assessment when an obstetrical or gynecological etiology is suspected [13]. A combined transabdominal and transvaginal approach is typically used for pelvic US imaging.

TVUS demonstrated a sensitivity of 83.3% for ovarian torsion, 84% for endometriotic cyst, 88.2% for hemorrhagic cysts, 58.3% for TOA, and 62.5% for dermoid cysts in a prospective study on 74 patients evaluated with TVUS and MRI. Overall sensitivity of TVUS for these pathological entities was 78.4% [26].

For the diagnosis of adnexal torsion with US, a meta-analysis of 12 studies including 1,187 patients reported a pooled sensitivity of 79% and a pooled specificity of 76%, with negative and positive likelihood ratios of 0.29 and 4.35, respectively [22].

Signs of ovarian torsion on US have varying accuracy: the sensitivity and specificity are 21% and 100% for ovarian tissue edema; 52% and 91% for absence of intraovarian vascularity; 76% and 99% for absence of arterial flow; and 100% and 97% for absence or abnormal venous flow [29].

Other signs indicating torsion are a unilaterally enlarged ovary with central afollicular stroma and multiple uniform 8 to 12 mm peripheral follicles (found in up to 74% of cases); ovarian enlargement is defined as a maximal ovarian dimension of >4 cm or volume >20 cm<sup>3</sup> in a premenopausal patient. However, up to 5% of torsed ovaries have been reported to be of normal size [21].

PID can be difficult to diagnose because the symptoms are often subtle and mild. In a small prospective study of 52 patients, the detection rate of moderate-to-severe salpingitis with US was 100%, compared with 25% in the case of mild salpingitis. Bilateral adnexal masses were seen 82% of the time in patients with PID versus 17% for those with other diagnoses. The positive likelihood ratio was 4.8, and the negative likelihood ratio was 0.22. In cases of salpingitis, the masses lying adjacent to the ovaries were on average 2 to 3 cm in diameter, solid ( $n = 14$ ), unilocular cystic ( $n = 4$ ), multilocular cystic ( $n = 3$ ), or multilocular solid ( $n = 1$ ), with thick walls and well vascularized at color Doppler [33].

Other specific TVUS findings, including wall thickness >5 mm, cogwheel sign, incomplete septa, and the presence of cul-de-sac fluid, differentiated patients with PID from the control group of hydrosalpinx [32].

A prospective study with 77 patients found that the best marker of tubal inflammatory disease was the presence of an incomplete septum of the tubal wall, which was present in 92% of the total cases but was not specific enough to discriminate between the acute or chronic processes. A thick wall and the “cogwheel” sign were sensitive markers of acute disease, present in 100% and 86% of the acute cases, respectively, whereas a thin wall and “beads-on-a-string” sign were indicators of chronic disease, present in 97% and 57% of chronic cases, respectively [34].

Pelvic US has a reported sensitivity of 93% and a specificity of 98% for identification of TOA, a complication of PID. A tubo-ovarian complex is an inflammatory pelvic mass with no pus collection in which adherent, inflamed, edematous ovary, and tubes cannot be separated with the endovaginal probe. TOA demonstrates loss of the normal boundaries of the structures by pus-filled tissue with typical features of complex adnexal mass of varying echogenicity with debris, septations, and irregular margins. Other findings of TOA are pyosalpinx and loculated and speckled echogenic fluid in the cul-de-sac [35].

Evaluation of endometriosis in 104 patients revealed, with respect to rectosigmoid and retrocervical sites, a sensitivity of 98% and 95%, a specificity of 100% and 98%, a PPV of 100% and 98%, an NPV of 98% and 97%, and an accuracy of 99% and 97% with TVUS, demonstrating better results than MRI [36].

### **Variant 3: Acute pelvic pain in the reproductive age group. Nongynecological etiology suspected, $\beta$ -hCG positive (either urine or serum). Initial imaging.**

#### **CT Abdomen and Pelvis With IV Contrast**

Performing contrast-enhanced CT of the abdomen and pelvis may be necessary for timely intervention and decreasing the risk to the fetus and/or patient (please refer to the ACR Appropriateness Criteria® topic on “[Major Blunt Trauma](#)” [20] for the initial evaluation in cases of abdominal trauma). In a retrospective study, in 36% of 80 pregnant patients, CT showed a finding explaining abdominal pain. The most common diagnosis was appendicitis with a sensitivity of 92%, specificity of 99%, and NPV of 99%. The other diagnoses included urinary tract calculi, small-bowel obstruction, cholelithiasis, pyelonephritis, diaphragmatic hernia, cecal bascule, ileus, and metastatic lymphadenopathy. In 52 pregnant patients, the first study was US, with 14 of them having normal findings on US but abnormal findings on CT (30% of patients with the normal US); 9 of those required surgery [37].

A small retrospective case series of 8 pregnant patients with inconclusive findings on MRI and persistent or worsening severe abdominal pain found CT of the abdomen and pelvis useful to diagnose internal hernia, intestinal volvulus, perforation of acute appendicitis, and hemoperitoneum. However, only 75% of these patients received IV contrast for their imaging study [38].

#### **CT Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG.

#### **CT Pelvis With IV Contrast**

There is no relevant literature to support the use of CT pelvis with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

#### **CT Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT pelvis without and with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

#### **CT Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT pelvis without IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

### **MRI Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of MRI abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. However, MRI, with its excellent soft tissue contrast, is preferred over CT for assessing the pregnant patient for nongynecological pathologies [39]. Please refer to the Special Imaging Considerations section above for a discussion about the use of gadolinium-based contrast in the setting of pregnancy.

### **MRI Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of MRI abdomen and pelvis without IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG, although it could be performed as a first imaging test in a number of clinical scenarios, such as exacerbation of known inflammatory bowel disease, postoperative complications, and suspected appendicitis in patients with high body mass index, especially late in pregnancy.

If a life-threatening diagnosis must be excluded considered (please refer to the ACR Appropriateness Criteria<sup>®</sup> topic on “[Major Blunt Trauma](#)” [20] for an initial evaluation in cases of abdominal trauma), and US and MRI abdomen and pelvis without IV contrast are inconclusive or nondiagnostic, MRI abdomen and pelvis with contrast could be considered.

MRI abdomen and pelvis may be appropriate if index of suspicion is high for appendicitis or bowel abnormalities, especially late in pregnancy. The rate of nonvisualization of the appendix on MRI is lower than US and reported to be 30.9% in a retrospective cohort study of 171 pregnant patients. Patients with nonvisualization of the appendix on MRI were more likely to be beyond the first trimester [40]. Evaluation for appendicitis with pelvic MRI in 51 pregnant patients for which a previous US did not demonstrate the appendix showed an overall sensitivity of 100%, a specificity of 93.6%, and a prevalence-adjusted PPV and NPV of 1.4% and 100%, respectively, with an accuracy of 94.0% [41].

Another recent study in 49 pregnant patients showed that in 88% of patients, appendicitis was ruled out, and surgery was prevented when MRI was performed after inconclusive US. MRI diagnosed all cases with acute appendicitis, with one case remaining inconclusive. The overall statistical performance of MRI shows a similar NPV of 100% with PPV of 83.3% [42]. Visualization of the normal appendix on MRI may be sometimes challenging. However, a retrospective study in 58 pregnant patients with suspected appendicitis showed that if MRI study was of sufficient diagnostic quality, with no ancillary signs of appendicitis, there were no cases of acute appendicitis. This was true despite the lack of visualization of the appendix in up to 50% of cases by at least 1 of 3 radiologists participating in the study. Therefore, if appendix is not visualized, the recommendation for interpretation is to word the report as low risk for appendicitis rather than indeterminate for excluding appendicitis [43]. The T1 bright appendix sign, defined as a high-intensity signal filling more than half the length of the appendix on T1-weighted imaging, was shown to be a specific sign for a normal appendix in a retrospective study of 125 pregnant patients. The sensitivity, specificity, PPV, and NPV are 44.9%, 95.5%, 97.6%, and 30.0%, respectively. In this study, all 4 patients with a borderline size appendix with appendicitis showed negative T1 bright appendix sign [44]. The addition of DWI showed no significant improvement to MRI detection of appendicitis in a retrospective study of 125 pregnant patients [45].

Evaluation of urinary causes of pain in pregnant patients can be performed with static-fluid MR urography without gadolinium administration. Physiological hydronephrosis can be diagnosed by extrinsic compression of the middle third of the ureter by a gravid uterus, no filling defect, and a collapsed ureter below it; whereas ureteral obstruction by a calculus can demonstrate renal edema or perirenal/periureteral fluid, and in cases with distal calculi, MR urography would show a double kink sign with constriction at the pelvic brim and at the vesicoureteral junction with a standing column of urine in the pelvic ureter. Small calculi were only identified using high resolution T2-weighted sequences [46].

Evaluation for pelvic deep vein thrombosis is limited with Doppler US, as demonstrated in a small study of 27 patients with median gestational age of 29 weeks in which 3 cases of pelvic deep vein thrombosis were diagnosed with time-of-flight MRI sequences after normal US. Deep vein thrombosis was extending more cranially into the pelvis in 65% of women than on the US, suggesting that MRI has an important role as a complementary technique in diagnosing deep vein thrombosis during pregnancy [47].

### **US Abdomen and Pelvis Transabdominal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging and both should be performed when possible. A transabdominal-only approach for the pelvis could serve as an alternative if the transvaginal approach is not feasible. The sensitivity, specificity, and accuracy of abdominal US for the diagnosis of appendicitis in 38 pregnant patients were 61.2%, 80%, and 63.8%, respectively [48].

US performance for the evaluation of appendicitis in pregnant patients appears to be similar to the same-age nonpregnant patients, as shown in a case-control study with 67 pregnant patients compared with 133 nonpregnant young patients. PPV was 94% in the pregnant group and 91% in the nonpregnant group, with corresponding NPV of 40% and 43% [49]. This is even though the appendix is not visualized on US in 68% to 97% of patients [40].

US with graded compression of the appendix has similar accuracy to nonenhanced CT; however, it is more limited in the third trimester due to the large size of the gravid uterus [39].

This may be a useful initial imaging approach if pregnancy location and gestational age are unknown at the time of an acute presentation.

### **US Duplex Doppler Adnexa**

A combined transabdominal and TVUS approach is typically used for pelvic US imaging. This document considers Doppler imaging to be a standard component of pelvic US.

### **US Pelvis Transvaginal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging and both should be performed when possible. There is no relevant literature to support the use of transvaginal pelvic US as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of positive  $\beta$ -hCG. Transabdominal abdominopelvic US would be a preferred modality for assessment. TVUS pelvis may be an appropriate the appropriate initial imaging approach if pregnancy location and gestational age are unknown at the time of an acute presentation.

### **Variant 4: Acute pelvic pain in the reproductive age group. Nongynecological etiology suspected, $\beta$ -hCG negative (either urine or serum). Initial imaging.**

#### **CT Abdomen and Pelvis With IV Contrast**

CT has become the most useful study for imaging of appendicitis. A meta-analysis of 31 studies with 4,341 patients for the diagnosis of appendicitis showed a pooled sensitivity of 94% and specificity of 94% [50], whereas pooled US showed a pooled sensitivity of 83% and specificity of 93%. This study was not specific to women and included adults of all genders.

In a recent single-center retrospective study of 790 patients, CT of the abdomen and pelvis with IV contrast demonstrated a statistically significant improved yield (ie, a study with no indeterminate findings) of 97.5% compared with US of 15.8%. The negative appendectomy rate was also significantly lower at 3.3% for the CT group in comparison with 17.7% with US diagnosis [51].

With the increased interest in nonoperative antibiotic management of uncomplicated appendicitis, appendicoliths are important to detect. Higher failure rates of conservative management are seen in the presence of appendicoliths. Furthermore, appendicoliths are associated with increased inflammation and risk of perforation. Appendicoliths are readily identified with CT and found in nearly 40% of adults with proven appendicitis, compared with slightly more than 4% of those without appendicitis [52].

In another study, 84% of cases with noninflamed appendix showed luminal filling when positive oral contrast reaches the cecum, thus excluding diagnosis of appendicitis with high certainty. Therefore, the use of positive oral contrast may augment diagnostic accuracy and confidence in cases of suspected acute appendicitis. No appendix filling with contrast was noted in proven acute appendicitis cases [53]. Diluted oral contrast with 1-hour or 3-hour regimens has a similar diagnostic performance [54]. Nevertheless, no difference was found in the sensitivity, specificity, or average interpretation time when neutral oral contrast was administered compared with positive oral contrast [55].

Single-institution randomized trials showed that low-dose CT was noninferior to standard-dose CT in regard to the negative appendectomy rate, the appendiceal perforation rate, or the proportion of patients needing additional imaging tests [56,57].

### **CT Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT abdomen and pelvis without and with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG.

### **CT Abdomen and Pelvis Without IV Contrast**

CT of the abdomen and pelvis without IV contrast remains a useful tool for the diagnosis of appendicitis. Evaluation for appendicitis with a nonenhanced CT was shown to be conclusive in up to 75% of cases in a study of 536 patients, with a reported sensitivity, specificity, PPV, and NPV of 90%, 96%, 84.8%, and 97.4%, respectively. However, in the 132 (25%) inconclusive cases (ie, no definitive diagnosis of appendicitis or normal appendix), the initial noncontrast CT study was followed by contrast-enhanced CT with a sensitivity, specificity PPV, and NPV of 95.6%, 92.3%, 73%, and 99%, respectively [58].

The evaluation of urolithiasis is typically performed with noncontrast abdominal and pelvic CT (“stone protocol”), because IV contrast may obscure small renal stones. “Stone protocol” CT also may be used to diagnose other causes for abdominal pain, although lack of IV contrast limits its utility. A retrospective study showed that a patient history of urolithiasis and positive urinalysis for blood has a 94% sensitivity for predicting renal calculi. However, 15% of patients without a history of renal stones and negative urinalysis have a nonrenal stone diagnosis when presenting with flank pain. Thus, a contrast-enhanced CT is indicated in patients with flank pain with a negative history of renal stones [59].

No difference was noted between standard- and low-dose CT for detecting ureteral stones, with a sensitivity, specificity, and accuracy ranging from 92% to 99%, 86% to 93%, and 92% to 98%, respectively [60]. These results are similar to those reported in a meta-analysis [61]. Notably, the sensitivity of low-dose CT for detecting stones  $\leq 2$  mm in diameter was lower at 68% to 79% [60]. Low-dose CT was comparable to standard-dose CT in visualizing hydronephrosis and had the same diagnostic performance in diagnosing alternative diseases. Perinephric stranding was less apparent on low-dose CT than on standard-dose CT [60,62].

### **CT Pelvis With IV Contrast**

There is no relevant literature to support the use of CT pelvis with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

### **CT Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of CT pelvis without and with IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

### **CT Pelvis Without IV Contrast**

There is no relevant literature to support the use of CT pelvis without IV contrast as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Note that CT pelvis alone is seldom performed and is usually part of a concurrent CT of the abdominal and pelvis.

### **MRI Abdomen and Pelvis Without and With IV Contrast**

There is no relevant literature to support the use of MRI abdomen and pelvis without and with IV contrast as the initial imaging modality for the evaluation of acute pelvic pain. However, MRI can be useful for equivocal cases of appendicitis and renal obstruction. In a small study of 51 patients, a combination of DWI and T2-weighted images increased the accuracy for the diagnosis of appendicitis, with decreased ADC values correlating with appendicitis. The presence of low ADC in the peri-appendiceal fat was also notable in the presence of complicated appendicitis [63]. That is contrary to the study of 125 pregnant patients in which the addition of DWI showed no significant improvement to MRI detection of appendicitis [45].

MRI performed similarly to abdominal US, followed by abdominal and pelvic CT if findings on US were negative or inconclusive for the detection of perforated appendicitis with low sensitivities (57% for MRI and 48% for US followed by the conditional CT). The missed diagnoses of perforated appendicitis were misclassified as simple appendicitis [64].

### **MRI Abdomen and Pelvis Without IV Contrast**

There is no relevant literature to support the use of MRI abdomen and pelvis without IV contrast as the initial imaging modality for the evaluation of acute pelvic pain. However, MRI can be useful for equivocal cases of

appendicitis and renal obstruction. MR urogram without IV contrast was shown to have a 95% sensitivity and 100% specificity for the detection of hydronephrosis, and it has good agreement to determine the level of obstruction as compared to IV urography. The correct diagnosis was made in 94% of patients with MR urogram without IV contrast [65].

### **US Abdomen and Pelvis Transabdominal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. A transabdominal-only approach for the pelvis could serve as an alternative if the transvaginal approach is not feasible. US may be used for the evaluation of suspected appendicitis in adults with a pooled sensitivity of 83% (95% confidence interval [CI], 78%-87%) and a pooled specificity of 93% (95% CI, 90%-96%), as shown in a meta-analysis of 31 studies with 4,341 patients. In the meta-analysis, CT demonstrated a higher pooled sensitivity of 94% (95% CI, 92%-95%) and a similar specificity of 94% (95% CI, 92%-95%) in that study [50].

In low pretest probability populations, a negative or equivocal US for appendicitis can be used with confidence to exclude this condition without the need for further imaging, with an NPV of 100% and 96%, respectively. However, in cases of moderate or high pretest probability of acute appendicitis and equivocal US, the sensitivity of the US falls to 63% and, thus, should not be solely used to exclude appendicitis [66].

A combination of abdominal US and clinical features successfully predicted uncomplicated appendicitis in 94% of 678 patients in a retrospective cohort study [67].

Evaluation for appendicitis with graded compression of the appendix increases specificity and decreases negative appendectomy rates, as shown in a retrospective study of more than 1,000 patients, with a sensitivity of 83%, a specificity of 100%, and a negative appendectomy rate of 8.4% [68].

Evaluation of renal stones with US is limited. A study of 50 patients demonstrated a sensitivity of 52% to 57% in the right kidney and 32% to 39% in the left kidney when compared with CT for detection of renal stones by US. This study also showed no significant impact of body mass index on the detection of renal stones [69].

A multicentric study of 144 patients showed that in 75% of cases, the presence or absence of hydronephrosis on US correctly predicted the presence or absence of a ureteral stone on CT. Hydronephrosis on US had a PPV of 77% for the presence of a ureteral stone and an NPV of 71% for the absence of a ureteral stone [70].

In patients with renal colic, normal renal US predicts no need for urological intervention in the 90 days following the study. Therefore, these patients can be managed conservatively with analgesia and clinical follow-up [71]. Another study of 77 patients with suspected renal colic and no hydronephrosis on US showed no need for hospital admission within 30 days [72]. On the other hand, “positive” US with stones and moderate-to-severe hydronephrosis has a high likelihood of subsequent urological intervention, with a sensitivity of 97%, a specificity of 28.1%, and a likelihood ratio of 3.86 [73].

### **US Duplex Doppler Pelvis**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging. This document considers Doppler imaging to be a standard component of pelvic US. In a study of 815 patients, sensitivity and specificity of twinkle artifact on color Doppler US for detection of renal stones were 97.2% and 99%, respectively, with a PPV and NPV of 97.6% and 85.7%, respectively [74].

### **US Pelvis Transvaginal**

A combined transabdominal and transvaginal approach is typically used for pelvic US imaging, and both should be performed when possible. There is no relevant literature to support the use of transvaginal pelvic US as the initial imaging modality for clinically suspected nongynecological etiology of pelvic pain in the setting of negative  $\beta$ -hCG. Transabdominal abdominopelvic US would be a preferred modality for assessment.

### **Summary of Recommendations**

- **Variant 1:** US duplex Doppler adnexa, US pelvis transabdominal, and US pelvis transvaginal are usually appropriate as the initial imaging for patients in the reproductive age group with acute pelvic pain for whom gynecological etiology is suspected and  $\beta$ -hCG is positive. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously whereby each procedure provides unique clinical information to effectively manage the patient’s care).

- **Variation 2:** US duplex Doppler adnexa, US pelvis transabdominal, and US pelvis transvaginal are usually appropriate as the initial imaging for patients in the reproductive age group with acute pelvic pain for whom gynecological etiology is suspected and  $\beta$ -hCG is negative. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously whereby each procedure provides unique clinical information to effectively manage the patient's care).
- **Variation 3:** US duplex Doppler adnexa, US pelvis transabdominal, and US pelvis transvaginal are usually appropriate as the initial imaging for patients in the reproductive age group with acute pelvic pain for whom nongynecological etiology is suspected and  $\beta$ -hCG is positive. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously whereby each procedure provides unique clinical information to effectively manage the patient's care). The panel did not agree on recommending MRI abdomen and pelvis without IV contrast for this clinical scenario. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure as an initial imaging study. Imaging with this procedure is controversial but may be appropriate.
- **Variation 4:** US abdomen and pelvis transabdominal, US duplex Doppler pelvis, and US pelvis transvaginal are usually appropriate as the initial imaging for patients in the reproductive age group with acute pelvic pain for whom nongynecological etiology is suspected and  $\beta$ -hCG is negative. These procedures are complementary (ie, more than one procedure is ordered as a set or simultaneously whereby each procedure provides unique clinical information to effectively manage the patient's care). CT abdomen and pelvis with IV contrast or CT abdomen and pelvis without IV contrast are equivalent alternatives to US abdomen and pelvis transabdominal, US duplex Doppler pelvis, and US pelvis transvaginal (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending MRI abdomen and pelvis without and with IV contrast for this clinical scenario as an initial imaging study. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. Imaging with this procedure is controversial but may be appropriate.

### Supporting Documents

The evidence table, literature search, and appendix for this topic are available at <https://acsearch.acr.org/list>. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

### Safety Considerations in Pregnant Patients

Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- [ACR-SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging \(MRI\)](#) [75]
- [ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#) [1]
- [ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound](#) [76]
- [ACR Manual on Contrast Media](#) [4]
- [ACR Manual on MR Safety](#) [2]



## Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

## Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document [77].

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
○	0 mSv	0 mSv
⊕	<0.1 mSv	<0.03 mSv
⊕⊕	0.1-1 mSv	0.03-0.3 mSv
⊕⊕⊕	1-10 mSv	0.3-3 mSv
⊕⊕⊕⊕	10-30 mSv	3-10 mSv
⊕⊕⊕⊕⊕	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."

## References

1. American College of Radiology. ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation. Available at: <https://www.acr.org/-/media/acr/files/practice-parameters/pregnant-pts.pdf>. Accessed September 29, 2023.

2. American College of Radiology. ACR Committee on MR Safety. ACR Manual on MR Safety. Version 1.0. Available at: <https://www.acr.org/-/media/ACR/Files/Radiology-Safety/MR-Safety/Manual-on-MR-Safety.pdf>. Accessed September 29, 2023.
3. De Santis M, Straface G, Cavaliere AF, Carducci B, Caruso A. Gadolinium periconceptional exposure: pregnancy and neonatal outcome. *Acta Obstet Gynecol Scand* 2007;86:99-101.
4. American College of Radiology. ACR Committee on Drugs and Contrast Media. Manual on Contrast Media. Available at: [https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast\\_Media.pdf](https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf). Accessed September 29, 2023.
5. Kao LY, Scheinfeld MH, Chernyak V, Rozenblit AM, Oh S, Dym RJ. Beyond ultrasound: CT and MRI of ectopic pregnancy. *AJR Am J Roentgenol* 2014;202:904-11.
6. Huang Q, Zhang M, Zhai RY. The use of contrast-enhanced magnetic resonance imaging to diagnose cesarean scar pregnancies. *Int J Gynaecol Obstet* 2014;127:144-6.
7. Srisajjakul S, Prapaisilp P, Bangchokdee S. Magnetic resonance imaging in tubal and non-tubal ectopic pregnancy. *Eur J Radiol* 2017;93:76-89.
8. Ramanathan S, Raghu V, Ladumor SB, et al. Magnetic resonance imaging of common, uncommon, and rare implantation sites in ectopic pregnancy. *Abdom Radiol (NY)* 2018;43:3425-35.
9. Durur-Karakaya A, Seker M, Durur-Subasi I. Diffusion-weighted imaging in ectopic pregnancy: ring of restriction sign. *Br J Radiol* 2018;91:20170528.
10. Leong GTT, Leonardi M, Lu C, et al. Doppler Color Scoring System in Women With an Incomplete Miscarriage: Interobserver and Intraobserver Reproducibility Study. *J Ultrasound Med* 2019;38:2437-45.
11. Braffman BH, Coleman BG, Ramchandani P, et al. Emergency department screening for ectopic pregnancy: a prospective US study. *Radiology* 1994;190:797-802.
12. Frates MC, Doubilet PM, Peters HE, Benson CB. Adnexal sonographic findings in ectopic pregnancy and their correlation with tubal rupture and human chorionic gonadotropin levels. *J Ultrasound Med* 2014;33:697-703.
13. American College of Radiology. ACR–ACOG–AIUM–SPR–SRU Practice Parameter for the Performance of Ultrasound of the Female Pelvis. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/US-Pelvis.pdf>. Accessed September 29, 2023.
14. Doubilet PM, Benson CB, Bourne T, Blaivas M. Diagnostic criteria for nonviable pregnancy early in the first trimester. *Ultrasound Q* 2014;30:3-9.
15. Crochet JR, Bastian LA, Chireau MV. Does this woman have an ectopic pregnancy?: the rational clinical examination systematic review. *JAMA* 2013;309:1722-9.
16. Goldstein SR, Snyder JR, Watson C, Danon M. Very early pregnancy detection with endovaginal ultrasound. *Obstet Gynecol* 1988;72:200-4.
17. Mehta TS, Levine D, Beckwith B. Treatment of ectopic pregnancy: is a human chorionic gonadotropin level of 2,000 mIU/mL a reasonable threshold? *Radiology* 1997;205:569-73.
18. Barnhart KT, Fay CA, Suescum M, et al. Clinical factors affecting the accuracy of ultrasonography in symptomatic first-trimester pregnancy. *Obstet Gynecol* 2011;117:299-306.
19. Moschos E, Twickler DM. Endometrial thickness predicts intrauterine pregnancy in patients with pregnancy of unknown location. *Ultrasound Obstet Gynecol* 2008;32:929-34.
20. Shyu JY, Khurana B, Soto JA, et al. ACR Appropriateness Criteria® Major Blunt Trauma. *J Am Coll Radiol* 2020;17:S160-S74.
21. Duignan S, Oliva E, Lee SI. Ovarian torsion: diagnostic features on CT and MRI with pathologic correlation. *AJR Am J Roentgenol* 2012;198:W122-31.
22. Wattar B, Rimmer M, Rogozinska E, Macmillian M, Khan KS, Al Wattar BH. Accuracy of imaging modalities for adnexal torsion: a systematic review and meta-analysis. *BJOG* 2021;128:37-44.
23. Jeong WK, Kim Y, Song SY. Tubo-ovarian abscess: CT and pathological correlation. *Clin Imaging* 2007;31:414-8.
24. Hiller N, Fux T, Finkelstein A, Mezeh H, Simanovsky N. CT differentiation between tubo-ovarian and appendiceal origin of right lower quadrant abscess: CT, clinical, and laboratory correlation. *Emerg Radiol* 2016;23:133-9.
25. Li W, Zhang Y, Cui Y, Zhang P, Wu X. Pelvic inflammatory disease: evaluation of diagnostic accuracy with conventional MR with added diffusion-weighted imaging. *Abdom Imaging* 2013;38:193-200.
26. Sofic A, Husic-Selimovic A, Katica V, et al. Magnetic Resonance Imaging (MRI) and Transvaginal Ultrasonography (TVU) at Ovarian Pain Caused by Benign Ovarian Lesions. *Acta Inform Med* 2018;26:15-18.

27. Wang T, Li W, Wu X, et al. Tubo-Ovarian Abscess (with/without Pseudotumor Area) Mimicking Ovarian Malignancy: Role of Diffusion-Weighted MR Imaging with Apparent Diffusion Coefficient Values. *PLoS One* 2016;11:e0149318.
28. Bazot M, Darai E, Hourani R, et al. Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. *Radiology* 2004;232:379-89.
29. Nizar K, Deutsch M, Filmer S, Weizman B, Beloosesky R, Weiner Z. Doppler studies of the ovarian venous blood flow in the diagnosis of adnexal torsion. *J Clin Ultrasound* 2009;37:436-9.
30. Navve D, Hershkovitz R, Zetounie E, Klein Z, Tepper R. Medial or lateral location of the whirlpool sign in adnexal torsion: clinical importance. *J Ultrasound Med* 2013;32:1631-4.
31. Valsky DV, Esh-Broder E, Cohen SM, Lipschuetz M, Yagel S. Added value of the gray-scale whirlpool sign in the diagnosis of adnexal torsion. *Ultrasound Obstet Gynecol* 2010;36:630-4.
32. Molander P, Sjoberg J, Paavonen J, Cacciatore B. Transvaginal power Doppler findings in laparoscopically proven acute pelvic inflammatory disease. *Ultrasound Obstet Gynecol* 2001;17:233-8.
33. Romosan G, Bjartling C, Skoog L, Valentin L. Ultrasound for diagnosing acute salpingitis: a prospective observational diagnostic study. *Hum Reprod* 2013;28:1569-79.
34. Timor-Tritsch IE, Lerner JP, Monteagudo A, Murphy KE, Heller DS. Transvaginal sonographic markers of tubal inflammatory disease. *Ultrasound Obstet Gynecol* 1998;12:56-66.
35. Adhikari S, Blaivas M, Lyon M. Role of bedside transvaginal ultrasonography in the diagnosis of tubo-ovarian abscess in the emergency department. *J Emerg Med* 2008;34:429-33.
36. Abrao MS, Goncalves MO, Dias JA, Jr., Podgaec S, Chamie LP, Blasbalg R. Comparison between clinical examination, transvaginal sonography and magnetic resonance imaging for the diagnosis of deep endometriosis. *Hum Reprod* 2007;22:3092-7.
37. Lazarus E, Mayo-Smith WW, Mainiero MB, Spencer PK. CT in the evaluation of nontraumatic abdominal pain in pregnant women. *Radiology* 2007;244:784-90.
38. Raj MH, Mullins JN, Chi JM, Choy AH, Grimaldi GM, Friedman B. The utility of abdominopelvic CT in pregnant patients with abdominal pain and a negative or inconclusive abdominal MRI. *Clin Imaging* 2020;59:88-94.
39. Long SS, Long C, Lai H, Macura KJ. Imaging strategies for right lower quadrant pain in pregnancy. *AJR Am J Roentgenol* 2011;196:4-12.
40. Theilen LH, Mellnick VM, Longman RE, et al. Utility of magnetic resonance imaging for suspected appendicitis in pregnant women. *Am J Obstet Gynecol* 2015;212:345 e1-6.
41. Pedrosa I, Levine D, Eyvazzadeh AD, Siewert B, Ngo L, Rofsky NM. MR imaging evaluation of acute appendicitis in pregnancy. *Radiology* 2006;238:891-9.
42. Amitai MM, Katorza E, Guranda L, et al. Role of Emergency Magnetic Resonance Imaging for the Workup of Suspected Appendicitis in Pregnant Women. *Isr Med Assoc J* 2016;18:600-04.
43. Al-Katib S, Sokhandon F, Farah M. MRI for appendicitis in pregnancy: is seeing believing? clinical outcomes in cases of appendix nonvisualization. *Abdom Radiol (NY)* 2016;41:2455-59.
44. Shin I, An C, Lim JS, Kim MJ, Chung YE. T1 bright appendix sign to exclude acute appendicitis in pregnant women. *Eur Radiol* 2017;27:3310-16.
45. Wi SA, Kim DJ, Cho ES, Kim KA. Diagnostic performance of MRI for pregnant patients with clinically suspected appendicitis. *Abdom Radiol (NY)* 2018;43:3456-61.
46. Spencer JA, Chahal R, Kelly A, Taylor K, Eardley I, Lloyd SN. Evaluation of painful hydronephrosis in pregnancy: magnetic resonance urographic patterns in physiological dilatation versus calculous obstruction. *J Urol* 2004;171:256-60.
47. Torkzad MR, Bremme K, Hellgren M, et al. Magnetic resonance imaging and ultrasonography in diagnosis of pelvic vein thrombosis during pregnancy. *Thromb Res* 2010;126:107-12.
48. Aras A, Karaman E, Peksen C, Kiziltan R, Kotan MC. The diagnosis of acute appendicitis in pregnant versus non-pregnant women: A comparative study. *Rev Assoc Med Bras (1992)* 2016;62:622-27.
49. Segev L, Segev Y, Rayman S, Nissan A, Sadot E. The diagnostic performance of ultrasound for acute appendicitis in pregnant and young nonpregnant women: A case-control study. *Int J Surg* 2016;34:81-85.
50. Doria AS, Moineddin R, Kellenberger CJ, et al. US or CT for Diagnosis of Appendicitis in Children and Adults? A Meta-Analysis. *Radiology* 2006;241:83-94.
51. Crocker C, Akl M, Abdolell M, Kamali M, Costa AF. Ultrasound and CT in the Diagnosis of Appendicitis: Accuracy With Consideration of Indeterminate Examinations According to STARD Guidelines. *AJR Am J Roentgenol* 2020;215:639-44.

52. Ranieri DM, Enzerra MD, Pickhardt PJ. Prevalence of Appendicoliths Detected at CT in Adults With Suspected Appendicitis. *AJR Am J Roentgenol* 2021;216:677-82.
53. Tang SJ, Pickhardt PJ, Kim DU, Pooler BD. Positive Oral Contrast Solution at MDCT for Suspected Acute Appendicitis in Adults: Rate of Appendiceal Luminal Filling of Normal and Inflamed Appendixes. *AJR Am J Roentgenol* 2019;213:W211-W17.
54. Wadhwani A, Guo L, Saude E, et al. Intravenous and Oral Contrast vs Intravenous Contrast Alone Computed Tomography for the Visualization of Appendix and Diagnosis of Appendicitis in Adult Emergency Department Patients. *Can Assoc Radiol J* 2016;67:234-41.
55. Naeger DM, Chang SD, Kolli P, Shah V, Huang W, Thoeni RF. Neutral vs positive oral contrast in diagnosing acute appendicitis with contrast-enhanced CT: sensitivity, specificity, reader confidence and interpretation time. *Br J Radiol* 2011;84:418-26.
56. Kim K, Kim YH, Kim SY, et al. Low-dose abdominal CT for evaluating suspected appendicitis. *N Engl J Med* 2012;366:1596-605.
57. Sippola S, Virtanen J, Tammilehto V, et al. The Accuracy of Low-dose Computed Tomography Protocol in Patients With Suspected Acute Appendicitis: The OPTICAP Study. *Ann Surg* 2020;271:332-38.
58. Tamburrini S, Brunetti A, Brown M, Sirlin C, Casola G. Acute appendicitis: diagnostic value of nonenhanced CT with selective use of contrast in routine clinical settings. *Eur Radiol* 2007;17:2055-61.
59. Desai V, Cox M, Deshmukh S, Roth CG. Contrast-enhanced or noncontrast CT for renal colic: utilizing urinalysis and patient history of urolithiasis to decide. *Emerg Radiol* 2018;25:455-60.
60. Kim BS, Hwang IK, Choi YW, et al. Low-dose and standard-dose unenhanced helical computed tomography for the assessment of acute renal colic: prospective comparative study. *Acta Radiol* 2005;46:756-63.
61. Niemann T, Kollmann T, Bongartz G. Diagnostic performance of low-dose CT for the detection of urolithiasis: a meta-analysis. *AJR Am J Roentgenol* 2008;191:396-401.
62. Poletti PA, Platon A, Rutschmann OT, Schmidlin FR, Iselin CE, Becker CD. Low-dose versus standard-dose CT protocol in patients with clinically suspected renal colic. *AJR Am J Roentgenol* 2007;188:927-33.
63. Inoue A, Furukawa A, Nitta N, et al. Accuracy, criteria, and clinical significance of visual assessment on diffusion-weighted imaging and apparent diffusion coefficient quantification for diagnosing acute appendicitis. *Abdom Radiol (NY)* 2019;44:3235-45.
64. Leeuwenburgh MM, Wiezer MJ, Wiarda BM, et al. Accuracy of MRI compared with ultrasound imaging and selective use of CT to discriminate simple from perforated appendicitis. *Br J Surg* 2014;101:e147-55.
65. Muthusami P, Bhuvaneshwari V, Elangovan S, Dorairajan LN, Ramesh A. The role of static magnetic resonance urography in the evaluation of obstructive uropathy. *Urology* 2013;81:623-7.
66. Lourenco P, Brown J, Leipsic J, Hague C. The current utility of ultrasound in the diagnosis of acute appendicitis. *Clin Imaging* 2016;40:944-8.
67. Geerdink TH, Augustinus S, Atema JJ, Jensch S, Vrouwenraets BC, de Castro SMM. Validation of a Scoring System to Distinguish Uncomplicated From Complicated Appendicitis. *J Surg Res* 2021;258:231-38.
68. Shirah BH, Shirah HA, Alhaidari WA, Elraghi MA, Chughtai MA. The role of preoperative graded compression ultrasound in detecting acute appendicitis and influencing the negative appendectomy rate. *Abdom Radiol (NY)* 2017;42:109-14.
69. Ulasan S, Koc Z, Tokmak N. Accuracy of sonography for detecting renal stone: comparison with CT. *J Clin Ultrasound* 2007;35:256-61.
70. Sternberg KM, Pais VM, Jr., Larson T, Han J, Hernandez N, Eisner B. Is Hydronephrosis on Ultrasound Predictive of Ureterolithiasis in Patients with Renal Colic? *J Urol* 2016;196:1149-52.
71. Yan JW, McLeod SL, Edmonds ML, Sedran RJ, Theakston KD. Normal renal sonogram identifies renal colic patients at low risk for urologic intervention: a prospective cohort study. *CJEM* 2015;17:38-45.
72. Fields JM, Fischer JI, Anderson KL, Mangili A, Panebianco NL, Dean AJ. The ability of renal ultrasound and ureteral jet evaluation to predict 30-day outcomes in patients with suspected nephrolithiasis. *Am J Emerg Med* 2015;33:1402-6.
73. Taylor M, Woo MY, Pageau P, et al. Ultrasonography for the prediction of urological surgical intervention in patients with renal colic. *Emerg Med J* 2016;33:118-23.
74. Abdel-Gawad M, Kadasne RD, Elsobky E, Ali-El-Dein B, Monga M. A Prospective Comparative Study of Color Doppler Ultrasound with Twinkling and Noncontrast Computerized Tomography for the Evaluation of Acute Renal Colic. *J Urol* 2016;196:757-62.

75. American College of Radiology. ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI). Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/mr-fetal.pdf>. Accessed September 29, 2023.
76. American College of Radiology. ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound. Available at: <https://www.acr.org/-/media/ACR/Files/Practice-Parameters/us-ob.pdf>. Accessed September 29, 2023.
77. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: <https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf>. Accessed September 29, 2023.

The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.