MRI for First-Line Evaluation of Children Suspected of Having Acute Appendicitis

Jonathan R. Dillman, MD, MSc  •  Andrew T. Trout, MD

From the Department of Radiology, Cincinnati Children’s Hospital Medical Center, 3333 Burnet Ave, Cincinnati, OH 45229; and Department of Radiology, University of Cincinnati College of Medicine, Cincinnati, Ohio. Received January 8, 2019; revision requested January 11; final revision received January 16; accepted January 16.

Address correspondence to J.R.D. (e-mail: jonathan.dillman@cchmc.org).

Conflicts of interest are listed at the end of this article.
See also the article by Mushtaq et al in this issue.

Acute appendicitis remains the most common abdominal surgical emergency in the pediatric population. Imaging in children and adults suspected of having acute appendicitis allows more timely diagnosis and decreases the negative appendectomy rate (1). US, CT, and, increasingly, MRI are used to successfully assess children suspected of having acute appendicitis and to identify alternative sources of abdominal pain (2–5). Each of these modalities “may be appropriate” as a first diagnostic test in pediatric patients with intermediate or high clinical risk of acute appendicitis (6). However, for children, there is a paucity of literature describing the diagnostic performance of MRI as the first-line imaging modality.

In the current issue of Radiology, Mushtaq et al (7) describe the clinical effectiveness of noncontrast MRI as the first-line imaging test for the evaluation of children (18 years of age and younger) suspected of having appendicitis at a single medical center. In 402 patients, approximately 25% of whom had appendicitis, noncontrast MRI had a sensitivity of 97.9%, a specificity of 99%, and an accuracy of 98.8%. Importantly, among the approximately 75% of patients without appendicitis, an alternative cause for the patients’ symptoms was identified in more than one-third, thereby providing a diagnosis in approximately 50% of imaged patients. The authors rightfully conclude that “when performed as the initial imaging modality in children suspected of having acute appendicitis, MRI examinations had high diagnostic performance for the diagnosis of acute appendicitis and in providing alternative diagnoses” (7).

Although the study was slightly limited by the selection of the population (268 patients were excluded because they underwent CT or US as a first-line imaging examination, and 379 were excluded because of a lack of follow-up documented in the medical record), these limitations are unlikely to substantially impact the main study conclusions.

The MRI protocol described by Mushtaq and colleagues allows free breathing and requires no oral or intravenous contrast material administration. The protocol included nine pulse sequences, but the median total imaging time was only 21 minutes. The free-breathing MRI combined with the short overall examination time likely contributed to the fact that 97% of examinations could be performed without sedation. The authors suggest that similar results are possible regardless of whether the examination is performed at a field strength of 1.5 or 3.0 T and that these examinations can be accurately interpreted by diagnostic radiology trainees (with 94% absolute agreement between resident and attending radiologists). Overall, the protocol used appears (a) robust, using commonly available pulse sequences; (b) generalizable across MRI unit manufacturers; (c) patient and technologist friendly; and (d) likely to perform well in patients of all ages (including adults) and in a variety of clinical practice environments.

The results of the current study add to a growing body of literature supporting the role of MRI for evaluating pediatric appendicitis. Previously, Orth et al (8) prospectively compared US and noncontrast MRI (with six pulse sequences) in 81 pediatric patients suspected of having acute appendicitis and concluded that MRI demonstrated high diagnostic performance (with a sensitivity of 93%, a specificity of 98%, and a negative predictive value of 96%, when treating equivocal interpretations as positive). In a clinical effectiveness study by Dillman and colleagues (3), noncontrast MRI (with four pulse sequences) was performed in 103 awake children suspected of having acute appendicitis who had previously undergone an equivocal US examination. MRI was found to have a sensitivity of 94% and a specificity of 100%, and an alternative cause of abdominal pain was established in nearly 20% of patients. More recently, two meta-analyses have been performed to assess the diagnostic performance of MRI for pediatric appendicitis. A meta-analysis by Moore et al (5) of 11 studies found a pooled sensitivity of 96%, specificity of 96%, and negative predictive value of 98%. Another meta-analysis by Eng et al (9) specifically assessed the diagnostic performance of MRI after an initial inconclusive US. On the basis of five studies, the pooled sensitivity of MRI was 97% and the pooled specificity was 97%.

This growing body of literature suggests that both MRI and CT likely have similar diagnostic performances as primary modalities and second-line (after US) modalities for suspected appendicitis in children. Although the diagnostic performance of US is lower than that of both CT and MRI, US is likely to remain the dominant first-line imaging modality at centers experienced in its use, in part for cost and accessibility reasons. Outside of centers using US, or MRI as a second-line modality, the use of MRI for pediatric appendicitis is increasing. Some of this trend may reflect the perceived advantages of MRI over CT, including the lack of ionizing radiation...
and no need for intravenous or oral contrast material. These advantages, however, are debated, with the American Association of Physicists in Medicine stating that there is no statistically significantly increased risk of cancer based on a single CT examination, and with some practices advocating the use of intravenous gadolinium-based contrast material for MRI of pediatric appendicitis (10).

Irrespective of the potential advantages, not all practices can, or may want to, implement MRI for pediatric appendicitis. Availability of MRI at all hours and within a reasonable time frame from the clinical order remain challenges at many institutions. Even in the current study, where a concerted effort was made to use MRI for appendicitis, the median time from order to preliminary report was 2 hours 52 minutes. This included the median 21 minutes of imaging time, which is markedly longer than the average CT acquisition (which takes only seconds). Cost also remains a potential barrier to implementation of MRI.

The relative advantages of one imaging modality over another and workflows driving modality selection are relevant to the current state of imaging of pediatric appendicitis. There are multiple very good and reasonable alternative imaging approaches, each of which is supported by the literature. Therefore, the best diagnostic strategy for children with right lower quadrant abdominal pain who are suspected of having appendicitis will ultimately emphasize the strengths of your department. In our opinion, US, CT, and noncontrast MRI are all appropriate first-line imaging tests for assessing suspected pediatric appendicitis.

Disclosures of Conflicts of Interest: J.R.D. disclosed no relevant relationships. A.T.T. Activities related to the present article: disclosed no relevant relationships. Activities not related to the present article: a representative of the American College of Radiology, is an unpaid member of the board of the Joint Review Committee on Educational Programs in Nuclear Medicine Technology; is a consultant for Guerbet Group; has a grant from Siemens Medical Solutions; institution has grants or grants pending from Canon Medical Systems; is on the speakers bureau of Applied Radiology; receives royalties from Reed Elsevier and Wolters Kluwer. Other relationships: disclosed no relevant relationships.

References