

## **Magnetic Resonance Imaging Evaluation of Appendicitis in Pregnancy**

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Acute appendicitis is the most common cause of acute abdomen in pregnancy, complicating approximately 1 per 1500 pregnancies [1]. Clinical diagnosis of appendicitis in pregnant women is confounded by several factors found in a normal pregnancy. Such confounding factors include nonspecific leucocytosis, displacement of abdominal and pelvic structures from their normal locations by the gravid uterus, a difficult abdominal examination, and nonspecific nausea and vomiting [2, 3]. Guarding in the setting of peritonitis may not occur because of the loss of elasticity in the abdominal wall musculature [4].

Ultrasound is usually the first imaging technique of choice because of its availability, lack of ionizing radiation, and lack of need for IV contrast media. However, ultrasound of the appendix is a highly operator-dependent examination that can be further limited by the pregnant body habitus. Moreover, the diagnosis of acute appendicitis by sonography is easier in the first trimester than in later pregnancy. The sensitivity of sonography in detecting appendicitis in pregnancy has been reported to be 66-100%. In addition, an elevated or retrocaecal appendix as such may be difficult to find sonographically and a ruptured appendix may have nonspecific findings on ultrasound.

Delay in diagnosis of appendicitis leads to increased perforation rates. Early diagnosis is therefore very important because increased rate of fetal loss and maternal mortality—has been reported with surgical delay of more than 24 hours from the time of onset of symptoms [5]. Rate of fetal loss is less than 2% in uncomplicated acute appendicitis, whereas it can be greater than 30% in presence of perforation [1,6]. The rate of perforation also rises from 30% in the first and second trimesters to 70% in the third. Fortunately, no deleterious effect of non-contrast MRI has been reported in the developing fetus.

### **MRI TECHNIQUE**

The patient is imaged in the supine position with a surface phased-array coil covering the abdomen and pelvis. A comprehensive multiplanar imaging protocol is used. The field of view extends from the dome of the liver superiorly through the pubic symphysis inferiorly. The protocol includes axial, sagittal, and coronal T2-weighted single-shot fast spin-echo (SSFSE) sequences; axial true fast imaging with steady-state precession (FISP) sequences; axial in-phase and out-of-phase T1-weighted gradient-echo (GRE) sequences; and axial short tau inversion-recovery sequences.

The multiplanar T2-weighted SSFSE images allow imaging of the bowel in a relatively motionless state and help confirm the location of the appendix in more than one plane. The axial T1-weighted GRE images are obtained to confirm appendiceal patency by demonstrating blooming artefact from air or oral contrast material in the appendix lumen from out-of-phase to in-phase imaging. The axial true FISP images help differentiate high-signal-intensity adnexal vessels from the lower signal intensity of a normal appendix, and the axial short tau inversion-recovery sequence is used to highlight any periappendiceal edema or fluid associated with appendicitis.

### **MRI FEATURES OF APPENDICITIS**

Imaging evaluation for appendicitis during pregnancy begins with localizing the appendix. With advancing gestation, the cecum and appendix are increasingly elevated out of the pelvis by the gravid uterus. Therefore, it is important to also search outside the right lower quadrant for the appendix. Lee et al [7] reported that as the cecum is displaced and tilted anteriorly and outwardly out of the pelvis with growth of the gravid uterus, a caecal tilt angle of at least 90° on sagittal MR images is predictive of the appendix being located in the right upper quadrant rather than the right lower quadrant.

Once the appendix is localized, it can be evaluated for features of a normal, inflamed, or indeterminate appendix. MR imaging features of a normal appendix include a diameter less than 6 mm, an appendiceal wall thickness less than 2 mm, low luminal signal intensity on T1- and T2-weighted images, and no periappendiceal fat stranding or fluid. MR imaging features of appendicitis include an appendiceal diameter greater than 7 mm, an appendiceal wall thickness greater than 2 mm, high-signal-intensity luminal contents on T2-weighted images due to fluid or edema, and hyperintense periappendiceal fat stranding and fluid. An appendix with high-signal-intensity luminal contents on T2-weighted images and a diameter between 6 and 7 mm without associated wall thickening or periappendiceal fat stranding or fluid is considered indeterminate for appendicitis and warrants close clinical follow-up [8].

MR imaging has been described as an effective modality for diagnosis of appendicitis during pregnancy, with 100% sensitivity and 94% specificity reported [8,9]. MRI is increasingly being used for diagnosis of acute appendicitis, especially in the second and third trimester. MRI should also be used for failed diagnosis with sonography.

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