ELSEVIER

Canadian Association of Radiologists Journal xx (2017) 1–9

CANADIAN ASSOCIATION OF RADIOLOGISTS JOURNAL

www.carjonline.org

Magnetic Resonance Imaging / Formation image de résonance magnétique

Utility of Magnetic Resonance Imaging for the Diagnosis of Appendicitis During Pregnancy: A Canadian Experience

Michael Burns, MB, BCh, BAO[a,*], Cameron J. Hague, MD[a], Patrick Vos, MD[a], Pari Tiwari, MD[a], Sam M. Wiseman, MD[b]

[a]*Department of Radiology, St Paul's Hospital & University of British Columbia, Vancouver, British Columbia, Canada*
[b]*Department of Surgery, St Paul's Hospital & University of British Columbia, Vancouver, British Columbia, Canada*

Abstract

Purpose: The objective of the study was to evaluate the performance of magnetic resonance imaging (MRI) for the diagnosis of appendicitis during pregnancy.
Methods: We conducted a retrospective review of all MRI scans performed at our institution, between 2006 and 2012, for the evaluation of suspected appendicitis in pregnant women. Details of the MRI scans performed were obtained from the radiology information system as well as details of any ultrasounds carried out for the same indication. Clinical and pathological data were obtained by retrospective chart review.
Results: The study population comprised 63 patients, and 8 patients underwent a second MRI scan during the same pregnancy. A total of 71 MRI scans were reviewed. The appendix was identified on 40 scans (56.3%). Sensitivity of MRI was 75% and specificity was 100% for the diagnosis of appendicitis in pregnant women. When cases with right lower quadrant inflammatory fat stranding or focal fluid, without appendix visualization, were classified as positive for appendicitis, MRI sensitivity increased to 81.3% but specificity decreased to 96.4%.
Conclusions: MRI is sensitive and highly specific for the diagnosis of appendicitis during pregnancy and should be considered as a first line imaging study for this clinical presentation.

Résumé

Objectif : Notre étude visait à évaluer l'efficacité de l'imagerie par résonance magnétique (IRM) pour diagnostiquer l'appendicite pendant la grossesse.
Méthodes : Nous avons réalisé une analyse rétrospective de tous les examens d'IRM effectués dans notre établissement entre 2006 et 2012 pour évaluer les appendicites présumées chez les femmes enceintes. Nous avons obtenu les données des examens d'IRM réalisés, ainsi que celles des échographies effectuées pour la même indication, dans le système d'information radiologique. Les données cliniques et pathologiques ont été tirées d'un examen rétrospectif des dossiers.
Résultats : La population étudiée comprenait 63 patientes, dont 8 qui ont subi un deuxième examen d'IRM pendant la même grossesse. Au total, 71 examens d'IRM ont été analysés. L'appendice a été repéré dans 40 examens (56,3 %). La sensibilité de l'IRM était de 75 % et sa spécificité à 100 % pour le diagnostic de l'appendicite chez les femmes enceintes. Lorsque des cas avec fluide local ou de remaniement de la graisse inflammatoire dans le quadrant inférieur droit, sans visualisation de l'appendice, ont été déclarés des cas positifs d'appendicite, la sensibilité de l'IRM est passée à 81,3 %, mais la spécificité a diminué pour atteindre 96,4 %.
Conclusions : L'IRM présente une bonne sensibilité et une spécificité élevée pour le diagnostic de l'appendicite pendant la grossesse et devrait constituer l'examen d'imagerie de première intention pour ce tableau clinique.

Key Words: Abdominal pain; Appendicitis; Magnetic resonance imaging; Pregnancy

* Address for correspondence: Michael Burns, MB, BCh, BAO, Department of Radiology, Royal Inland Hospital, Kamloops, BC, V2C2T1, Canada.

E-mail address: mdburns@me.com (M. Burns).

0846-5371/$ - see front matter © 2017 Canadian Association of Radiologists. All rights reserved.
http://dx.doi.org/10.1016/j.carj.2017.02.004

Appendicitis is a common cause of abdominal pain during pregnancy, with a reported incidence that ranges from 1 in 760 women to 1 to 1493 women [1−3]. However, the clinical diagnosis of appendicitis during pregnancy is challenging. Contributing factors include altered anatomy due to the presence of the gravid uterus, a physiological inflammatory response (elevated white blood cell count and left shift in neutrophils), and a broader differential diagnosis due to other possible obstetrical causes of abdominal pain. This has led to the accuracy of the clinical diagnosis of appendicitis during pregnancy to range from 67% to 75% [1,3]. Traditionally, a lower threshold for appendectomy in suspected cases is recommended because a delay in diagnosis is associated with a higher risk of perforation, and associated fetal and maternal morbidity and mortality. During pregnancy the reported fetal loss rate ranges from 2% to 3% for nonperforated appendicitis and 6% to 20% for perforated appendicitis [4−6]. These risks have led to a higher negative appendectomy rate in pregnant women (23%-50%) compared with nonpregnant women (14%-29%) and men (6%) [2,5−8]. Currently, the optimal imaging test or imaging algorithm for the diagnosis of appendicitis during pregnancy is controversial. The 2011 American College of Radiology Appropriateness Criteria designated ultrasound (US) of the right lower quadrant, with graded compression, as the initial investigation of choice; with magnetic resonance imaging (MRI) recommended following either negative or equivocal US [9]. The diagnostic accuracy of US for appendicitis during pregnancy varies considerably in the current literature. The rate of appendix visualization during pregnancy was 93% in Lim et al's [10] study [10] but was only 3%-12% in subsequent reports [11−13].

The potential advantages of MRI for diagnosis of appendicitis during pregnancy include excellent soft tissue contrast, anatomical detail, multiplanar imaging, and the absence of ionizing radiation exposure. Excellent diagnostic performance of MRI has been documented in numerous studies, with a recent meta-analysis of 6 studies reporting on MRI for diagnosis of appendicitis during pregnancy having a calculated sensitivity of 91% and specificity of 98% [14]. Currently, the most commonly accepted approach for the imaging of suspected appendicitis during pregnancy is to perform US as the first-line imaging test, followed by MRI if US is negative or inconclusive [9,14−16]. The objective of the current study was to evaluate the performance characteristics of MRI for the diagnosis of appendicitis during pregnancy at a Canadian centre. Our initial observations regarding utilisation of MRI for diagnosis of appendicitis during pregnancy was previously reported by Vu et al, and the current study updates our experience [17].

Methods

Patient Population

The study was a retrospective cohort study of consecutive pregnant women who underwent MRI for suspected appendicitis at St Paul's Hospital, Vancouver, BC, Canada between 2006 and 2012. Approval for conduct of this study was obtained from the Clinical Research Ethics Board of the University of British Columbia.

Imaging

All MRI scans were performed on a General Electric Signa HD 1.5T system (GE Healthcare, Milwaukee, WI). An 8-channel body coil was used. No oral or intravenous contrast was administered. The following sequences were used: axial and coronal T2-weighted fast recovery fast spin echo with parallel imaging using array coil spatial sensitivity encoding (ASSET) (echo time 100 ms, repetition time 2567 ms for axial and 3750 ms for coronal, 6-mm slice thickness, matrix 256 × 224, 38-cm field of view, and bandwidth 62.5 kHz), and axial and coronal T2-weighted steady-state free precession (fast imaging employing steady-state acquisition [FIESTA]) with fat saturation (echo time minimum/full, flip angle 75°, 6-mm slice thickness, matrix 224 × 224, 38-cm field of view, and bandwidth 83.33 kHz). Coronal cine FIESTA sequences and sagittal FIESTA sequences were added in some cases, at the discretion of the abdominal radiologist. All MR studies were read by one of three experienced staff abdominal radiologists (P.V., P.T., or C.J.H.). When US was performed in our department prior to MRI, a variety of different US machines were used. Scanning was generally performed by an US technician, sometimes with additional scanning by a resident, fellow, or staff radiologist. All studies were interpreted by a staff radiologist. In some cases, US scanning was carried out at a different hospital prior to transfer of the patient to our centre for surgical consultation.

Data Collection

The study patients were identified through a search of the radiology information system using the keywords *pregnant*, *gestation*, *appendicitis*, and *fetus*. The patient medical records were then retrospectively reviewed to obtain clinical data. US and MRI findings were obtained from the reports on the radiology information system. Specific information obtained from the MRI report included whether the appendix was visualized; appendiceal diameter (when seen); presence or absence of appendiceal inflammatory changes suggesting appendicitis; presence or absence of periappendiceal inflammatory changes; and any other relevant positive findings.

The MRI was considered diagnostic of appendicitis if the appendix was dilated (>7 mm), or if the appendix was normal in diameter (6-7 mm) with wall thickening or periappendiceal inflammatory changes (Figures 1 and 2). Appendicitis was excluded in the setting of a normal diameter appendix with no wall thickening or periappendiceal inflammatory change. Studies in which the appendix was not visualized but which showed focal inflammatory changes, such as fat stranding or free fluid that was confined to the region of the cecal pole, were classified as inconclusive.