

Should MRI Be the Imaging Modality of Choice in Suspected Appendicitis During Pregnancy?

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Abstracts

Aim

The aim of this review was to evaluate the efficacy of magnetic resonance imaging (MRI) in determining appendicitis during pregnancy.

Methods

We retrospectively reviewed the clinical course for all pregnant patients with suspected appendicitis from 2013-2018. We evaluated the efficacy of MRI and Alvarado scoring and its impact on management.

Results

Twenty-nine pregnant patients with suspected appendicitis had an MRI. The majority (90%, n=26/29) had normal diagnostics with two patients (10.3%) having findings consistent with acute appendicitis. Two other patients proceeded to laparoscopy, one with an inconclusive MRI, and one patient with clinical appendicitis. We found no accurate correlation between pregnancy and Alvarado scoring.

Conclusion

MRI is a safe adjunct in accurately diagnosing appendicitis in pregnancy. Its routine use could help reduce rates of negative appendectomies and the potential risk to maternal and fetal health.

Keywords: Pregnancy, Appendicitis, MRI, Emergency Surgery

Introduction

Acute appendicitis is the most common surgical emergency in pregnancy. Annually, acute appendicitis complicates between 1/750 to 1/1,000 pregnancies.¹ It is more frequent in the second trimester than in the first or third trimester.²

Diagnosis remains a clinical decision but is often supported with haematological and biochemical findings. However, with improved access to imaging, this can aid diagnosis, especially in borderline cases, such as the presence of significant co-morbidities or previous surgeries. Its use could also potentially reduce the rate of negative appendectomy (normal histopathology).

It is well accepted that in later pregnancy, with alterations in body habitus coupled with physiological changes that clinical assessment can be difficult. In addition, abdominal pain can be caused by other factors (constipation, round ligament tension, back pain, gallstones, or urinary tract infections).

Acute appendicitis is a serious complication and is associated with spontaneous abortion in the first trimester and premature delivery in the second trimester.³ Therefore, accurate and prompt diagnosis is essential to avoid any treatment delays that could result in harm to mother or foetus.^{4,5}

Several studies have observed that biochemical results are poor in diagnosing acute appendicitis.³ Historically, clinical diagnosis alone resulted in high negative appendectomy rates (23 - 37%).⁶ Contemporary studies have highlighted the benefit of radiological assessment with significant reductions in negative appendectomies^{7, 8} and improved detection of other pathologies. However, access to emergency magnetic resonance imaging (MRI) is difficult. The aim of this study was to evaluate the access and efficacy of MRI in pregnant patients presenting with clinical features of appendicitis. The combination of symptoms and clinical judgment in deciding which patient needs surgical treatment must be balanced with the need for imaging modalities to enhance diagnostic capabilities. Therefore, it is imperative to identify any means available to improve diagnostic accuracy, reduce rates of negative appendectomy and also reduce delays in operative intervention in those patients who require surgery.

The primary end point was to evaluate the efficacy of MR imaging in determining appendicitis in this pregnant cohort. The secondary endpoint was to determine the correlation between clinical parameters of appendicitis with imaging in pregnant patients in whom a clinical suspicion of appendicitis existed. The characteristics examined were; referral source, Gestational age, length of stay (LOS), Alvarado score, clinical impression and the use of other imaging modalities.

Methods

A retrospective review of pregnant patients presenting with a suspicion of acute appendicitis that had MRI evaluation between 2013-2018 was performed. Electronic patient records were reviewed and patient demographics, medical history, diagnostics, laboratory results and clinical management were assessed.

In our institution, all pregnant women were assessed for intra-abdominal pathology using a standardized MRI protocol that consists of axial and coronal contrast-enhanced fat-saturated T1 weighted imaging on a Philips Achieva 1.5 Tesla machine. One litre of Volumen contrast is consumed orally 3 hours prior to scanning. All scans are reported by a consultant radiologist.

Results

Twenty-nine patients had an MRI scan to specifically assess for the presence of acute appendicitis during pregnancy. Interestingly, the majority of referrals originated from our local maternity hospital, accounting for 79% (n=23/29) of the cohort. Other sources of referrals were self-presentation to the emergency department (7% n=2/29) and from general practice referrals (14% n=4/29).

Table 1. WCC and CRP trend.

Imaging	Normal WCC	Elevated WCC (Mean level)	Normal CRP	Elevated CRP (Mean level)
Normal MRI	17	10 (15.2)	11	16 (48.6)
Appendicitis on MRI	0	2	0	2

The median age was 29 years (23-35) with the majority of women assessed being in their 2nd trimester (62%, n=18/29). Seventeen (59%) patients had initial ultrasound imaging, followed by MRI scan. The time difference between US+MRI versus straight to MRI was on average 180 minutes.

Twenty six (90%) patients had a normal MRI scan, with two patients having radiological confirmation of acute appendicitis. Both patients having confirmation of acute appendicitis on imaging proceeded to surgical management (one patient had a laparoscopic and the other had an open appendicectomy). In addition, one patient with an inconclusive MRI scan, but with high clinical suspicion for appendicitis had a diagnostic laparoscopy and appendicectomy. Histology confirmed appendicitis in all cases managed operatively. Median length of stay for the those managed surgically versus those with normal MRI was 3.1 days versus 1.4 days respectively.

Table 2. Availability of MRI in maternity Hospitals.

Hospital	MRI on site?
Coombe	No
Holles Street	Yes
Rotunda	No
Cork University	Yes
Kerry General (Tralee)	Yes (Private onsite - Alliance Medical)
South Tipperry	Yes (Private onsite - Alliance Medical)
St Luke's (Kilkenny)	No
Waterford	Yes
Wexford	No (Private offsite - Alliance Medical)
Galway	Yes
Letterkenny	Yes
Mayo	Yes
Portiuncula (Ballinasloe)	Yes (Private onsite - Alliance Medical)
Sligo	Yes
Limerick	Yes (University Hospital Limerick)
Cavan/Monaghan	Yes
Drogheda	Yes (Private onsite - Alliance Medical)
Midlands (Mullingar)	No
Midlands (Portlaoise)	Yes (only in last 2 months)

On review of laboratory findings, 10 patients had an elevated white cell count (WCC) and 16 patients had an elevated C-Reactive protein (CRP) level in the presence of a normal MRI scan. (Table 1).

On reviewing the use of the Alvarado scoring system in pregnant patients, we found considerable spread in the score across the cohort of patients. 55.2% (n=16) had a normal Alvarado score, 34.5% (n=10) had a score of 5-6, 10.3% (n=3) had a score of 7-8, and no patients had a score of 9-10. This suggests Alvarado scoring provides limited diagnostic accuracy in the pregnant cohort.

Table 3. Advantages and disadvantages of imaging modalities.

Imaging Technique	Major Advantages	Major Disadvantages
Ultrasound	Cost, accessible, safe	Limited by body habitus, operator dependent , high rate of non visualization
CT	Highly sensitive and specific	Ionising radiation
MRI	Highly sensitive and specific	Costly, not accessible in all centres, technical

Discussion

To date there is no national or international consensus for the best diagnostic approach in pregnant patients presenting with signs and symptoms of acute appendicitis. To the best of our knowledge, this is the first series to report on an institutional experience of healthcare provision to pregnant patients with suspected appendicitis in Ireland. Furthermore, there are no robust national guidelines regarding imaging in suspected appendicitis during pregnancy.

In order to identify services available, we contacted the radiology department and obstetrics teams in the 19 maternity hospitals via telephone to determine if MRI imaging was available in their institution. Details are available in table 2.

During the telephone conversation, we sought to identify if there was access to another institution for this imaging modality for those without direct access to MRI. In the case of the Coombe, St. James's hospital was identified as the axillary hospital, for the Rotunda it was the Mater, for Mullingar it was the Midland Regional Hospital in Tullamore and for St. Luke's, St. Vincents was identified as the axillary hospital.

In the series by Mc Gory, it was found that the rate of negative appendectomy was considerably higher in pregnant compared with nonpregnant women - 23% vs 10%.⁹ Lemmieux reported even higher rates of negative appendectomy in pregnancy – up to 35%. They demonstrated that both perforated appendicitis, and negative appendectomy during pregnancy are associated with a high risk of premature delivery.^{10,11}

The American College of Radiology Appropriateness Criteria (2011) deemed that ultrasound with graded compression should be the initial imaging modality of choice in this cohort of patients, reserving MRI when visualization of appendix is difficult.^{12,13}

The main finding is the identification of a non-compressible, blind-ended tubular structure in the lower right quadrant. In such cases, ultrasounds can reveal the possible cause of the patient's symptoms (e.g. ovarian cyst or torsion, degeneration or torsion of myoma, nephrolithiasis, cholecystitis).

However, ultrasound is operator dependant and rates of non-visualization of the appendix remains alarmingly high (65-97%), with potential delay in diagnosis.¹⁴

CT imaging while it can reduce the rate of negative appendectomy¹⁵, is not a favourable imaging modality due to ionizing radiation and the potential teratogenic and carcinogenic effects on the developing foetus. (Table 3)

It is widely reported that MRI has increased sensitivity and specificity in the setting of acute appendicitis in pregnancy (80–100% and 93–98%, respectively).¹⁶ Spalluto *et al* recommends that all pregnant women therefore should have an MRI when presenting with abdominal pain due to multiple confounding factors of pregnancy.¹⁷ The use of prompt MRI in this cohort has been shown to reduce rates of both negative laparotomy and perforation. Additionally, MRI frequently identifies alternative diagnosis for abdominal pain when appendicitis is not present.¹⁸

However, access to MRI is not available in all centres and furthermore, it is not available out of hours routinely, and therefore the use of clinical acumen must come to the fore in these scenarios. In our institution, those suspected to have appendicitis were categorised as high priority and hence avoided delay in access to the imaging modality. Those with MRI confirmed appendicitis (n=2) were transferred to theatre and operated on within two hours of diagnosis. A consultant surgeon performed the surgery and a Consultant Obstetrician was present should an obstetric emergency arise.

It is likely that the gain for fetal outcome in the future lies in the diagnostic pathway rather than the type of surgery performed. Abdominal pain continues to pose a difficult dilemma in pregnancy with the potential consequences of a missed diagnosis of appendicitis catastrophic. Similarly, operative intervention in this cohort can have detrimental consequences on maternal and fetal outcomes.

The use of MRI in pregnant women presenting with abdominal pain to our institution provided accurate and prompt diagnosis in 97% of patients. Its routine use would substantially reduce unnecessary surgical procedures, while ensuring accurate diagnosis.

Declaration of Conflicts of Interest:

All authors declare no conflict of interest.

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