Magnetic Resonance Imaging Versus Ultrasound as the Initial Imaging Modality for Pediatric and Young Adult Patients With Suspected Appendicitis

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DAN MOORE, MS4, RADY JOURNAL CLUB 7/7/20
Learning Objectives

- By the end of this journal club, participants will:
  - Know the epidemiology, pathophysiology, and etiology of appendicitis
  - Be familiar with the different presentations of appendicitis
  - Be able to assess different imaging modalities in the approach to pediatric abdominal pain
Module Outline

I. Case
II. Background
III. Article Overview
IV. Clinical Questions
V. Key Points
9 yo F with no significant PMH presents to UNC ED with 12 hour history of increasing abdominal pain. Also complains of low-grade fever, nausea, vomiting, and anorexia

BP 107/55, Pulse 110, T 100.8, RR 24, SpO2 100%

Physical exam is remarkable for RLQ pain with guarding and rebound tenderness present
Case questions

1. What is your differential diagnosis for increasing abdominal pain in 9 yo F?
2. What labs and imaging studies would you order?
3. Next steps?
Case

- Patient underwent targeted ultrasound
  - Diagnosis: appendicitis
- Treatment
  - Laparoscopic appendectomy
Case – Questions to Consider

- When should you suspect pediatric appendicitis?
- What should guide your preferred imaging modality when appendicitis is high on your differential?
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Case

- Epidemiology
  - Annually, up to 250,000 cases of appendicitis are reported. The estimated lifetime risk is 12% for males and 25% for females. Although appendicitis can occur at any age, it most commonly occurs between the ages of 10 and 19 years.¹

- Pathophysiology
  - Luminal obstruction and continued appendiceal mucous production leads to luminal distension and eventual rupture of the appendix
Case

- Symptomatology
  - Classically periumbilical pain that migrates to McBurney point
  - Can also present with pelvic, flank, RUQ and LLQ pain depending on anatomical position
  - Fever, nausea, vomiting, diarrhea, anorexia
- Physical Exam
  - Rebound tenderness in RLQ
  - Psoas/Rosving/Obturator sign
- Lab Findings
  - Elevated WBC count
- Etiology
  - Appendicitis in children is usually caused by lymphoid hyperplasia
  - In children it can rarely also be caused by fecaliths and other obstructing masses
Imaging Modalities:
- Ultrasound: Incompressible, >6 mm thickened appendix
  - Low-cost
  - No ionizing radiation exposure
  - Limited by habitus
  - Operator-dependent
- MRI
  - Higher cost
  - More time required
  - Need MRI-trained radiologist
  - MRI not always available
- CT
  - Most common imaging ordered prior to surgery
  - Concern for radiation exposure
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Purpose: A study of rapid MRI as a first-line imaging evaluation of suspected pediatric appendicitis

Journal: Journal for the American Academy of Emergency Medicine (JEM)

Study Type: Prospective randomized cohort trial of 82 patients ages 2-30 with suspected appendicitis
Material and Methods

- Imaging modalities: Initial rapid MRI vs. US with rapid MRI if needed
- If the physician decided to obtain radiologic imaging, the predetermined imaging modality for the day of the week was used.
- Time intervals (minutes) between triage, order placement, start of imaging, end of imaging, image result, and disposition (discharge vs. admission), as well as total charges (diagnostic testing, imaging, and repeat ED visits) were recorded.
Results

- Over a 100-day period, 82 patients were imaged to evaluate for appendicitis;
- 45 of 82 (55%) of patients were in the US-first group (median age 12.3)
- 37 of 82 (45%) patients were in the rapid MRI-first group (median age 13.5)
- 11 of 45 (24%) of US-first patients had inconclusive studies, resulting in follow-up rapid MRI and five return ED visits contrasted with no inconclusive studies or return visits (p < 0.05) in the rapid MRI group.
- The rapid MRI compared to US group was associated with longer ED length of stay (mean difference = 100 minutes; 95% confidence interval [CI] = 35–169 minutes) and increased ED charges (mean difference = $4,887; 95% CI = $1,821–$8,513).
175 Study Patients

82 Eligible Patients

37 (45%) Rapid MRI

9 (24%) Positive appendicitis

6 (16%) Negative appendicitis with secondary radiologic diagnosis

- 3: Proctitis
- 1: Ovarian cyst
- 1: Ovarian teratoma
- 1: Pyelonephritis

22 (60%) Negative appendicitis

45 (55%) Ultrasound

11 (24%) Positive appendicitis

21 (47%) Negative appendicitis

13 (29%) Non-diagnostic for appendicitis

11 (85%) Follow-up rapid MRI

2 (18%) Radiologic diagnosis

- 1: Septic arthritis
- 1: Acute cholecystitis

9 (82%) Negative

93 Excluded Patients

- Appendicitis was not the primary differential diagnosis (n:40)
- Study protocol was not followed (n:35)
- Patient was too young to tolerate imaging modality – all rapid MRI (n:13)
- Imaging modality was not available - broken or lack of technical support staff (n:3)
- Imaging had previously been performed (n:2)
Discussion

- Rapid MRI
  - Increased cost
    - Charged as a full MRI A/P
    - Similar in cost to CT A/P
    - US group had more return visits, though was not significant compared to increased cost of MRIs
  - Longer wait times between when imaging is ordered and when it is performed
    - Due to time spent in MRI patient screening, patient transport, and in wait for MRI availability
Ultrasound continues to be gold standard first line imaging for suspected pediatric appendicitis

Consider issues with US (body habitus) on deciding when to move straight to rapid MRI or CT

Rapid MRI has potential to rival ultrasound if availability and cost come down in the future

- Given increased access and specificity/sensitivity nearing 100%
- Remaining barriers include MRI screening time and patient transport
Study Limitations

- Time, resource availability, and differences in charges vary institutionally and therefore can’t be generalized.
- Disproportionate female representation in study (66% in US, 70% in MRI) which may be due to provider bias.
- POC ultrasound was not included as a modality in the study.
- Cost effectiveness of incidental MRI findings was unable to be included in the study.
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Clinical Questions

- When is H&P enough to proceed without imaging?
- When should ultrasound be used to evaluate suspected pediatric appendicitis?
- What factors might lead you to pursue further imaging?
- How do you decide whether to incorporate these findings into your own clinical practice?
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Key Points

- Appendicitis should always be on the differential in rapidly increasing pediatric abdominal pain.
- Ultrasound is your friend; don’t hesitate to use it as an additional diagnostic tool!
- If ultrasound is negative, reconsider patient’s clinical picture before proceeding with more imaging.
References


5. Imler, Daniel, et al. “Magnetic Resonance Imaging Versus Ultrasound as the Initial Imaging Modality for Pediatric and Young Adult Patients With Suspected Appendicitis.” AAEM, 24 Apr. 2017