Decline in Abdominal CT Utilization Rates for Emergency Department Diagnosis of Appendicitis after Implementation of a Focused MRI Protocol

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Introduction

Acute appendicitis is a common pediatric surgical emergency. Although diagnosis of appendicitis can be made by clinical symptoms, imaging may be required when the clinical picture is not clear. Ultrasound (US) and computed tomography (CT) have been the primary imaging tools used to confirm or exclude the diagnosis of appendicitis; however, use of US can be complicated by non-diagnostic studies. Magnetic resonance imaging (MRI) is sensitive and specific for the diagnosis of appendicitis in children.

Abstract

Background: Ultrasound (US) and computed tomography (CT) have been the primary imaging tools used to confirm or exclude the diagnosis of appendicitis; however, use of US can be complicated by non-diagnostic studies. Magnetic resonance imaging (MRI) is sensitive and specific for the diagnosis of appendicitis in children.

Objective: To assess whether a decrease in ED CT utilization rates to evaluate for appendicitis would be achieved with the implementation of a MRI protocol.

Materials and Methods: We retrospectively compared rates of ED CT utilization for pediatric patients aged 3-21 years with suspected appendicitis over an 18-month period prior to adoption of ubiquitously available dedicated appendiceal MRI protocol (7/2008-12/2009) with those from an 18-month period following adoption of the protocol (7/2012-12/2013). Frequency of abdominal CTs done for the evaluation of appendicitis in the early and late time periods were compared via Chi-squared test.

Results: In the early period, 94/175 (53.7%) of abdominal CTs were done to rule out appendicitis. In the late period, 55/147 (37.4%) of abdominal CT’s were done to rule out appendicitis. X² test showed a significant decrease between early and late abdominal CT usage to evaluate appendicitis (p= 0.005). Abdominal CTs ordered for indications other than ruling out appendicitis increased by 13.8% during the same time period.

Conclusion: Availability of an MRI protocol to diagnose appendicitis decreased use of abdominal CT scans, thereby decreasing radiation exposure in children with abdominal pain concerning for appendicitis in an ED setting.

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Material and Methods

A retrospective review of CT use in the evaluation of appendicitis prior to and following the adoption of an MRI protocol was performed.

Protocol development

The MRI protocol was developed in conjunction with radiology to image children with suspected appendicitis. Five millimeter slices of the right lower quadrant are obtained using an 8 minute non-contrast study on a 1.5 Tesla magnet. This protocol was trialed and then adopted from January 2010 to June 2012, during which time MRI was used only following an equivocal ultrasound or a negative ultrasound but high suspicion for appendicitis. After the protocol adoption phase (starting 7/2012), the choice of imaging studies was left up to the clinician. Sedation is not used.

Data collection

We obtained rates of ED CT utilization over an 18-month period prior to the trial of the dedicated appendiceal MRI protocol (7/2008-12/2009) and those from the 18-month period following adoption of the protocol (7/2012-12/2013). All abdominal CTs for patients aged 3-21 years were identified for each time period and patient charts and radiology requisitions were reviewed by an emergency medicine resident, medical student, or pediatric emergency medicine attending physician, after training by a principal investigator, to determine the indication of the study. They were categorized as either performed for the evaluation of acute appendicitis or performed for evaluation of another etiology. The latter group primarily contained CTs performed as part of a trauma evaluation. No changes to the medical center’s trauma protocols, catchment area, or accreditation occurred during these time periods.

Statistics

Descriptive statistics are reported. Frequency of CT scans done in the evaluation of appendicitis in the early and late time periods were compared via Chi-squared test.

Results

The pre-protocol group contained 175 patients with a mean age of 18.5 years (range 8-21 years), and was comprised of 63% males and 37% females. In this group, 94/175 (53.7%) of abdominal CTs were done to rule out appendicitis. In the post-protocol period, 147 patients were identified with a mean age of 17.5 years (range 4-21 years). Males comprised 59% of this group. Post-protocol, 55/147 (37.4%) of abdominal CTs were done to rule out appendicitis. X² test showed a significant decrease between early and late abdominal CT usage to diagnose appendicitis (p = 0.005). Overall, this represented a 41.5% decline in the number of pediatric CT scans for the evaluation of appendicitis and an overall decrease in the total number of abdominal CT scans performed on children aged 3-21 years. Concurrently abdominal CTs ordered for indications other than suspected appendicitis increased by 13.6% during the same time period (Figure 1), resulting in an overall decrease of 16%. While it is possible that some patients were recognized to be poor MRI candidates in the ED, there was no documentation of cancelled studies due to patient intolerance nor of deferring of a study pending sedation.

Discussion

Overall CT utilization for children has increased during the past 2 decades [13,14]. In girls, a radiation-induced solid cancer is projected to result from every 300-390 abdomen/ pelvis CTs [14]. This underlines the importance of limiting CT use in children whenever possible. Our study shows a reduction in the rate if CT use when a ubiquitously available MRI protocol was implemented. MRI availability is one strategy among many to reduce ionizing radiation exposure in children undergoing evaluation to rule out appendicitis.

Certain populations may be subjected to a disproportionate rate of CT imaging; thus benefitting more from an alternative option. Burr et al found that patients who presented during nighttime hours with symptoms of appendicitis were more likely to have a CT performed [15]. Obese patients with suspected appendicitis receive CT scans at a rate 3-4 times higher than their normal weight counterparts [16,17]. Children who present to hospitals not dedicated to the care of children are more likely to have CT imaging performed [7,18-20].

The practice of US followed by MRI if US yields equivocal results has been demonstrated not to change time to antibiotic administration, length of stay, perforation rates, or negative appendectomy rate compared with CT scanning [21]. In our institution, we use US as the primary imaging modality. However, use of US has historically led to subsequent CT imaging in over half of patients, given frequent inconclusive ultrasound results [22,23]. Our study, which substituted MRI for CT as the secondary imaging modality, reduced the rates of CT down by 16% overall, a far greater decrease than the 6% decline in pediatric CT use that national studies have demonstrated recently [24]. MRI availability and established protocols may empower acute care physicians throughout the United States to avoid use of CT imaging in pediatric patients undergoing evaluation of appendicitis.

General emergency medicine physicians order CT scans more frequently than their pediatric emergency medicine colleagues without an increase in diagnosis of appendicitis or rates of surgery [25].

Limitations

This is a retrospective study focusing on CT utilization. Clearly, clinical factors may impact the decision to obtain imaging. Clinical scoring systems, evaluation by a surgeon, and laboratory testing...
can help reduce CT usage in children with suspected appendicitis [18,26]. However, no protocols or changes were made between the time frames to encourage or discourage the use of these modalities. Cost of MRI is more than that of CT imaging, and this may be a factor in widespread use of MRI. Obtaining an MRI from the ED may not be possible in all practice settings, particularly for young children. While we had no studies canceled due to agitation, the population studied had a mean age in late adolescence. Had more young children undergone MRI, more refusals might have been noted in the preschool and school-age children.

**Conclusion**

Institution of an MRI protocol to diagnose appendicitis was associated with a decrease in the use of abdominal CT scans, thereby decreasing radiation exposure in children with abdominal pain concerning for appendicitis in an ED setting.

**References**