Is ultrasound first the correct approach for pediatric appendicitis in a community hospital?

R. Haj, D.O.[1], K. Leneweaver D.O.[1], E. Kessler M.D. [1,2]

[1]Flushing Hospital Medical Center, Department of Surgery, Flushing, New York
[2]Weill Cornell Medical Center, Depertment of Pediatric Surgery, New York, New York

Introduction

Increasing concern for pediatric radiation exposure from utilization of CT scanning has led to a concerted effort to decrease exposure for common pediatric conditions.[1,2] An estimated 1,730 neoplasms in the US are attributable to pediatric radiation exposure.[4] Centers have reported up to 50% of patients obtaining a CT prior to proceeding to the OR.[5] Evaluation for appendicitis accounts for approximately 5-10% of all pediatric ED visits. With a renewed focus on reducing radiation exposure in the pediatric population this has led to the development of an "ultrasound first" approach.[1] However, in the community hospital setting nondiagnostic ultrasound rates are reported as high as 74%.[3] Given this information we performed a retrospective evaluation at our own community hospital to evaluate the diagnostic accuracy of U/S of pediatric patients presenting with signs of appendicitis. The goal is to assess the need for any change in practice norms to reduce radiation exposure in our pediatric population.

Methods

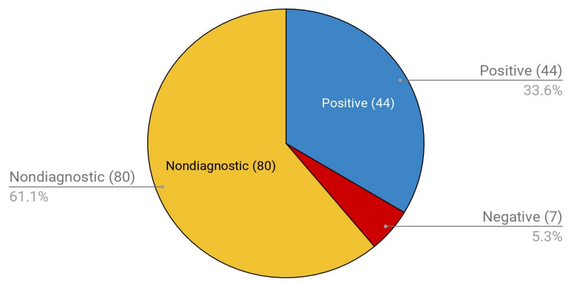
This study is a retrospective cohort conducted at our community hospital in NY. Patients were identified from December 1, 2012-December 31, 2017 using the EPIC EMR review of pediatric patients (<18 years old) who underwent abdominal ultrasound for abdominal pain. Patients were excluded if US was performed as an outpatient or for other intra-abdominal pathology. In total 169 patients were identified 38 were excluded and 131 patients were evaluated via chart review for the study. All U/S performed were based on standard department protocol utilizing a 6-15 Mhz linear-array probe with classic graded compression technique. U/S were reviewed by board certified radiologist and imaging was finalized as acute appendicitis, negative appendicitis, or appendix not visualized. Secondary signs of appendicitis were not recorded during U/S evaluation.

A Pediatric Appendicitis Score (PAS) was determined based on the patient's initial surgical consult note, ER physician documentation, and H&P. Fever was determined based on documented fever (>38C) on day of admission and WBC count determination (>10,000) and Absolute Neutrophil Count (ANC; >7,500) were based on CBC results on day of admission. Computed Tomography results were recorded as positive for appendicitis, negative for appendicitis, or not performed. All reports were confirmed by a board certified radiologist. Patient outcome was documented based on intervention whether surgical, drainage by Interventional Radiology, or no surgical intervention. Diagnosis at discharge was recorded as well as any pathology results as reported by a board certified pathologist when available.

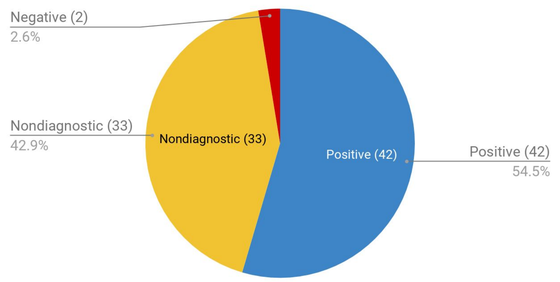
Data

One hundred and thirty-one patients who underwent ultrasound evaluation for possible appendicitis were reviewed. Seventy-five (57.3%) were male and 56 (42.7%) female with an average age of 10 years old (range 3-18 years). At presentation, the average PAS score was 4. Seventy-seven (58.8%) of the patients had a PAS greater than 3, an indication for further imaging. The PAS score was less than 4 for 6 (4.62%) patients who were later determined to have appendicitis based on further imaging or pathology.

Final Ultrasound Report (Fig. 1)



Ultrasound Result of PAS >3 (Fig. 2)

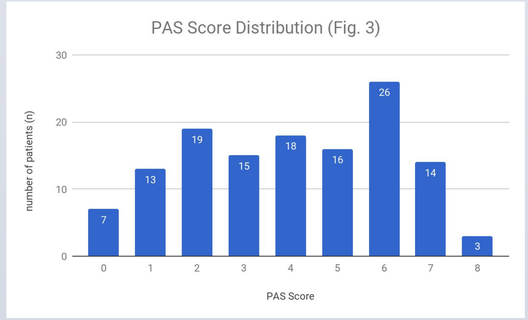


Non-appendicitis Diagnosis Undergoing Ultrasound (table 1)

Diagnosis	N	percent
Unspecified abdominal pain/no clear diagnosis	21	16.03%
Gastroenteritis/gastritis	10	7.63%
Constipation	9	6.87%
Mesenteric adenitis	6	4.58%
Gynecologic source (ovarian cyst, middleschmertz)	3	2.29%
Cholecystitis	1	0.76%
Small Bowel Obstruction	1	0.76%
Transfer to Outside Institution	3	2.29%
Total	54	41.22%

Of the 131 ultrasounds, 44 (33.5%) demonstrated acute appendicitis, 7 (5.34%) no appendicitis, and 80 (61.1%) were nondiagnostic. Follow up CT scan was obtained for 47 (35.8%) patients of which 38 (29.0%) had nondiagnostic ultrasound. Twenty-six (19.8%) had appendicitis diagnosed by CT while 11 (8.4%) had appendicitis ruled out by CT.

PAS Score Distribution (Fig. 3)



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Discussion

The utilization of ultrasound at our institution is quite high despite low diagnostic utility. Furthermore, many ultrasounds were not followed with CT scans either due to low clinical suspicion, resolution of symptoms, or missed diagnosis. Well validated scoring systems for imaging in appendicitis such as PAS would limit unnecessary ultrasounds and subsequent CT scans. In our study, following PAS recommendations would have reduced the number of ultrasounds by 71 (54%). Fifty-four (41.2%) due to low PAS scores. However, the PAS score mischaracterized 6 (4.6%) patients; ultrasound was diagnostic for only 2 patients. This is similar to values in prospective validation studies that found a false negative of 1.1 - 4.5%[6,7] utilizing PAS scores.

Similarly, patients with high PAS scores >7 may not warrant any imaging prior to proceeding to the OR. This would further reduce the number of ultrasounds by 17 (12.9%). Fifteen of the 17 children had pathology proven appendicitis with 2 children transferred due to pediatric surgeon availability, therefore, final pathology was not available. Shah et. al. (2016) states that advantages of the direct to OR approach may be justified by decreased wait times and imaging, but it was noted the negative appendectomy rate increased from 5.6% to 8.7% (p=0.09).[7]

Limiting radiation exposure is important for the pediatric population. Ten children with diagnostic ultrasounds also underwent CT scans. Nine had positive ultrasounds and one had a negative ultrasound. These CT scans would be avoidable if an algorithmic approach to diagnosing appendicitis was used in conjunction with PAS score in which a positive ultrasound is an indication to proceed to the OR, while a negative ultrasound does not require further workup of appendicitis. Improving diagnostic technique and partnering with higher volume pediatric hospitals may also provide additional training opportunities to assist ultrasound technicians in gaining experience in obtaining views of the appendix further limiting the need to proceed to CT scanning due to a nonvisualized appendix.

Conclusion

Utilization of a scoring system would decrease unnecessary ultrasound utilization, increase diagnostic yield by excluding low probability patients, and potentially avoid excessive CT scans through a standardized approach. Implementation of such an algorithm would have limited increase in missed diagnosis with cost savings.