

Imaging of the Pregnant Patient with Symptoms

Donald L. Renfrew, MD

Workup of pregnant patients presenting with symptoms depends on whether the symptoms represent a *complication of pregnancy* or represent disease *complicating the pregnancy*. See Table 1.

COMPLICATIONS OF PREGNANCY

Complications of pregnancy include miscarriage, ectopic pregnancy, molar pregnancy, placental abruption, intra-amniotic infection, uterine rupture, and severe pre-eclampsia with or without the HELLP syndrome¹. See Table 2. Imaging for complications of pregnancy (other than pre-eclampsia and the HELLP syndrome) typically consists of pelvic ultrasound (Table 1), and additional imaging studies are seldom necessary.

For women with a positive pregnancy test (with or without symptoms), transvaginal pelvic ultrasound results will generally fall into one of four categories (see Rodgers et al):

1. Viable intrauterine pregnancy (IUP) at X age. The ultrasound exam shows a live intrauterine fetus (or fetuses) with age established by size on the ultrasound.
2. IUP at X age of unknown viability.

¹ HELLP = Hemolysis, Elevated Liver Enzymes, and Low Platelet Count

- a. *Probably normal (but too early to demonstrate fetal cardiac activity)*. The ultrasound exam shows an empty gestational sac without yolk sac or embryo, a gestational sac with a yolk sac but no embryo, or a gestational sac with a yolk sac and an embryo less than or equal to 4 mm in size with no cardiac activity.
 - b. *Probably abnormal*. The ultrasound examination shows findings suspicious for, but not diagnostic of, pregnancy failure (e.g. no cardiac activity in a fetus measuring 5 mm, no fetal pole in a gestational sac measuring 20 mm).
3. Pregnancy of unknown location.
 - a. With a normal appearance of the endometrium, possibilities include an early IUP, an occult ectopic pregnancy, and a completed spontaneous abortion.
 - b. With an abnormal endometrium, the possibilities include a spontaneous abortion in progress (usually shows a thickened endometrium) or an early IUP (gestational sac vrs decidual cyst) or abnormal IUP.
 4. Nonviable IUP at X age.
 - a. There is a fetus with a crown-rump length of 7 mm or greater with no fetal cardiac activity.

- b. There is a gestational sac measuring 25 mm or greater with no fetus.
- c. Sequential scans show no heartbeat 2 or more weeks after a scan with a gestational sac and no yolk sac, or 11 days after a scan with a gestational sac and a yolk sac.

In a young women with a positive pregnancy test and a live, intrauterine pregnancy, the likelihood of an additional, ectopic pregnancy is very small, except in patients who are taking fertility drugs or who have undergone in vitro fertilization. Patients with an ectopic pregnancy will fall into category 3 (above), with no IUP. The ultrasound study in women with ectopic pregnancy may show no additional abnormality, a hypervascular mass in the adnexa (most ectopic pregnancies implant in the fallopian tube), or (in rare cases) an extrauterine gestational sac and fetus.

Molar pregnancy may be accompanied by pelvic and abdominal pain, but the most characteristic feature is a disproportionate elevation of beta human chorionic growth hormone (beta HCG). Ultrasound typically shows a lack of a normal intra-uterine pregnancy with, instead, a vascular multicystic mass. Placental abruption is a difficult diagnosis, and ultrasound is relatively insensitive (see Glantz and Purnell). Ultrasound of the abdomen may be performed in pre-eclampsia and the HELLP syndrome to evaluate for free fluid in the abdominal cavity (a result of hemorrhage) or abnormalities of the liver (hemorrhage into the liver parenchyma or along the capsule).

DISEASE COMPLICATING PREGNANCY

Pregnant women may fall prey to any disease that nonpregnant women experience. Some of these diseases actually occur somewhat more frequently in pregnant women. Diseases complicating pregnancy (and the early post-

partum period) include ovarian torsion, acute appendicitis, gallbladder disease, bowel obstruction, inflammatory bowel disease, pancreatitis, diverticulitis, cystitis, pyelonephritis, nephrolithiasis, pneumonia, gastroenteritis, and pulmonary embolism. These diseases generally produce symptoms as noted in Table 3, and for a discussion of the imaging evaluation of these symptoms in nonpregnant women, please see the appropriate chapters on abdominal pain, nausea and vomiting, chest pain, dyspnea, and flank pain. Imaging in pregnant women does *not* automatically progress as outlined in those chapters, however, secondary to concerns regarding maternal and fetal irradiation and contrast material injection. For additional discussion of these topics, please see “Chapter 16: Contrast materials and radiation exposure.” Briefly, imaging of pregnant patients with symptoms of a disease complicating the pregnancy consists of ultrasound of the abdomen for patients with abdominal pain, US of the pelvis in patients with pelvic pain, and US of the lower extremities in patients with either leg swelling and tenderness along the course of the veins, or dyspnea and tachycardia suspicious for pulmonary embolism. Additional imaging is generally done only after evaluation by an obstetrician and in consultation with a radiologist. Use of ionizing radiation is avoided, if possible, because of the *stochastic* and *deterministic* effects of radiation. The stochastic effect presumably occurs even at very low doses of radiation, and results in an increased frequency of the development of malignancy following radiation exposure. This effect also occurs, of course, in nonpregnant patients, but in pregnant patients two issues increase the degree of concern over radiation exposure: 1) female breast tissue is much more sensitive to radiation during pregnancy; and 2) the ethical quandary of increasing the cancer risk of a fetus. While there are many factors that figure into the calculation

of the risk, as a generalization the lifetime risk of cancer increases approximately 0.1% per 10 mSv of exposure. This is roughly the dose of a CT study of the abdomen and pelvis using a circa 2000 era CT scanner (although the dose may be much lower with newer equipment and dose modification). Note that it is also roughly the dose *to the mother* for a chest CT, but that the infant dose in a chest CT is less than 1 mSv. Plain film exposure is generally much less than 1 mSv. This risk is generally felt to be reasonable in cases where a diagnosis is necessary (for example, with suspected appendicitis or pulmonary embolism) and no other options are available. There is a trend to use noncontrast MR in such situations as a substitute for CT in these circumstances.

Deterministic effects of radiation are linearly related to dose and have a definite threshold. Such effects occur only at much higher doses than produce stochastic effects². Indeed, only extraordinary circumstances would lead to the degree of exposure (at least 50 mSv, and more likely greater than 100 mSv) necessary to produce deterministic effects on the fetus. These levels of radiation would only occur with multiple CT scans or procedures requiring prolonged fluoroscopy. Only severely ill patients would ever undergo these levels of medical radiation. If such a high level of exposure occurs during the first two weeks following conception, the fetus either survives intact or does not survive (an “all or none” effect). If the exposure occurs three to four weeks after conception, the likelihood of spontaneous abortion increases. If the exposure occurs in the 5th to 10th week following conception, the likelihood of possible fetal malformations increases; if the exposure

between the 11th and 27th week, mental development is delayed or permanently damaged. All of these high levels of radiation also cause an increased risk of cancer with the general rule of approximately a 0.1% increase in risk per 10 mSv exposure.

In addition to avoiding the use of ionizing radiation, intravenous contrast is also best avoided in pregnant patients. Iodine containing contrast used for CT studies may suppress thyroid function in the fetus, and gadolinium containing contrast agents have shown teratogenic effects in animal studies. While both of these concerns are more theoretic than actual (see, for example, the paper by Bourjelly et al documenting a *lack* of fetal thyroid suppression following IV iodinated contrast), in most instances injection of contrast is avoided if possible. Certainly, any imaging work-up requiring ionizing radiation and/or intravenous contrast material which *can* be postponed until after delivery *should* be postponed until after delivery.

² Models of exposure vary, but most authorities assume that even tiny amounts of ionizing radiation are associated with an associated (tiny) increase in the likelihood of future development of cancer.

Table 1. Imaging of the Pregnant Patient with Symptoms

Indication	Imaging Examination
Pelvic pain with vaginal discharge and suspected complication of pregnancy	Ultrasound of the pelvis.
Flank pain +/- hematuria and suspected urinary calculus	Ultrasound of the kidneys and pelvis. MR urogram for problem cases. See "Flank pain" documents at www.symptombasedradiology.com for further details including a discussion of imaging in patients who are <i>not</i> pregnant.
Abdomen or pelvis pain with anorexia, nausea and vomiting, and suspected appendicitis	Ultrasound of the pelvis. MR of the abdomen and pelvis for problem cases. See "Abdominal pain" for further details including a discussion of imaging in patients who are <i>not</i> pregnant.
Chest pain or dyspnea and suspected pulmonary embolism	Ultrasound of both lower extremities to search for deep venous thrombosis. If negative, one of the following three studies will likely need to be performed, depending on local practice patterns: 1) noncontrast magnetic resonance angiography of the pulmonary arteries; 2) computed tomographic angiography of the pulmonary arteries; or 3) a nuclear medicine perfusion study of the lungs. See "Chest Pain" and "Dyspnea" for further details including a discussion of imaging in patients who are <i>not</i> pregnant.

**Table 2. Complications of Pregnancy:
Causes, Clinical Features, and Imaging Findings**

Cause	Clinical Features	Imaging Findings
Miscarriage	Pelvic pain and vaginal bleeding	Lack of live intra-uterine fetus; lack of heartbeat with fetal crown-rump length of than 7 mm or more; lack of fetus with gestational sac mean diameter of 25 mm or more; failure to progress on sequential scans.
Ectopic pregnancy	In vitro fertilization or fertility drugs; abdominal pain; vaginal bleeding	Lack of live intra-uterine fetus; adnexal mass with hyperemia; ectopic gestational sac with live fetus (rare)
Molar pregnancy	Abdominal pain; hyperemesis; disproportionate elevation of betaHCG	Lack of normal intra-uterine fetus; endometrial multicystic mass
Placental abruption	Pelvic pain and vaginal bleeding; uterine contractions	Separation of the placenta from the uterus
Intra-amniotic infection (chorioamnionitis)	Fever; abdominal pain; leukocytosis; tachycardia; uterine contractions	A shortened cervical canal is a risk factor for chorioamnionitis.
Uterine rupture	History of prior cesarean delivery or uterine pregnancy, peritoneal irritation, vaginal bleeding	Free fluid in the peritoneal cavity; discontinuity of the uterus
Severe Pre-eclampsia and the HELLP syndrome	Abdominal pain; hypertension; hemolysis; elevated AST and LDH; low platelets	Complications including hepatic infarction, hematoma, or rupture. Placental abruption.

**Table 3. Diseases Complicating Pregnancy:
Causes, Clinical Features, and Imaging Findings**

Cause	Clinical Features	Imaging Findings
Ovarian torsion	Pelvic pain on the side of the torsion; elevated WBC count	Cysts, swelling, or diminished flow (on color Doppler) of the ovary
Acute appendicitis	Right lower quadrant pain; anorexia; elevated WBC count	Swollen appendix; peri-appendiceal fat stranding
Gallbladder disease	Intermittent right upper quadrant pain; fever and leukocytosis	Gallstones; gallbladder wall thickening; pericholecystic fluid
Bowel obstruction	Prior abdominal surgery; abdominal pain; new onset nausea and vomiting after the first trimester	Distension proximal to, and collapse distal to, the obstruction; abnormality at the transition point (e.g., hernia)
Inflammatory bowel disease	Abdominal pain; altered bowel movements; fever; weight loss	Bowel wall thickening; fat stranding
Pancreatitis	Upper abdominal pain; elevated amylase and lipase; elevated WBC count	Pancreas swelling and peripancreatic fat stranding; focal fluid collections in or adjacent to the pancreas
Diverticulitis	Abdominal pain and fever; elevated WBC count	Diverticulae; pericolic fat stranding; free air or free fluid in the peritoneal cavity
Pyelonephritis	Flank pain; fever; pyuria	Hyperemia of the kidney; hydronephrosis with debris
Nephrolithiasis	Flank pain; hematuria	Renal stone in the collecting system
Pneumonia	Abdominal or chest pain; fever; cough; dyspnea	Lung consolidation; pleural effusion
Pulmonary embolism	Acute chest pain; dyspnea; decreased oxygen saturation	Filling defect in the pulmonary artery; abnormal lung perfusion
No imaging findings		
Cystitis, gastroenteritis		

REFERENCES

Bourjelly G, Chathoub M, Phornphutkul C et al. Neonatal thyroid function: effect of a single exposure to iodinated contrast medium in utero. *Radiology* 2010; 256:744-750.

Gawande A. *The Checklist Manifesto*.

Glantz C, Purnell L. Clinical utility of sonography in the diagnosis and treatment of placental abruption. *J Ultrasound Med* 2002; 21:837-840.

Hooton TM. Urinary tract infections and asymptomatic bacteriuria in pregnancy. UpToDate, accessed 4/20/12.

Kilpatrick CC, Orejuela FJ. Approach to abdominal pain in the pregnant and post-partum woman. UpToDate, accessed 4/20/12.

Preminger GM, Curhan GC. Nephrolithiasis during pregnancy. UpToDate, accessed 4/20/12.

Rodgers SK, Chang C, DeBardleben JT, Horrow MM. Normal and abnormal US findings in early first-trimester pregnancy: review of the Society of Radiologists in Ultrasound 2012 Consensus Panel recommendations. *RadioGraphics* 2015; 35:2135-2148.

Spalluto LB, Woodfield CA, DeBenedictis CM, Lazarus E. MR imaging evaluation of abdominal pain during pregnancy: appendicitis and other nonobstetric causes. *RadioGraphics* 2012;32:317-334.

Thadhani PI, Maynard SE. Renal and urinary tract physiology in normal pregnancy. UpToDate, accessed 4/20/12.

Wang PI, Chong ST, Kiellar AZ et al. Imaging of pregnant and lactating patients: Part 1, evidence-based review and recommendations. *AJR* 2012;198:778-784.

Wang PI, Chong ST, Kiellar AZ et al. Imaging of pregnant and lactating patients: Part 2, evidence-based review and recommendations. *AJR* 2012;198:785-792.