An Audit of Ultrasound Performance in Diagnostic Appendicitis in the Emergency Setting at a Pediatric Tertiary Hospital

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Background

Clinical audits are essential tools in radiology for enhancing the quality of care and ensuring patient safety. By systematically reviewing current practices against established standards, audits can identify gaps and suggest improvements. This study focuses on a retrospective audit of pediatric patients who underwent ultrasound imaging for suspected appendicitis. The aim was to correlate ultrasound findings with pathology-proven surgical outcomes to assess the diagnostic accuracy of ultrasound in this context. Understanding the performance of ultrasound in diagnosing appendicitis in children is crucial, given its non-invasive nature and wide availability. The findings from this audit can help refine current practices and improve diagnostic reliability, ultimately contributing to better patient care.

Study Design

A retrospective review was conducted from September 25 to December 31, 2023, to assess the diagnostic accuracy of ultrasound for pediatric patients with suspected appendicitis. Radiology reports were filtered using informatics software to identify those mentioning “appendix,” “appendicitis,” or related terms. Data were manually extracted from patient charts and compiled into an Excel spreadsheet for further analysis. Patients were classified into categories: True Positive (TP), False Positive (FP), True Negative (TN), False Negative (FN), and "Not Applicable" (NA), based on ultrasound findings and subsequent surgical outcomes. A 2x2 contingency table was constructed to calculate sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of ultrasound for diagnosing appendicitis. Further analysis was conducted on false-positive cases to explore common ultrasound findings and identify factors contributing to false-positive diagnoses. The audit also reviewed opportunities for improving clinical practice by correlating ultrasound findings with clinical scores, such as the Pediatric Appendicitis Score (PAS) and Appendicitis Risk Calculator (pARC), and standardizing radiology reporting.

Age	Gender 1=M 2=F	Appendicits on Ultrasound 1=Y 2=N	Appendix Seen 1=Y 2=N	Surgery Done 1=Y 2=N	Appendicits Confirmed 1=Y 2=N	Patient Classification
14	1	2	2	2		NA
9	2	2	2	2		NA
11	1	2	1	2		NA
11	1	2	2	2		NA
9	2	1	1	2		NA

Figure 1: Snapshot of excel spreadsheet

Patient Classification Categories
True positive (TP): Patient had positive appendicitis on ultrasound, and positive appendicitis on pathology *Patients with initially negative ultrasound, followed by positive ultrasound within 24 hours, or positive appendicitis on follow-up cross-sectional imaging were counted as (TP)*
False negative (FN): Patient had "normal appendix" or "appendix not visualized" but positive appendicitis on pathology
False positive (FP): Patient had positive appendicitis diagnosis on ultrasound, but normal appendix on pathology
True Negative (TN): Patient had "normal appendix" or "appendix not visualized on ultrasound" and normal appendix on pathology
NA category: 1. Patient had "appendix not visualized" on ultrasound and did not have surgery 2. Patient had normal appendix on ultrasound and did not have surgery 3. "Appendix" mentioned incidentally/part of routine evaluation/no concern for appendicitis 4. Positive appendicitis on ultrasound but conservatively managed (no surgery) 5. Other pathology seen on ultrasound (not appendix related) 6. Ultrasound findings "equivocal" for acute appendicitis

Figure 2: Patient Classification Categories

Results

Diagnostic Performance of Ultrasound:

- Sensitivity: 98.9% – Ultrasound has a high sensitivity for diagnosing appendicitis in pediatric patients, effectively identifying most true cases.
- Specificity: 50% – The specificity is relatively low, indicating a significant rate of false positives where ultrasound suggests appendicitis when it is not present.
- Positive Predictive Value (PPV): 93.9% – A high PPV reflects that when ultrasound indicates appendicitis, there is a strong likelihood that the diagnosis is accurate.
- Negative Predictive Value (NPV): 85.7% – A moderate NPV suggests that when ultrasound does not indicate appendicitis, there is a reasonable certainty that the condition is absent.

Classification of NA Cases:

A pie chart (Figure 4) categorizes patients who had ultrasounds but did not undergo surgery, providing insights into varied clinical scenarios such as incidental findings, conservative management, or equivocal ultrasound results.

Analysis of False Positive Cases:

All false-positive cases met 2-3 criteria for acute appendicitis on ultrasound (Figure 5). Common findings included an enlarged appendix diameter (ranging from 6.9 mm to 10 mm), fat stranding, hyperemia, and the presence of appendicolith or free fluid.

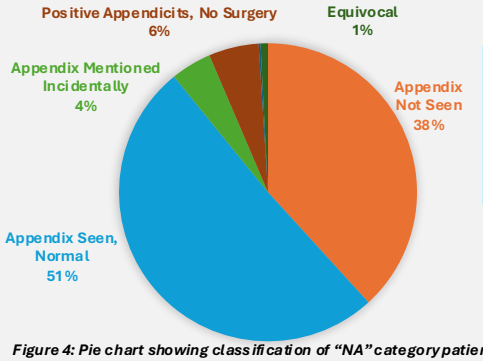


Figure 4: Pie chart showing classification of “NA” category patients (those who had ultrasound but did not have surgery)

		Pathology proven appendicitis: Positive	Pathology proven appendicitis: Negative
Ultrasound Findings	Positive	TP : 92	FP : 6
	Negative	FN : 1	TN : 6

Figure 3: Data analysis (2 x 2 table)

Patient	Finding seen on US
1	8 mm diameter, fat stranding
2	7 mm diameter, fat stranding, hyperemia, appendicolith
3	8 mm, fat stranding
4	7 mm, minimal fat stranding
5	10 mm, fat stranding, free fluid, prominent lymph nodes in RLQ
6	6.9 mm, fat stranding, hyperemia, free fluid

Figure 5: Analysis of False Positive Cases
(All false positive cases met 2-3 criteria for acute appendicitis)

Conclusion

This clinical audit demonstrates that while ultrasound is highly sensitive (98.9%) and has a high positive predictive value (PPV) (93.9%) for diagnosing pediatric appendicitis, its specificity is limited (50%), resulting in a significant number of false positives. The moderate negative predictive value (NPV) (85.7%) further indicates some limitations in ruling out appendicitis when ultrasound findings are negative. The analysis of false-positive cases revealed that many patients exhibited multiple ultrasound criteria suggestive of appendicitis, such as enlarged appendix diameter, fat stranding, and hyperemia, yet had normal pathology. This discrepancy underscores the need for a more standardized approach to interpreting these ultrasound criteria in clinical practice. Overall, these findings highlight the importance of refining diagnostic criteria and enhancing radiology reporting to improve diagnostic accuracy, reduce unnecessary surgical interventions, and optimize patient outcomes in pediatric imaging.