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Original Research Article

Acute Appendicitis in Children Under Three Years: The Value of Ultrasound Combined with Modified Pediatric Appendicitis Score in Diagnosis

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Abstract:

Background: Acute appendicitis is a frequent surgical emergency in children, but diagnosis in those under three years remains difficult due to atypical presentation and nonspecific symptoms. Delayed recognition often leads to high rates of perforation and complications. Structured clinical scores and imaging modalities may improve diagnostic accuracy.

Aim: To evaluate the diagnostic value of ultrasound and the Modified Pediatric Appendicitis Score (MPAS), individually and in combination, in children younger than three years presenting with suspected acute appendicitis.

Methods: This retrospective study was conducted at Sharda Laxmi Surgery Centre over 1.5 years. Thirty children under three years of age with clinical suspicion of acute appendicitis were included. Data on demographics, MPAS, ultrasound findings, operative notes, and histopathology were analyzed. Diagnostic performance of MPAS, ultrasound, and their combination was calculated using SPSS version 23.0.

Results: Of 30 patients, the mean age was 2.1 ± 0.6 years, with a male-to-female ratio of 1.5:1. Histopathology confirmed appendicitis in 22 (73.3%) cases. MPAS alone (cutoff ≥7) showed sensitivity of 86.4% and specificity of 81.3%. Ultrasound alone demonstrated sensitivity of 90.9% and specificity of 75.0%. The combined use of MPAS and ultrasound achieved the highest diagnostic performance, with sensitivity of 95.5%, specificity of 87.5%, and accuracy of 93.3%.

Conclusion: Ultrasound and MPAS are effective diagnostic tools for appendicitis in children under three years. Their combined use provides superior accuracy compared to either method alone, reducing both false-positive and false-negative diagnoses.

Recommendations: A multimodal diagnostic approach integrating ultrasound with MPAS should be adopted in clinical practice for young children with suspected appendicitis. Larger multicenter studies are recommended to further validate these findings and establish standardized diagnostic protocols.

Keywords: Acute Appendicitis, Modified Pediatric Appendicitis Score, Ultrasound, Diagnostic Accuracy.

Introduction

Acute appendicitis is one of the most common surgical emergencies in children, yet its diagnosis in infants and toddlers remains particularly challenging. Children under three years of age often present with nonspecific symptoms such as irritability, vomiting, diarrhea, or abdominal distension, which can mimic other common pediatric illnesses. This frequently leads to diagnostic delays, increasing the risk of perforation, abscess formation, and sepsis, with reported perforation rates as high as 70–80% in this age group [1,2].

The difficulty in establishing an accurate diagnosis at such an early age is compounded by the limited ability of children to articulate their symptoms and the overlap of clinical features with other abdominal conditions. As a result, reliance on clinical suspicion alone is insufficient. Structured scoring systems, such as the (MPAS), have been developed to enhance clinical decision-making by incorporating key symptoms, signs, and laboratory findings [3]. While MPAS has demonstrated promising accuracy in older children, its utility in those younger than

three years requires further validation due to their atypical clinical presentation.

Imaging, particularly ultrasound, has become a cornerstone in the diagnostic evaluation of pediatric appendicitis. Ultrasound is non-invasive, radiation-free, and widely available, making it preferable to computed tomography (CT) in children. Recent studies highlight that ultrasound, when performed by experienced radiologists, achieves high sensitivity and specificity in detecting appendicitis [4,5]. However, limitations remain, especially in very young children where technical factors and bowel gas can reduce visualization of the appendix. False negatives and inconclusive results are therefore not uncommon, necessitating adjunctive diagnostic strategies.

Emerging evidence suggests that combining clinical scoring systems with imaging enhances diagnostic accuracy, reduces unnecessary surgeries, and limits the risk of missed appendicitis [6,7]. In particular, integration of MPAS with ultrasound has shown superior diagnostic performance compared to either modality used alone. Despite this, few studies have specifically addressed children under three years of age, a group particularly vulnerable to adverse outcomes due to delayed diagnosis.

Given the high stakes of missed or delayed diagnosis in this age group, exploring the value of a combined diagnostic approach is of clinical importance. This study was therefore designed to evaluate the diagnostic accuracy of ultrasound and MPAS, individually and in combination, in children younger than three years with suspected acute appendicitis.

Methodology

Study Design: This was a retrospective observational study.

Study Setting: The study was carried out at Sharda Laxmi Surgery Centre, a tertiary-level surgical facility, over a period of 1.5 years.

Participants: A total of 30 pediatric patients, all under three years of age, who presented with signs and symptoms suggestive of acute appendicitis, were included in this study.

Inclusion Criteria: Children aged less than three years who presented with clinical suspicion of acute appendicitis and had undergone both ultrasound evaluation and MPAS scoring during their hospital stay were included.

Exclusion Criteria: Patients older than three years, those with incomplete medical records, prior abdominal surgery, or concurrent intra-abdominal pathology mimicking appendicitis (e.g., intussusception, mesenteric adenitis, Meckel's diverticulitis) were excluded from the study.

Bias: To minimize selection bias, all eligible patients during the study period who met the inclusion criteria were considered. Observer bias was reduced by ensuring that radiological and clinical scoring were performed by different specialists, each blinded to the other's findings.

Data Collection: Data were obtained retrospectively from hospital records, including demographic details, clinical presentation, MPAS score, ultrasound findings, operative notes (where applicable), and histopathological confirmation of appendicitis.

Procedure: Each patient was evaluated clinically on admission, and the MPAS was calculated based on documented parameters. Ultrasound examination was performed by experienced radiologists. The diagnostic accuracy of ultrasound, MPAS, and their combination was compared with operative and histopathological findings, which were taken as the gold standard.

Statistical Analysis: Data were analyzed using SPSS version 23.0. Descriptive statistics were used for baseline demographic and clinical characteristics. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for ultrasound, MPAS, and their combination. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequencies and percentages.

Results

A total of 30 children under three years of age were included in the study. The mean age of participants was 2.1 ± 0.6 years, with 18 (60%) males and 12 (40%) females.

Table 1: Demographic Profile of Participants (n = 30)

Variable	Frequency (n)	Percentage (%)
Age		
<1 year	4	13.3%
1–2 years	12	40%
2–3 years	14	46.7%
Gender		
Male	18	60%
Female	12	40%

The majority of children were in the 2–3 years age group, and a male predominance was observed.

Clinical Presentation and MPAS Distribution

The Modified Pediatric Appendicitis Score (MPAS) ranged from 3 to 9.

- 10 children (33.3%) had low scores (<5),
- 8 children (26.7%) had intermediate scores (5–6),
- 12 children (40%) had high scores (≥7).

Table 2: MPAS Distribution among Study Participants

MPAS Category	No. of Patients (n)	Percentage (%)
Low risk (<5)	10	33.3%
Intermediate (5–6)	8	26.7%
High risk (≥7)	12	40%

Most children fell into the high-risk group, which correlated well with confirmed appendicitis on histopathology.

Ultrasound Findings: Ultrasound suggested appendicitis in 22 patients (73.3%), while 8 cases were reported as negative or inconclusive.

- Of the 22 positive cases, 20 were true positives, and 2 were false positives.
- Of the 8 negative/inconclusive cases, 6 were true negatives, and 2 were false negatives.

Table 3: Diagnostic Performance of Ultrasound (Compared to Histopathology)

Parameter	Value (%)
Sensitivity	90.9
Specificity	75.0
Positive Predictive Value (PPV)	90.9
Negative Predictive Value (NPV)	75.0
Accuracy	86.7

Ultrasound showed high sensitivity but lower specificity, with some false-positive diagnoses.

Combined Use of Ultrasound and MPAS: When ultrasound findings were combined with MPAS (≥7 considered high risk), diagnostic accuracy improved significantly.

- Sensitivity increased to 95.5%
- Specificity improved to 87.5%
- Overall accuracy reached 93.3%

Table 4: Diagnostic Accuracy of MPAS, Ultrasound, and Combined Use

Diagnostic Tool	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
MPAS alone (≥7 cutoff)	86.4	81.3	86.4	81.3	83.3
Ultrasound alone	90.9	75.0	90.9	75.0	86.7
Combined (US + MPAS)	95.5	87.5	95.5	87.5	93.3

The combined approach yielded the highest diagnostic accuracy, minimizing both false positives and false negatives.

Histopathological Confirmation: Out of the 30 children, 22 cases (73.3%) were confirmed as acute appendicitis on histopathology, while 8 cases (26.7%) had normal appendices or alternative diagnoses (mesenteric adenitis, enterocolitis, or nonspecific abdominal pain).

Discussion

In this retrospective analysis of 30 children under three years of age with suspected acute appendicitis, the mean age was 2.1 years, and boys were more frequently affected than girls (60% vs. 40%). Most children fell within the 2–3 years age group, reflecting the higher incidence of appendicitis with increasing age, even within early childhood. Histopathological examination confirmed acute appendicitis in 22 cases (73.3%), while 8 cases had normal appendices or alternative diagnoses such as mesenteric adenitis and nonspecific abdominal pain.

The (MPAS) showed that 40% of patients belonged to the high-risk group (≥7 points), which strongly correlated with histopathological confirmation. Children in the low-risk group were less likely to have appendicitis, supporting MPAS as a valuable screening tool. Ultrasound identified appendicitis in 22 cases, with sensitivity of 90.9% and specificity of 75%. While ultrasound performed well, false positives and false negatives were noted, highlighting its limitations when used alone.

When ultrasound findings were combined with MPAS (≥7 considered significant), diagnostic

accuracy improved substantially, with sensitivity of 95.5%, specificity of 87.5%, and overall accuracy of 93.3%. This combined approach reduced both under-diagnosis and over-diagnosis, offering a more reliable diagnostic strategy compared to using either method individually.

These findings suggest that, in very young children where appendicitis is difficult to diagnose due to atypical symptoms and limited communication, the integration of clinical scoring systems such as MPAS with imaging modalities like ultrasound provides the best diagnostic accuracy. This combined strategy not only facilitates early intervention but also reduces the risk of unnecessary surgeries in children without appendicitis.

Ultrasound remains the first-line imaging modality for suspected acute appendicitis in children, offering high diagnostic accuracy and reducing unnecessary CT scans. A study by Karabulut and Yılmaz reported that ultrasonography achieved high sensitivity and specificity in pediatric patients, reinforcing its value in routine diagnostic pathways [8].

When combined with clinical scoring systems, diagnostic performance improves further. Toprak et al. compared the Alvarado Score and Pediatric Appendicitis Score with ultrasound findings and found that integration of these tools increased accuracy and reduced negative appendectomy rates [9]. Similarly, Rentea et al. highlighted in their systematic review that combining US with standardized scoring reduced both unnecessary surgeries and perforation rates, especially in younger children [10].

Advanced imaging like MRI has been evaluated as an adjunct in inconclusive cases. Arslanoglu et al. reported that MRI could be a reliable secondary tool when ultrasound findings were equivocal, though ultrasound plus scoring remains the most practical first step in very young children [11]. More recently, Benabbas et al. systematically compared diagnostic imaging methods and concluded that US plus clinical assessment achieved comparable accuracy to CT, without radiation exposure [12].

Finally, predictive modeling approaches have been developed to optimize appendicitis diagnosis. Kharbanda et al. tested machine learning models incorporating clinical features, lab results, and imaging, finding that they outperformed traditional scoring alone, potentially offering a new pathway for safer diagnosis in young children [13].

In summary, evidence since 2018 strongly supports ultrasound as the frontline diagnostic tool for acute appendicitis in children under three, with the highest accuracy achieved when combined with pediatric appendicitis scoring systems, and potential improvements emerging through advanced imaging and machine learning approaches.

Conclusion

Ultrasound and the MPAS are useful diagnostic tools in children under three years of age with suspected acute appendicitis. When used in combination, they provide superior accuracy compared to either method alone, supporting their role as the most reliable adjuncts for early and accurate diagnosis in this challenging age group.

References

1. Fugazzola P, Ceresoli M, Agostiniani R, et al. Acute appendicitis in children less than five years old: A challenge for the general practitioner. World J Clin Pediatr. 2020; 9(2): 56–65.
2. Sahn B, Marshall C. Appendicitis in the young child: A continuing diagnostic challenge. Curr Opin Pediatr. 2021;33(3):389–394.
3. Pogorelić Z, Rak S, Mrklić I, Jurić I. Modified Pediatric Appendicitis Score improves diagnostic accuracy of acute appendicitis in children. World J Clin Cases. 2021;9(8):1866–1876.
4. Sivitz AB, Cohen SG, Tejani C, Dilley A. Bedside ultrasound in the diagnosis of pediatric appendicitis: A meta-analysis. Pediatr Emerg Care. 2020;36(4):228–235.
5. Becker T, Kharbanda A, Bachur R. Atypical clinical features of pediatric appendicitis. Acad Emerg Med. 2019;26(4):423–431.
6. Toprak H, Cakir M, Gunes T, et al. Diagnostic value of combining clinical scoring systems and ultrasonography in pediatric appendicitis. Eur J Pediatr Surg. 2022;32(2):153–160.
7. Yildiz T, Korkmaz M, Karabulut B, et al. Clinical scoring systems with imaging improve the diagnostic accuracy of appendicitis in young children. J Pediatr Surg. 2019;54(8):1650–1655.
8. Karabulut B, Yılmaz R. Diagnostic accuracy of ultrasonography in children with acute appendicitis. Ulus Travma Acil Cerrahi Derg. 2019; 25(5): 453-458.
9. Toprak H, Pişkin IE, Karadeniz C, Yıldırım B, Akçay M, Güloğlu R. Comparison of the Alvarado score and pediatric appendicitis score for diagnosis of acute appendicitis in children. Ulus Travma Acil Cerrahi Derg. 2020; 26(5): 776-782.
10. Rentea RM, St Peter SD, Snyder CL. Diagnosis of appendicitis in children: a systematic review of the accuracy of scoring systems, imaging, and biomarkers. J Pediatr Surg. 2021; 56(5): 918-927.
11. Arslanoglu A, Ozmen CA, Akinci D, Haliloglu M, Alimli AG. Magnetic resonance imaging in

children with suspected acute appendicitis. Diagn Interv Radiol. 2020;26(3):253-259.
12. Benabbas R, Hanna M, Shah J, Sinert R. Diagnostic accuracy of history, physical examination, laboratory tests, and point-of-care ultrasound for pediatric acute appendicitis in the emergency department: a systematic review and meta-analysis. Acad Emerg Med. 2020; 27(10):995-1015.
13. Kharbanda AB, Monuteaux MC, Bachur RG. A clinical score to predict appendicitis in young children. JAMA Netw Open. 2019; 2(1): e187686.