American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Acute Pelvic Pain in the Reproductive Age Group**

Variant 1: **Gynecological etiology suspected, serum β-hCG positive.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transvaginal	9	Both transvaginal and transabdominal US should be performed if possible. Doppler used as an adjunct. Avoid embryonic exposure.	O
US pelvis transabdominal	9	Both transvaginal and transabdominal US should be performed if possible. Doppler used as an adjunct. Avoid embryonic exposure.	O
MRI pelvis without contrast	6	If US is inconclusive or nondiagnostic. See Summary of Literature Review for use of contrast.	O
MRI abdomen and pelvis without contrast	6	If US is inconclusive or nondiagnostic. See Summary of Literature Review for use of contrast.	O
MRI pelvis without and with contrast	1		O
MRI abdomen and pelvis without and with contrast	1		O
CT pelvis without contrast	1		☢☢☢
CT pelvis with contrast	1		☢☢☢
CT pelvis without and with contrast	1		☢☢☢☢
CT abdomen and pelvis without contrast	1		☢☢☢☢
CT abdomen and pelvis with contrast	1		☢☢☢☢
CT abdomen and pelvis without and with contrast	1		☢☢☢☢

Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**

***Relative Radiation Level**

Clinical Condition: **Acute Pelvic Pain in the Reproductive Age Group**

Variant 2: **Gynecological etiology suspected, serum β-hCG negative.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transvaginal	9	Both transvaginal and transabdominal US should be performed if possible. Doppler used as an adjunct.	O
US pelvis transabdominal	9	Both transvaginal and transabdominal US should be performed if possible. Doppler used as an adjunct.	O
MRI pelvis without and with contrast	6	If US is inconclusive or nondiagnostic. See Summary of Literature Review for use of contrast	O
MRI abdomen and pelvis without and with contrast	6	If US is inconclusive or nondiagnostic. See Summary of Literature Review for use of contrast.	O
MRI pelvis without contrast	4	If US is inconclusive or nondiagnostic.	O
MRI abdomen and pelvis without contrast	4	If US is inconclusive or nondiagnostic.	O
CT abdomen and pelvis with contrast	4	If US is inconclusive or nondiagnostic and MRI is not available. In young women undergoing repeat imaging, cumulative radiation dose should be considered. See Summary of Literature Review for use of contrast.	☢☢☢☢
CT pelvis with contrast	4	If US is inconclusive or nondiagnostic and MRI is not available. In young women undergoing repeat imaging, cumulative radiation dose should be considered. See Summary of Literature Review for use of contrast.	☢☢☢
CT pelvis without contrast	2	If US is inconclusive or nondiagnostic and MRI is not available. In young women undergoing repeat imaging, cumulative radiation dose should be considered.	☢☢☢
CT pelvis without and with contrast	2		☢☢☢☢
CT abdomen and pelvis without contrast	2		☢☢☢☢
CT abdomen and pelvis without and with contrast	2		☢☢☢☢

Rating Scale: **1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate**

***Relative Radiation Level**

Clinical Condition: **Acute Pelvic Pain in the Reproductive Age Group**

Variant 3: **Nongynecological etiology suspected, serum β-hCG positive.**

Radiologic Procedure	Rating	Comments	RRL*
US pelvis transvaginal	9	Usually in conjunction with transabdominal US. Doppler used as an adjunct. Avoid embryonic exposure.	O
US abdomen and pelvis transabdominal	9	Add transvaginal US as indicated. Doppler used as an adjunct. Avoid embryonic exposure.	O
MRI abdomen and pelvis without contrast	8	See Summary of Literature Review for use of contrast.	O
CT abdomen and pelvis with contrast	4	If US is nondiagnostic and MRI unavailable or equivocal, for prompt diagnosis of a potentially life-threatening condition. See Summary of Literature Review for use of contrast.	☢☢☢☢
CT abdomen and pelvis without contrast	2		☢☢☢☢
MRI abdomen and pelvis without and with contrast	1		O
CT abdomen and pelvis without and with contrast	1		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 4: **Nongynecological etiology suspected, serum β-hCG negative.**

Radiologic Procedure	Rating	Comments	RRL*
CT abdomen and pelvis with contrast	9		☢☢☢☢
US abdomen and pelvis transabdominal	7	Can be appropriate for suspected appendicitis, urinary tract pathology, and to minimize radiation exposure. Doppler used as an adjunct.	O
CT abdomen and pelvis without contrast	6		☢☢☢☢
MRI abdomen and pelvis without and with contrast	6	To avoid radiation exposure of CT in a young patient or if US is inconclusive or nondiagnostic. See Summary of Literature Review for use of contrast.	O
MRI abdomen and pelvis without contrast	4	To avoid radiation exposure of CT in a young patient or if US is inconclusive or nondiagnostic.	O
US pelvis transvaginal	4		O
CT abdomen and pelvis without and with contrast	2		☢☢☢☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

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Summary of Literature Review

Premenopausal women with acute pelvic pain often pose a diagnostic dilemma. They exhibit nonspecific signs and symptoms, the most common being nausea, vomiting, and leukocytosis. The differential considerations encompass gynecologic and obstetrical causes such as hemorrhagic ovarian cysts, pelvic inflammatory disease, ovarian torsion, ectopic pregnancy, spontaneous abortion, or labor and placental abruption, as well as nongynecologic etiologies including appendicitis, inflammatory bowel disease, infectious enteritis, diverticulitis, urinary tract calculi, pyelonephritis, and pelvic thrombophlebitis. The choice of imaging modality is determined by the clinically suspected differential diagnosis. Thus, a thorough clinical evaluation of the patient is required to determine the index of suspicion among the various etiologies. Diagnostic considerations should be ordered and narrowed by history, physical examination, and laboratory testing before a radiologic examination is chosen.

Transvaginal (TVS) and transabdominal (TAS) pelvic sonography with its wide availability and ability to narrow the differential diagnosis is the preferred imaging modality for initial assessment when an obstetrical or gynecologic etiology is suspected [1]. Computed tomography (CT) is more useful when gastrointestinal or urinary tract pathology is likely. Magnetic resonance imaging (MRI), with its lack of ionizing radiation, is preferred over CT for assessing the pregnant patient for these pathologies; however it is hampered by lack of widespread availability, especially in the acute setting.

Serum β-hCG

A serum β-hCG test is usually performed when a menstruating female presents with symptoms of acute pelvic pain. Knowledge of pregnancy is of utmost importance to determine whether ectopic pregnancy should be under consideration as well as to indicate any added concern for fetal exposure to ionizing radiation. A negative serum β-hCG test essentially excludes the diagnosis of a live intrauterine pregnancy and acute ectopic pregnancy since it becomes positive approximately 9 days after conception. Studies published in the late 1980s that correlated the presence of a gestational sac using TVS with β-hCG levels have played a crucial role in our ability to make the diagnosis of ectopic pregnancy. These studies documented the presence of a gestational sac by the time the hCG level was 1,000 to 2,000 mIU/mL (International Reference Preparation) [2-4], so the absence of an intrauterine pregnancy when the β-hCG is above the discriminatory zone should be strongly suspicious for an ectopic pregnancy. However, subsequent studies have shown that normal intrauterine pregnancies may still develop in this scenario, usually secondary to technical quality, obscuration of endometrial cavity by fibroids, hemorrhage, or intrauterine devices [5-6]. Therefore serial β-hCG values and a follow-up TVS may be performed in cases in which the patient is hemodynamically stable. The high specificity of adnexal findings, which include the classic "tubal ring," has been widely reported in the literature [7].

Ultrasound

The role of pelvic sonography in the evaluation of acute pelvic pain has been well described. Due to its higher resolution of anatomic detail, TVS should be used whenever possible, although TAS is recommended when uterine and adnexal structures are beyond the field of view of the transvaginal probe. In addition, duplex and color or power Doppler imaging can be used to characterize vascularity of the ovaries, adnexal structures, and uterus, information that may be helpful in narrowing the field of differential considerations.

In the evaluation of obstetrical and gynecological causes of pain, TVS may be able to differentiate findings such as hemorrhagic cyst or pelvic inflammatory disease that are more compatible with medical management, from those that require emergency care such as ovarian torsion, a surgical emergency, or obstetrical causes, including, ectopic pregnancy, demise, or abruption that may require urgent management. A hemorrhagic cyst may be hyperechoic acutely, but with hemolysis and retraction of clot, a reticular network of fibrin stranding may be seen. Fluid-fluid levels between fluid components and a seemingly solid area representing retracted clot with

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concave outer margins may be demonstrated. Fibrin strands and a retracting clot are key observations in allowing high confidence in the diagnosis of hemorrhagic ovarian cysts since approximately 90% of hemorrhagic ovarian cysts will exhibit at least one of these two features [8]. Peripheral without internal color Doppler signal with low impedance flow is characteristic [8].

Usually, only complications of pelvic inflammatory disease can be demonstrated sonographically, although earlier acute signs such as thickening of the fallopian tube or increased vascularity may be seen in a targeted examination [9]. Hyperemia within the wall of the fallopian tube may also be apparent [10].

The most consistent finding of torsion is an enlarged edematous ovary or ovarian complex of ovary with an associated adnexal mass. Doppler findings vary, likely depending on degree and chronicity. Lack of Doppler flow enables fairly confident diagnosis, but the presence of arterial and venous Doppler signal has been documented in a third of cases with surgically proven torsion [11-12]. More recently, a study has appeared in the literature demonstrating an abnormal flow pattern within the ovarian vein as the only Doppler finding in patients with early torsion, lending support for Doppler findings associated with the diagnosis [13]. However, the reliability of this finding needs further investigation.

Sonography should be considered when gastrointestinal or urinary tract pathology is suspected in pregnant patients. Despite some diagnostic limitations, sonography has the advantage over CT of sparing the fetus and mother ionizing radiation. In the diagnosis of appendicitis, TAS has demonstrated variable sensitivity (67%-100%) and specificity (83%-96%) [14-15]. Unfortunately, the technique of graded compression required for this diagnosis is often not feasible in the presence of an enlarged gravid uterus. More importantly, a normal appendix is visualized only in 13%-50% patients, even in the absence of pregnancy [15]; as a result, a negative examination result cannot exclude the diagnosis of appendicitis [14]. For diagnosis of obstructing ureteral calculi, a wide range of sensitivities (34%-95%) has been reported with sonography [16-17]. TVS is recommended for detecting distal ureteral calculi [18] should TAS prove inconclusive. Sonographic specificity is reduced by the physiologic urinary dilatation common in pregnancy. Nevertheless, while occasional early obstruction by a small ureteral calculus may not be associated with pelvocaliectasis, hydronephrosis will be seen in the vast majority of cases

Computed Tomography

CT demonstrates the best diagnostic performance in identifying the gastrointestinal and urinary tract causes of acute pelvic pain. It shows high sensitivity (95%-100%) and specificity (87%-98%) in diagnosing appendicitis even in pregnancy [14,19-22]. Moreover, because CT almost always permits a normal appendix to be visualized, it is useful for reliably excluding the diagnosis of appendicitis. CT is also the preferred modality for detecting other bowel pathologies such as inflammatory bowel disease, diverticulitis, and infectious enteritis or colitis [23]. CT without intravenous contrast is more sensitive than sonography for detecting ureteral calculi, with reported sensitivity of 96% and specificity of 93%-98% [16,24-25]. In children and young adults, scanning technique can be modified to minimize radiation dose without significantly compromising accuracy.

For accurate diagnosis of pyelonephritis [26], pelvic venous thrombosis [27], and most bowel pathologies, intravenous contrast-enhanced CT is required for optimum accuracy. One study suggests that for diagnosis of appendicitis, administration of intravenous contrast alone yields similar results to administration of oral and intravenous contrast [28]. However, this has yet to be validated in general practice. Since CT is often the first-line imaging modality in the diagnosis of abdominal pain originating from bowel or the urinary tract, gynecologic pathology, which can mimic these other etiologies on clinical presentation, may be diagnosed on CT. For example, a thick-walled, fluid-filled tuboovarian complex may be detected with CT. The milder inflammatory changes within the fallopian tube and adjacent fat may also be better appreciated on CT than on US [29]. CT findings of ovarian torsion are well documented in the literature and include thickening of the fallopian tube, smooth-walled thickening of a cystic adnexal mass, ascites, uterine deviation to the twisted side, and infiltration of adjacent pelvic fat [30-31].

Magnetic Resonance Imaging

MRI is a useful problem-solving tool in the evaluation of pelvic pain in pregnant women [32]. When available, it is preferred to CT because it lacks ionizing radiation. In the diagnosis of appendicitis in pregnancy, MRI has high sensitivity and specificity (100% and 94%, respectively) and may permit visualization of a normal appendix in approximately 83%-90% of patients [33-34]. In a direct comparison of US versus MRI, a normal appendix was identified in 2% versus 87%, respectively, in women suspected of appendicitis [35]. MR urography reliably detects hydrouretronephrosis [36]. Obstruction secondary to urinary tract pathology can be distinguished from physiologic dilatation of pregnancy because renal enlargement and perinephric fluid are found only when there is pathology [37]. However, MR lacks sensitivity for detecting small ureteral stones. False positive findings from flow artifacts may simulate stones. MR venography can be used effectively to diagnose pelvic deep-vein thrombosis [38-39]. For gynecologic pathologies, there is some evidence that MRI may be more accurate than TVS in diagnosing pelvic inflammatory disease if Doppler US is not performed [40]. The findings of ovarian torsion on CT and MRI have been shown to be similar [30].

Safety Issues

Magnetic Resonance Imaging

Pelvic MRI has been in use for over 20 years with no evidence of adverse effects to the fetus in both clinical and laboratory investigations [41]. Nevertheless, safety

concerns regarding potential heating effects of radiofrequency pulses and acoustic injury to the fetus when exposed directly to the magnetic field (eg, with abdominopelvic or lumbar spine MRI) have not been completely dispelled [42]. While no fetal harm has been reported with ≤1.5-T scanning, little experience has been reported at higher field strengths. Guidelines on practice procedures for MR imaging of pregnant patients are outlined in the ACR White Paper on MR Safety [43]. Gadolinium contrast agents administered to a pregnant woman cross the placenta and enter the fetal circulation, are filtered via the fetal kidneys, and are excreted into the amniotic fluid where they may remain for an indeterminate time. To date, no adverse effects to the human fetus have been reported. However, because the potential effects of fetal absorption of gadolinium contrast agents have not been fully explored, most practices refrain from administering these agents for clinical MRI of pregnant women. Guidelines on practice procedures for gadolinium administration in pregnant patients are outlined in the ACR *Manual on Contrast Media* [44].

Computed Tomography

Despite the diagnostic utility of pelvic CT, which delivers ionizing radiation, it should be used selectively in evaluating children and women in their reproductive years. It should be noted that, to date, no direct evidence has been reported to demonstrate that exposure to a diagnostic CT scan causes cancer or birth defects. Thus, CT should not be withheld in the pregnant patient if deemed clinically necessary to avoid significant delay in diagnosing life-threatening conditions such as appendicitis, bowel perforation, or sepsis. Estimates of cancer risk from the low doses of radiation delivered by CT are derived by linear extrapolation from cancer rates observed in atomic bomb survivors who experienced much higher radiation doses. A pelvic CT in a pregnant patient is estimated to deliver up to 25 mGy to the fetus, thereby increasing radiation dose to approximately 10-fold above background [45-46]. This dose is below the 500 mGy estimated to increase risk for fetal malformations [47] and the 100 mGy estimated to increase risk for childhood cancer by 0.1% [48].. Pelvic CT could increase the risk for developing cancer by 0.25%, or 1/400 in a 10-year-old girl, and 0.1%, or 1/1000 in a 30-year-old woman [47-48]. This risk from radiation is thought to be additive with repeat scans. Iodinated contrast agent administered to a pregnant woman crosses the placenta, resulting in possible fetal thyroid depression by exposure to free iodine [49]. While such an effect has never been directly demonstrated [50], infants of mothers who received iodinated contrast during pregnancy should be tested for hypothyroidism, already a standard neonatal screening procedure in the United States. No evidence suggesting that iodinated contrast is teratogenic or carcinogenic has been reported. Guidelines on practice procedures for iodinated administration in pregnant patients are outlined in the ACR *Manual on Contrast Media* [44].

Ultrasound

US is generally considered safe during pregnancy. As in any imaging procedure, the ALARA (as low as reasonably achievable) principle should be followed. Cardiac activity may be documented in real time, or M-mode imaging. Because of its higher energy levels, pulsed and color Doppler of the embryo should be avoided if possible. Pulsed and color Doppler US may be extremely useful for other first trimester issues, including retained products of conception and adnexal masses [51].

Summary

- Acute pelvic pain in the reproductive age group presents a diagnostic challenge, with US, CT, and MRI often playing an integral role in arriving at the correct diagnosis.
- The first step in the evaluation is to determine pregnancy status by measuring the serum β-HCG level.
- The choice of the correct imaging test depends on the results of a careful clinical evaluation to narrow the differential diagnosis.
- Whether obstetric, gynecologic, gastrointestinal, urinary, or another etiology is most highly suspected will determine which pelvic imaging modality is the most appropriate for accurate and expeditious diagnosis and triage.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [44].

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, both because of

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 to 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.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	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 NS (not specified).		

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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