The adequate MR sequences for the detection of normal appendix in pregnant women

Poster No.: C-3310  
Congress: ECR 2010  
Type: Scientific Exhibit  
Topic: GI Tract  
Authors: J. W. Lee, Y. H. Jeon, J. Y. Hwang, S. A. Lee; Chuncheon/KR  
Keywords: Magnetic Resonance Imaging, Appendix, Pregnancy

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Purpose

1. Acute appendicitis is the most common cause of acute abdominal pain and surgical emergencies during pregnancy. A delayed diagnosis of acute appendicitis in pregnancy can give rise to premature labor and increase the fetal and maternal mortality rates. Anatomic alteration of the location of the appendix and non-specific leukocytosis during pregnancy make it difficult to reach an early diagnosis in acute appendicitis.

2. Ultrasonography is an initial study for determining the etiology of right lower quadrant pain during pregnancy, but may not be feasible due to the size of the enlarged uterus, bowel gas, and obesity.

3. Magnetic resonance imaging (MRI) is being used increasingly for imaging maternal and fetal disease during pregnancy because it provides multiplanar images with excellent soft tissue contrast resolution and no ionizing radiation.

4. This study determined which sequences are the best for detecting the appendix and hastening the diagnosis of appendicitis during pregnancy.

Methods and Materials

1. Patient Selection

Thirty-nine pregnant women who were clinically suspected of having fetal or maternal anomalies and underwent pelvic MRI between May 2005 and October 2009 were included. The mean patient age was 30 years (range 25-42 years) and the mean gestational age was 25 weeks (range 13-38 weeks). There were no abdominal signs of acute illness, especially acute appendicitis. The study was approved by the institutional review board. Written informed consent was obtained before MRI. We prospectively reviewed the medical records and MRI findings.

2. MRI

The MRI was performed on a 1.5-T system (Gyroscan Intera Release 11, Philips Medical Systems, Best, the Netherlands), with a SENSE body coil placed over the lower abdomen and pelvis. The MRI protocol included the use of axial fat-suppressed (FS) (scan mode: multiple slices in which several two-dimensional (2D) slices are scanned in an interleaved sequence) T2-weighted single-shot turbo spin-echo (SSTSE) sequences (axial T2/FS/SSTSE, TR/TE 4870 ms/80 ms, matrix 224×224, NEX 2, scan time 19.5 sec) and coronal FS T2-weighted SSTSE sequences (coronal T2/FS/SSTSE, TR/TE 6814 ms/80 ms, matrix 224×224, NEX 2, scan time 5.8 sec), and axial heavily T2-weighted SSTSE sequences (axial HT2/FS/SSTSE, TR/TE 6066 ms/160 ms, matrix 224×224, NEX 2, scan time 24.3 sec), coronal heavily T2-weighted SSTSE sequences (coronal HT2/FS/SSTSE,
TR/TE, 7782 ms/160 ms, matrix 224×224, NEX 2, scan time 15.8 sec), axial and coronal T1-weighted in-phase fast field-echo (FFE) sequences (T1/IP/FFE, TR/TE 150 ms/4.6 ms, matrix 176×176, NEX 1, scan time 14.3 sec), axial T2-weighted SSTSE sequences (T2/SSTSE, TR/TE 4860 ms/80 ms, matrix 224×224, NEX 2, scan time 19.34 sec), and axial T1-weighted out-of-phase FFE sequences (T1/OP/FFE, TR/TE 150 ms/2.3 ms, matrix 176×176, NEX 1, scan time 14.3 sec) of the lower abdomen and pelvis. In 13 examinations, axial FS T1-weighted FFE water-selective sequences (T1/FS/FFE, TR/TE 206 ms/4.89 ms, matrix 176×176, NEX 1, scan time 15.3 sec) were also obtained. The slice thickness was 5 mm with a 1.0-mm gap and the field of view was 34 cm for all sequences. The mean total examination time was 30 min for all studies (range 20-50 min).

3. Image Interpretation
The MRI findings were evaluated by two experienced radiologists who had subspecialty training in abdominal imaging and more than 10 years of experience in abdominal MRI. The image analysis included not only identification of the normal appendix by both radiologists (J Lee, YH Jeon), but also included the identification of fetal or uterine anomalies, which were the main clinical problem, by one radiologist (J Lee). We first evaluated one sequence for all patients. Then, a second sequence was evaluated in all patients, and so on in order. We were not aware of any of the information from the previously evaluated sequences during the analysis of the other sequences. The identification of the normal appendix was scored on a three-point scale: 1 = not identified, 2 = visualized faintly (less than half seen), and 3 = visualized clearly (more than half seen). We came to a consensus on identifying the appendix before the analysis. The appearance of the normal appendix was also described for each sequence obtained.

Results

1. Clinical Outcomes
Fetal anomalies were found in 17 of the 39 pregnant women, including hydronephrosis (n = 5), hydrocephalus (n = 3), ovarian cyst (n = 3), and left atrial myxoma, aorta aneurysm, femur fracture, situs inversus totalis, single left kidney, and duodenal atresia (n = 1 each). The remaining 22 pregnant women had maternal anomalies, including myoma (n = 8), ovarian cyst (n = 5), placental cyst (n = 3), uterine synechiae (n = 2), and ovary teratoma, ovary endometriosis, placental previa totalis, and abruptio placenta (n = 1 each).

2. The Normal Appendix
Observer 1 clearly visualized a normal appendix in 27 of 37 pregnant women (73.0%) on the axial T1/IP/FFE sequences(Fig. 1), 24 of 36 pregnant women (66.7%) on the axial T2/SSTSE sequences(Fig. 2), 24 of 37 pregnant women (64.9%) on the axial T1/OP/FFE sequences(Fig. 3), 6 of 13 pregnant women (46.2%) on the axial T1/FS/FFE sequences(Fig. 4), and 10 of 30 pregnant women (33.3%) on the axial T2/FS/SSTSE sequences(Fig. 5). In the remaining sequences, a normal appendix was visualized faintly or not at all (Fig. 6, 7, 8, 9).
Observer 2 clearly visualized a normal appendix in 28 of 36 pregnant women (77.8%) on the axial T2/TSE sequences, 25 of 37 pregnant women (67.6%) on the axial T1/IP/FFE sequences, 22 of 37 pregnant women (59.5%) on the axial T1/OP/FFE sequences, 7 of 13 pregnant women (53.8%) on the axial T1/FS/FFE sequences, and 11 of 30 pregnant women (36.6%) on the axial T2/FS/TSE sequences.

The ascending retrocecal appendix, however, was clearly visualized in any pulse sequences because of prominent fatty tissue. (Fig 10-17)

The normal appendix had a central hypointense and peripheral intermediate signal intensity wall on the axial T2/SSTSE, T1/IP/FFE, and T1/FS/FFE images and a central hyperintense and peripheral low signal intensity wall on the axial T1/OP/FFE and T2/FS/SSTSE images (Fig. 1-5).

Images for this section:

![Image](image_url)

**Fig. 1**: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial T1-weighted in-phase fast field-echo MR image clearly demonstrates the
normal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrow).

**Fig. 2:** A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial T2-weighted single-shot turbo spin-echo MR image clearly demonstrates the normal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrow).
**Fig. 3:** A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial T1-weighted out-of-phase fast field echo MR image clearly demonstrates the normal appendix with a central hyperintense and peripheral low signal intensity wall (arrows).
Fig. 4: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial T1-weighted fat suppressed fast field echo water selective MR image clearly demonstrates the normal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrow).
Fig. 5: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial T2-weighted fat-suppressed single-shot turbo spin-echo MR image faintly demonstrates a part of the normal appendix with a central hyperintense and peripheral low signal intensity wall(arrow).
**Fig. 6:** A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Axial heavily T2-weighted fat-suppressed single-shot turbo spin-echo MR image faintly demonstrates a part of the normal appendix with a central hyperintense and peripheral low signal intensity wall(arrow).
Fig. 7: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Coronal T1-weighted in-phase fast field-echo (FFE) MR image clearly demonstrates the normal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrows).
Fig. 8: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Coronal T2-weighted fat suppressed single SSTSE MR image faintly demonstrates a part of the normal appendix with and a central hyperintense and peripheral low signal intensity wall (arrow).
Fig. 9: A 35-year-old pregnant woman was diagnosed with endometriosis in right ovary. Coronal heavily T2-weighted fat suppressed SSTSE MR image faintly demonstrates a part of the normal appendix with a central hyperintense and peripheral low signal intensity wall (arrow).
**Fig. 10:** A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. An axial T1-weighted in-phase fast field-echo MR image clearly demonstrates the normal ascending retrocecal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrow).
Fig. 11: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Axial T2-weighted single-shot turbo spin-echo MR image clearly demonstrates the normal ascending retrocecal appendix with a central hypointense and peripheral intermediate signal intensity wall(arrow).
Fig. 12: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. An axial T1-weighted out of-phase fast field echo MR image clearly demonstrates the normal ascending retrocecal appendix with a central hyperintense and peripheral low signal intensity wall (arrow).
Fig. 13: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Axial T2-weighted fat-suppressed single-shot turbo spin-echo MR image clearly demonstrates the normal ascending retrocecal appendix with a central hyperintense and peripheral low signal intensity wall (arrow).
**Fig. 14:** A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Axial heavily T2-weighted fat-suppressed single-shot turbo spin-echo MR image clearly demonstrates the normal ascending retroceal appendix with a central hyperintense and peripheral low signal intensity wall (arrow).
Fig. 15: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Coronal T1-weighted in-phase fast field-echo MR image clearly demonstrates the normal ascending retrocecal appendix with a central hypointense and peripheral intermediate signal intensity wall (arrow).
Fig. 16: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Coronal T2-weighted fat suppressed single SSTSE MR image clearly demonstrates the normal ascending retroceal appendix with a central hyperintense and peripheral low signal intensity wall(arrow).
Fig. 17: A 37-year-old pregnant woman was diagnosed with fetal hydrocephalus and the normal ascending retrocecal appendix on MR images. Coronal heavily T2-weighted fat suppressed SSTSE MR image clearly demonstrates the normal ascending retrocecal appendix with a central hyperintense and peripheral low signal intensity wall (arrow).
Conclusion

1. Axial T2-weighted SSTSE, T1-weighted in-phase and out-of-phase FFE, and fat-suppressed T1-weighted SSTSE MRI sequences should be helpful for detecting the appendix in pregnancy.

2. In our study, we have a difficulty for detection of appendix on coronal fat suppressed T2 or heavily T2-weighted SSTSE images, and axial fat suppressed heavily T2-weighted SSTSE images.

3. It should be possible to save time in diagnosing appendicitis during pregnancy using adequate MRI sequences.

References


Personal Information

Ji Won Lee, M.D.

Department of Radiology, Kangwon National University College of Medicine, Hyoja 2-dong, Chuncheon-si, Kangwon-do, Republic of Korea.

mail: leejy@kangwon.ac.kr