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Research Article

MR Imaging of Pregnant Women with Abdominal Pain and Suspected Appendicitis: Diagnostic Accuracy and Outcomes

Abstract

Acute appendicitis is the most common cause of acute surgical abdomen during pregnancy. Our study was conducted to review our experience and diagnostic accuracy with MRI during pregnancy and clinical outcomes over a two year period. All pregnant women who underwent an MRI examination of the abdomen between January 2008 and January 2010 at Spectrum Health hospitals were included in the study. We retrospectively reviewed the medical records and MRI findings in 46 pregnant women. 46 pregnant women underwent a total of 53 MRI scans and of these, 23/46 (50%) presented with RLQ pain and other signs suspicious for appendicitis. 10/23 (43%) had MRI findings positive for acute appendicitis: 5/10 (50%) had uncomplicated acute appendicitis by MRI criteria, all were confirmed at surgery. 3/5 had a ruptured appendix with abscess, 1/5 had a perforated appendix with abscess and 1/5 had MRI findings suspicious for appendicitis but was discharged without surgery or further follow up. The sensitivity for diagnosing appendicitis by MRI in our 10 patients with positive findings was 89% (8 of 9 cases, with one case lost to follow up). The specificity was 100%, since all of the patients who had a normal appendix and/or no secondary signs of appendicitis on MRI were managed medically and were discharged without readmission for surgery. The negative predictive value (NPV) was 93% (13/14). Our study shows that MRI of the abdomen without contrast is an excellent alternative to CT and ultrasound for diagnosing and excluding acute appendicitis during pregnancy.

Objective

Acute appendicitis is the most common cause of acute surgical abdomen during pregnancy, occurring in approximately 1 in 1500 deliveries [1]. Acute appendicitis in pregnant women has been associated with premature labor and maternal and/or fetal death, particularly when perforation with peritonitis occurs [2]. Alteration of the position of the intra-abdominal contents by the pregnant uterus, and the overlapping signs and symptoms of normal pregnancy and acute appendicitis, are the two most important factors leading to difficulties in identification and diagnosis [3].

Computed tomography (CT) [4] and ultrasound (US) [5], have been traditionally used for diagnosing and excluding appendicitis. The major disadvantage of using CT in pregnancy is the radiation exposure of the fetus and the mother. The major disadvantages of US in pregnancy are that it is highly operator dependent and its diagnostic performance decreases with advancing gestational age, obesity, and bowel gas [6].

MRI is the recommended as the primary imaging modality for right lower quadrant (RLQ) pain during pregnancy if US is inconclusive [7]. Recent literature indicates that MRI can be used to accurately diagnose or exclude appendicitis. MRI also enables the diagnosis of alternative causes of RLQ pain (eg, pelvis abscess, tuboovarian abscess, ovarian torsion, adnexal mass, bowel obstruction) [8]. Furthermore, evaluation of the placenta and fetal anatomy can be obtained.

Our study was conducted to review our experience at Spectrum Health to evaluate our diagnostic accuracy with MRI during pregnancy and clinical outcomes over a two year period.

Materials and Methods

Patients

IRB approval was obtained. All pregnant women who underwent an MRI examination of the abdomen between January 2008 and January 2010 at Spectrum Health hospitals were included in the study. We retrospectively reviewed the medical records and MRI findings in 46 pregnant women (age range, 17 - 39; mean age 28). Eleven patients were in the first trimester, 20 patients were in the second trimester, and 15 patients were in the third trimester. Out of this group, women presenting with right lower quadrant pain and clinical concern for acute appendicitis were identified. The MRI used, as well as the image interpretation performed at the time of the procedure, are described below.

MR imaging

MRI was performed with a 1.5 - T General Electric magnet with a torso array coil except in instances the patient was too large when the body coil was utilized. The MRI sequences included axial and coronal T2 single shot fast spin Echo (SSFSE), axial and coronal steady state...
free precession (SSFP) with fat suppression, and axial and coronal 3D pre-contrast T1 (LAVA).

**Image interpretation**

Review and analysis of imaging findings were performed by radiologists with expertise in body MRI either by fellowship training or over five years clinical experience. Analysis included identification of appendix, characterization of the appendix (size, wall thickening, and periappendiceal edema, fluid collections), and a general overview of the abdominal and pelvic viscera. The appendix was considered normal if its maximum outer diameter measured <7 mm and there was no periappendiceal inflammatory change or fluid collection. RLQ inflammation/fluid was considered to be present if localized or asymmetric T2 hyperintensity or “fat stranding” on the T1 weighted images was detected.

**Results**

Patient data are summarized in Table 1. Figures 1-4 demonstrate representative MRI findings.

- 46 pregnant women underwent a total of 53 MRI scans
- 23/46 (50%) presented with RLQ pain and other signs suspicious for appendicitis
- 10/23 (43%) had MRI findings positive for acute appendicitis
- 5/10 (50%) had uncomplicated acute appendicitis by MRI criteria, all were confirmed at surgery
- 3/5 had a ruptured appendix with abscess

**Table 1: MR Findings and clinical outcome of the patients.**

| Age (y) / Trimester | Indication | MR Findings | Clinical Outcome and Treatment |
|---------------------|------------|-------------|-------------------------------|
| 21/2                | Abdominal pain | Negative for SBO | No treatment |
| 25/1                | Suspect appendicitis | Normal appendix | No treatment |
| 31/3                | Suspect appendicitis | Normal appendix | No treatment |
| 28/2                | Abdominal pain | Kidney stones | No immediate treatment |
| 22/3                | Suspect appendicitis | Psoas hematoma, less likely abscess | Perforated appendicitis with abscess, surgical debridement and drainage. |
| 17/3                | Suspect appendicitis | Acute appendicitis | Lap. appendectomy |
| 38/3                | Suspect appendicitis | Normal appendix | No treatment |
| 21/2                | Suspect appendicitis | Normal appendix | No treatment |
| 28/2                | Suspect appendicitis | Normal appendix | No treatment |
| 17/3                | Suspect appendicitis | Normal appendix | No treatment |
| 29/1                | Suspect appendicitis | Normal appendix | No treatment |
| 25/2                | Suspect appendicitis | Normal appendix | No treatment |
| 28/3                | Suspect appendicitis | Normal appendix | No treatment |
| 18/1                | Suspect appendicitis | Acute appendicitis | Lap. appendectomy |
| 26/1                | Suspect appendicitis | Normal appendix | No treatment |
| 33/2                | Abdominal pain, f/o Crohns | Thickened TI, normal appendix | Medical treatment |
| 33/1                | Suspect appendicitis | Normal appendix | No treatment |
| 38/2                | Suspect appendicitis | Normal appendix | No treatment |
| 33/1                | Suspect appendicitis | Normal appendix | No treatment |
| 24/2                | Suspect appendicitis | Right pelvic abscess | CT guided drain placement |
| 22/3                | Suspect appendicitis | Positive for acute appendicitis | Patient discharged prior to report. No flu |
| 39/3                | Suspect appendicitis | Perforated appendix | Appendectomy, surgical abscess debridement, and drain placement |
| 28/3                | Suspect appendicitis | Positive for acute appendicitis | Lap. appendectomy |
| 26/2                | Suspect appendicitis | Positive for acute appendicitis | Lap. appendectomy |
| 19/2                | Suspect appendicitis | Positive for acute appendicitis | Lap. appendectomy |
| 28/2                | Suspect appendicitis | Positive for acute appendicitis | Lap. appendectomy |

The sensitivity for diagnosing appendicitis by MRI in our 10 patients with positive findings was 89% (8 of 9 cases, with one case lost to follow up). These cases were confirmed at surgery. The specificity was 100%, since all of the patients who had a normal appendix and/or no secondary signs of appendicitis on MRI were managed medically and were discharged without readmission for surgery. The negative predictive value (NPV) was 93% (13/14) (Chart 1).
Discussion

Acute appendicitis is the most common surgical emergency in pregnancy. Diagnosis is difficult because this condition presents with signs and symptoms that are not unusual with pregnancy (e.g., nausea, vomiting, and leukocytosis). The enlarged uterus, especially in the 2nd and 3rd trimester, can elevate the anterior peritoneum and displace the appendix superiorly, making US and clinical diagnosis more difficult [2,9,10].

Traditionally, US and CT are the proven imaging modalities for diagnosing and excluding acute appendicitis in non-pregnant women with reported sensitivities and specificities greater than 85% and 95%, respectively. The American College of Radiology Appropriateness Criteria rates US of the RLQ with graded compression highest in this
In our study, the sensitivity and specificity for diagnosing appendicitis by MRI was 89% and 100%, respectively. The negative predictive value of MRI was 93%. Interestingly, positive laparotomy rates for appendicitis during pregnancy are reported to be approximately 50%, which is similar to the incidence of appendicitis (43%) by MRI in this patient group.

Conclusion

Our study shows that MRI of the abdomen without contrast is an excellent alternative to CT and ultrasound for diagnosing and excluding acute appendicitis during pregnancy. When ultrasound does not reveal the appendix, MRI offers another option to confirm a normal appendix without radiation risk. Our experience is concordant with the initial experiences published on this imaging technique and has the potential to significantly decrease negative laparotomy rates. Alternative etiologies for the patient’s pain were also discovered which provided valuable information. This study also reminds us that imaging results must be correlated closely with the clinical exam, particularly if there is clinical discordance.

Interestingly, the results from our study also show a novel application of MRI to follow up abdominal/pelvic abscesses in pregnant patients with ruptured appendicitis.

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