

Magnetic Resonance Imaging of Abdominal and Pelvic Pain in the Pregnant Patient



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KEYWORDS

• Pregnancy • Emergency • MR imaging • Acute abdomen • Appendicitis

KEY POINTS

- Evaluating the acute abdomen in pregnancy is complex because of altered physiology and the need to avoid radiation exposure.
- MR imaging is a safe and efficacious tool for accurate evaluation of the pregnant patient due to the lack of radiation exposure and its intrinsic high soft-tissue contrast.
- Developing dedicated protocols for evaluating the acute abdomen in pregnancy and institutional guidelines on issues including patient informed consent and IV contrast administration is important.
- Most acute abdominal and pelvic abnormalities can be diagnosed in a safe and timely manner using MR imaging.

Evaluation of the acute abdomen in a pregnant woman poses special challenges for both the radiologist and the referring physician for several reasons. The most appropriate imaging modality should be selected, balancing the risks of fetal radiation exposure with the potential benefits of establishing a prompt and accurate diagnosis. Imaging protocols vary from institution to institution, with a broad consensus slowly evolving over time. This review discusses the role of MR imaging in evaluating the common nonfetal causes of acute abdominal and pelvic abnormalities in the pregnant woman.

POTENTIAL RISKS OF RADIATION EXPOSURE TO THE FETUS

The potential effects of radiation exposure to the fetus have been discussed extensively in the literature.¹ As always, the most important principle in imaging the pregnant patient is that of ALARA (as low as reasonably achievable). The potential clinical benefits must be considered against the potential risk of radiation exposure when selecting the appropriate imaging modality. According to the most recent guidelines from the American College of Radiology (ACR), the risk of radiation-induced

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deterministic effects are thought to be minimal for exposure less than the 50 mGy threshold (5 rad).¹

The average radiation exposure of a single abdominal and pelvic computed tomographic (CT) examination performed with current equipment using an appropriate protocol should be much less than the 50-mGy threshold.^{2,3} However, if ionizing radiation can be completely avoided, and diagnostic accuracy can be maintained at a high level, then the use of imaging modalities that do not impart ionizing radiation to the fetus, particularly in the earlier stages of gestation, would be preferable.

SAFETY OF MR IMAGING IN PREGNANCY

Because of the absence of exposure to ionizing radiation, its multiplanar imaging capabilities, and excellent imaging quality and soft-tissue contrast, MR imaging has been shown to be an excellent option for imaging the pregnant patient with acute abdominal and pelvic disorders. The primary concerns for fetal exposure to MR imaging are the heating effects of the radiofrequency pulses and the effects of acoustic noise on the fetus.⁴ Higher strengths of the magnetic field, use of a higher flip angle, an increased number of radiofrequency pulses, and decreased spacing between them, are all associated with a higher specific absorption rate, leading to potentially higher fetal tissue heating.⁵ Sequences including single-shot fast spin-echo (SSFSE) are single acquisition echo-train spin-echo sequences and use 180° refocusing pulses. They are associated with higher fetal heating than gradient-echo sequences, which do not use the refocusing pulse.^{2,5} Tissue heating is however maximum at the maternal body surface and decreases near the center of the body, making fetal thermal damage less likely. To the authors' knowledge, there is no evidence of adverse fetal heating with a 1.5-T or lower field strength magnet.^{2,5,6} Similarly, exposure to acoustic noise has not been proven to adversely affect fetal hearing, because the noise gets attenuated while traveling through the amniotic fluid and gets delivered to the fetus at less than 30 dB.⁷⁻¹⁰

A few animal studies have raised the possibility of adverse effects of noncontrast MR imaging (ranging from 0.35 T to 1.5 T) on mice and chick embryos, whereas another study (4.7-T strength) found no significant adverse effects.¹¹⁻¹⁴ The duration of exposure of the embryos to MR imaging in these studies ranged from 6 to 48 hours, which does not parallel the situation in clinical practice. The applicability of these findings to the human embryo is somewhat controversial. Overall, MR imaging has been used safely for imaging

obstetric patients for more than the past 2 decades, without any documented adverse fetal effects.¹⁵ The International Commission on Non-ionizing Radiation Protection, in its statement on MR imaging in pregnancy, published in 2004 and updated in 2009, stated that "there is no clear evidence that exposure to static or low frequency magnetic fields can adversely affect pregnancy outcome," but concluded that the overall evidence to provide unequivocal guidelines is insufficient. It recommended that MR imaging should be performed in pregnancy only after a critical risk-benefit analysis, particularly in the first trimester, and that imaging time should be minimized.^{16,17}

The ACR guidelines on imaging patients in pregnancy do not recommend any special consideration for first trimester MR imaging, given the absence of documented adverse effects.¹⁸

According to the ACR guidelines, MR imaging can be performed in any stage of pregnancy if, in the medical opinion of a level 2 MR imaging personnel-designated attending radiologist, the examination is indicated after considering the risk-benefit ratio. The following should be documented in the radiology report or in the patient's medical records after conferring with the referring physician:

- i. The information was not/cannot be obtained by using ultrasound (US);
- ii. The information obtained from the examination will potentially directly benefit maternal or fetal care during the pregnancy;
- iii. The referring physician does not think it is wise to wait until after the patient delivers to obtain the MR imaging.

SAFETY OF INTRAVENOUS GADOLINIUM IN PREGNANCY

Intravenous (IV) gadolinium in pregnancy is considered a category C drug, with teratogenic effects having been demonstrated in animals without any definite effects on human fetuses.^{19,20} Because IV gadolinium crosses the placenta and remains in the amniotic fluid indefinitely, being recycled by the fetal kidneys, there is a theoretic risk of free gadolinium ions dissociating from the chelate and having an adverse effect on fetal development.^{3,18,19} According to the ACR guidelines for imaging pregnant patients, IV gadolinium should not be routinely used in pregnancy.¹⁸ Any decision to administer IV gadolinium in pregnancy should be made only after carefully balancing the risk and potential benefit and should be considered only in very select situations. The authors' practices almost never

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