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Imaging and the Value of the Pediatric Appendicitis Score for Diagnosis of Acute Appendicitis in the Pediatric Emergency Department

Çocuk Acil Servisinde Akut Apandisit Tanısı için Görüntüleme ve Pediatrik Apandisit Skorunun Değeri

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ABSTRACT

Objective: Acute appendicitis (AA) is a common cause of acute abdominal pain in pediatric patients. The diagnosis of AA in children can sometimes be difficult to make accurately. For this reason, ultrasonography (US) and computed tomography (CT) are also commonly used methods for diagnosis. Scoring systems such as the pediatric appendicitis score (PAS) have gained attention because they integrate multiple clinical and laboratory parameters to help predict AA. The aim of this study was to evaluate the efficacy of various clinical, laboratory, and imaging parameters in diagnosing appendicitis in children and to determine which factors are most predictive for accurate diagnosis.

Methods: The study included 153 patients who presented to the pediatric emergency department with abdominal pain and were operated on for AA. PAS was calculated for each case. Patients were divided into two groups as "appendicitis" and "non-appendicitis" according to pathology results.

Results: The positive predictive value and negative predictive value of US in the diagnosis of appendicitis were found to be 60% and 87%, respectively, while CT showed higher accuracy rates with 86% sensitivity and 97% specificity. Logistic regression modeling to investigate which parameters influence the histomorphologic diagnosis of appendicitis revealed that younger age increased the likelihood of appendicitis by 4.29-fold, high white blood cell increased it by 5.44-fold, high PAS increased it by 7.87-fold, and diagnostic US increased it by 7.91-fold.

Conclusion: The study suggests that the combination of laboratory tests and imaging modalities can improve the accuracy of appendicitis diagnosis, especially in children, and prevent unnecessary surgery.

Keywords: Acute appendicitis, pediatric appendicitis score, clinical decision

ÖZ

Amaç: Akut apandisit (AA), çocuk hastalarda akut karın ağrısının yaygın bir nedenidir. Çocuklarda AA tanısını doğru koymak bazen zor olabilir. Bu nedenle ultrasonografi (US) ve bilgisayarlı tomografi (BT) de tanı için yaygın olarak kullanılan yöntemlerdir. Pediatrik apandisit skoru (PAS) gibi skorlama sistemleri, AA'yı öngörmeye yardımcı olmak için birden fazla klinik ve laboratuvar parametresini entegre ettiği için dikkat çekmiştir. Bu çalışmanın amacı, çocuklarda apandisit tanısı koymada çeşitli klinik, laboratuvar ve görüntüleme parametrelerinin etkinliğini değerlendirmek ve hangi faktörlerin doğru tanı için en öngörücü olduğunu belirlemektir.

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Yöntem: Çalışmaya çocuk acil servisine karın ağrısı ile başvuran ve AA ön tanısı ile ameliyat edilen 153 hasta dahil edildi. Fizik muayene bulguları ve laboratuvar parametreleri kullanılarak her olgu için PAS hesaplandı. Hastalar patoloji sonuçlarına göre "apandisit" ve "apandisit olmayan" olarak iki gruba ayrıldı. Bu iki grup laboratuvar parametreleri, görüntüleme bulguları ve PAS açısından karşılaştırıldı.

Bulgular: Apandisit tanısında US'nin pozitif prediktif değeri ve negatif prediktif değeri sırasıyla %60 ve %87 olarak bulunurken, BT %86 duyarlılık ve %97 özgüllük ile daha yüksek doğruluk oranları gösterdi. Apandisitin histomorfolojik tanısını hangi parametrelerin etkilediğini araştırmak için yapılan lojistik regresyon modellemesi, genç yaşın apandisit olasılığını 4,29 kat, yüksek beyaz kan hücresi'nin 5,44 kat, yüksek PAS'nin 7,87 kat ve tanısal US'nin 7,91 kat artırdığını ortaya koydu.

Sonuç: Bu çalışma, laboratuvar testleri ve görüntüleme yöntemlerinin kombinasyonunun özellikle çocuklarda apandisit tanısının doğruluğunu artırabileceğini ve gereksiz cerrahiyi önleyebileceğini göstermektedir.

Anahtar Kelimeler: Akut apandisit, pediatrik apandisit skoru, klinik karar

INTRODUCTION

Acute onset abdominal pain is one of the most common causes of admission to the pediatric emergency department. When evaluating abdominal pain according to its etiology, it is necessary to first rule out the causes of acute abdomen because of the high mortality and morbidity associated with it. In childhood, especially in a certain age group, the most common and important cause of acute abdomen presenting to the emergency department is acute appendicitis (AA).[1-3] AA is most commonly diagnosed in the second decade of life. The average lifetime risk of developing AA is 8%.[4,5] In the United States of America, 80,000 children are treated for AA every year, and this rate was reported to be 4/1000 in children under 14 years, of age.[6]

In addition to the high number of cases presenting to emergency departments with abdominal pain, the difficulty in diagnosing AA in pediatric patients poses a diagnostic challenge. In approximately one-third of pediatric cases, AA does not present with typical symptoms. This leads to delayed diagnosis, the emergence of complications, and an increase in mortality rates.[7] For this reason, additional imaging methods and scoring systems that facilitate diagnosis are becoming increasingly important.[8,9] A detailed history and focused physical examination are of paramount value. Initial diagnostic tests should evaluate the serum levels of inflammatory biomarkers in these patients. Among the imaging methods, ultrasonography (US) should be the initial examination because it is non-invasive, it is accessible, and its cost is low compared to other methods. However, the inherent conditions, such as dependence on the individual and being affected by adipose tissue and intestinal gases, make it difficult for this examination to reach an accurate result.[10,11] If there is difficulty in diagnosis, pelvic-abdominal computed tomography (CT) is used in many clinics, including ours, for the diagnosis of AA in children due to its high sensitivity, and specificity.[12,13] Although magnetic resonance imaging (MRI) is known to produce results comparable to those of CT, unfortunately, patients cannot undergo MRI due to difficult access in many emergency departments, as CT scans continue to be performed. Although CT scanning has saved many patients from unnecessary surgeries, it has also exposed many patients to unnecessary radiation. This situation is worrisome regarding the cancer risk that pediatric patients will face.[14,15] Therefore, the importance of scoring systems that combine multiple parameters has increased. Some of these are scoring systems such as the pediatric appendicitis score (PAS), the Alvarado score, and the Refined Low-Risk Appendicitis Score.[8,16,17]

In this study we aimed to determine the parameters most important for accurately diagnosing appendicitis in childhood.

METHODS

This study was planned as an observational, cross-sectional, retrospective study. The study was conducted in a tertiary pediatric emergency department between January 1, 2019, and December 31, 2021. The study data were accessed from the hospital automation system. The study was approved by the İzmir Katip Çelebi University Non-Interventional Clinical Research Ethics Committee (decision number: 0478, date: 26.10.2023). All patients who presented to the emergency department with complaints of abdominal pain, whose examinations were completed in the emergency department, and who were diagnosed with appendicitis, and operated on, were included in the study. Those who were administered analgesic drugs before admission or in the emergency department, those who had some tests performed in a different laboratory, those who were not operated on, those who could not undergo a histomorphologic examination of the specimen obtained after the operation, those who were younger than two years of age, those with abdominal pain due to non-abdominal causes, pregnant women, those who could not establish a verbal relationship due to mental retardation or other mental illnesses, those diagnosed with Familial Mediterranean Fever, those who were immunosuppressed, and those who had undergone abdominal surgery were excluded from the study. In the study, besides age and gender, the day and time of admission was obtained. Hemogram parameters, serum

C-reactive protein (CRP) level, and procalcitonin level were determined as acute phase reactants in each patient. The nephelometric method was used to measure CRP (BN™ II System Siemens, CRP reagent Ireland), and a level of 0.0 to 0.8 mg/dL was thought to be normal. A complete blood count was evaluated with an electronic cell counter (COULTER LH 780 Hematology Blood Analyzer from Beckman Coulter). PAS was calculated for each case using physical examination findings and laboratory parameters.[6] PAS includes eight parameters and was scored on a scale of 10 points (Table 1). According to this scoring system, 1-3 were considered negative, 4-7 were considered suspicious, and 8 and above were considered positive.[16] In addition, abdominal ultrasounds evaluation was performed in all patients. All of the patients were examined using a system called SonoAce X8 from Samsung Medison in Seoul, Korea. This system had a 3 to 7 MHz convex transducer and a 5 to 12 MHz linear transducer. According to the ultrasound, the appendix had "AA" if it had a diameter of more than 6 mm from front to back, fluid around the appendix, an image of low-contrast inflammation, fluid inside the appendix, and the ability to compress the appendix.[10,18] Abdominal CT examination was performed, additionally, in cases where the diagnosis could not be made with these evaluations. CT scanning was performed using a Siemens SOMATOM Definition Flash dual-source 128 multi-detector scanner (Siemens Medical Solutions, Forchheim, Germany): tube voltage, 100 kVp; tube current, 87 and 190 mA; slice thickness, 6 mm; and 40 mL Xenetix® (Guerbet, Gorinchem, The Netherlands) at a rate of 4 mL/s. Post-contrast scanning was performed 60 seconds after intravenous injection of Xenetix 350. A low-dose technique was applied, and the effective dose was calculated for each scan with a size-specific dose estimate. If the appendix could not be seen on the CT scan, its outer diameter was less than 6 mm, or peri-appendiceal strands were missing, it was thought that there was "no AA".[12] Postoperatively, the specimens were evaluated by blinded pathologists independent of the study group. The presence of polymorphonuclear leukocytes, lymphocytes, or plasma cells in appendicitis biopsy was considered histopathologically diagnostic for "AA". The absence or minimal presence of acute inflammatory cells or a normal appearance of the appendix was interpreted histopathologically as "no AA." The patients were divided into two groups as "those with appendicitis" and "those without appendicitis" according to the pathology results. We compared these two groups in terms of laboratory parameters, imaging findings, and PAS.

Statistical Analysis

We used SPSS (Statistical Package for Social Sciences version 17.0) while evaluating the study's findings. The Kolmogorov-Smirnov test was used to determine whether the distribution of continuous numerical variables was close to normal. Frequency indicators of numerical data were presented as mean ± standard deviation and median [interquartile range (IQR)], whereas discrete data, as percentages. A t-test was used to compare the relationships between continuous data. A chi-square test was used to compare discrete data, and Fisher's exact test was used when the chi-squared assumption (χ^2) was not met. In addition, the relationships of continuous data were analyzed by Pearson's correlation analysis. Logistic regression analysis was used to predict which cases would be histopathologically diagnosed as appendicitis. In addition, a receiver operating characteristic (ROC) curve was drawn to find the cut-off value of PAS. A p value less than 0.05 was considered significant.

RESULTS

A total of 153 patients were included in the study. Of these, 99 (64.7%) were male and 45 (29.41%) presented between 08:00 and 16:00. The median age was 13 years (IQR=11-15). We took a detailed history, physical examination, blood tests, abdominal ultrasound, and abdominal CT imaging. According to the results of these tests, the median white

Table 1. Pediatric appendicitis score and right lower quadrant criteria

Sign/symptoms	Point
Nausea/emesis	1
Anorexia	1
Migration of pain to RLQ	1
Low grade fever (>38.0°)	1
RLQ tenderness on light palpation	2
Cough/percussion/heel tapping tenderness at RLQ	2
Leukocytosis (>10,000/mm^3)	1
Left shift (>75% neutrophilia)	1
Total	**10**

RLQ: Right lower quadrant

blood cell (WBC) count was 14500/mm^3 (IQR=11600-19050), the median neutrophil count was 11800/mm^3 (IQR=8200-16650), the median serum CRP level was 19.8 mg/dL (IQR=4.5-75.6), and the median serum procalcitonin level was 0.09 mg/dL (IQR=0.02-0.53) (Table 2).

According to the abdominal ultrasound results, 68 (44.4%) patients had normal results. The mean PAS obtained from these data was 6.8±1.05 (minimum-maximum=3-9). Abdominal CT imaging was performed in 21 undiagnosed cases, and pathology was detected in 15 (71.42%). As a result, surgeries were performed on all cases. We took the specimen from the operation for pathologic examination and evaluated the results. Accordingly, histomorphologic findings in 137 (89.5%) cases were consistent with appendicitis (Table 3).

The comparison of age, sex, WBC, autonomic nervous system (ANS), CRP, and procolcitonin results of patients with and without appendicitis according to histomorphologic findings is shown in Table 2.

Of the 137 people whose appendicitis was confirmed by histomorphology, 83 (60.58%) had it also detected on abdominal ultrasound. In the abdominal ultrasound examinations of 16 patients, in whom appendicitis was not identified via histomorphology, appendicitis was found on the ultrasound in only 2 cases (12.5%). This difference was statistically significant (p=0.01, X^2=11.5) (Table 3). Based on these results, the PPV of abdominal ultrasound for the diagnosis of appendicitis was 0.60, and the negative predictive value (NPV) was 0.87 (Table 4).

Table 2. Distribution of age, gender, and laboratory data of cases by groups

	Total (n=153)	**AA (+) (n=137)**	**AA (-) (n=16)**	**p**
Age, median (IQR)	13 (11-15)	13 (11-15)	14.5 (11.25-17.00)	0.087
Sex, n (%)				
Male	99(64.7%)	90 (90.9%)	9 (9.1)	0.45
Female	54 (35.3%)	47 (87%)	7 (13)	
WBC (/mm^3) median (IQR)	14.5 (11.6-19.05)	14.8 (11.45-18.95)	14.1 (11.70-21.60)	0.87
ANC (/mm^3) median (IQR)	11.8 (8.2-16.65)	11.8 (8.25-16.3)	9.9 (7.4250-19.35)	0.53
CRP (mg/dL), median (IQR)	19.8 (4.5-75.6)	22 (4.35-76.4)	7.95 (7.20-21.725)	0.30
PRC (mg/dL), median (IQR)	0.09 (0.02-0.53)	0.08 (0.0125-1.28)	0.27 (0.23-0.275)	0.25

IQR: Interquartile range, AA: Acute appendicitis, WBC: White blood cell, ANC: Absolute neutrophil count, CRP: C-reactive protein, PCR: Procalcitonin (gender comparison X^2, t-test used for other comparisons)

Table 3. Distribution of imaging and scoring systems according to the presence or absence of appendicitis based on the histopathological result of the operation material of the cases

	Op AA (-) n=16 (10.5%)	**Op AA (+) n=137 (89.5%)**	**Total**	**p**	**X^2**
US AA (-)	14 (20.6%)	54 (79.4%)	68 (100%)	0.01	11.5
US AA (+)	2 (2.4%)	83 (97.6%)	85 (100%)		
CT AA (-)	4 (66.7%)	2 (33.3%)	6 (100%)	0.015	5.9
CT AA (+)	2 (13.3%)	13 (86.7%)	15 (100%)		
PAS <7	11 (21.15%)	41 (78.85%)	52 (100%)	0.02	0.6
PAS >7	5 (4.95%)	96 (95.05%)	101 (100%)		

Op: Operation, US: Ultrasound, CT: Computed tomography, AA: Acute appendicitis, PAS: Pediatric appendicitis score

Table 4. Validity test results of imaging and scoring systems at different cutoff points

	Sensitivity	**Specificity**	**PPV**	**NPV**
CT	0.86	0.97	0.86	0.66
US	0.97	0.20	0.60	0.87
PAS=5	0.94	0.31		
PAS=6	0.7	0.68		
PAS=7	0.95	0.21	0.70	0.68

PPV: Positive predictive value, NPV: Negative predictive value, US: Ultrasound, CT: Computed tomography, PAS: Pediatric appendicitis score

In the abdominal CT tests that were done on 15 patients who had histomorphologic signs of appendicitis, 13 (86.66%) showed signs of appendicitis. In the abdominal CT evaluations, appendicitis was detected in only 2 out of 6 patients (33.3%) in whom it was not initially detected by histomorphology. This difference was statistically significant ($p=0.015$, $\chi^2=5.9$) (Table 3). Based on these results, the PPV of abdominal CT for the diagnosis of appendicitis was 0.86, and the NPV was 0.66 (Table 4).

Based on the histomorphology results, 96 (70.07%) of the 137 patients who were diagnosed with appendicitis had PAS 7 or higher. Based on the histomorphology results of 16 cases, no signs of appendicitis were found. PAS 7 or higher was found in only 5 cases, or 31.25%. This difference was statistically significant ($p=0.02$, $\chi^2=0.6$) (Table 3). To determine if someone has appendicitis, the PPV for a PAS of seven or more was found to be 0.70, and the NPV was 0.68 (Table 4). No significant association was found when examining the effect of presentation during working hours or on-call hours on the histomorphologic diagnosis of appendicitis ($p=0.18$ and $\chi^2=1.7$).

We used logistic regression modeling to determine which parameters changed the histomorphologic diagnosis of appendicitis. It was found that younger age increased the odds of appendicitis 4.29 times, higher WBC counts increased them 5.44 times, higher PAS increased them 7.87 times, and the use of diagnostic ultrasound increased them 7.91 times. Lab tests were compared to each other using PAS, and a weak positive correlation was found between WBC and PAS ($r=0.43$, $p<0.01$) and between ANS and PAS ($r=0.42$, $p<0.01$).

We investigated the relationship between the results of abdominal ultrasound and PAS. The mean PAS score of patients with a diagnostic abdominal ultrasound result was 6.94±0.83, while the mean PAS score of patients with a normal abdominal ultrasound result was 6.75±1.24 ($p=0.26$ and $T=1.1$).

We analyzed the relationship between the results of abdominal CT and the PAS score. The mean PAS score was 7.06±1.03 in patients with a diagnostic result on abdominal CT, while it was 6.0±0.89 in patients with a normal abdominal CT ($p=0.03$, $T=2.2$). Regarding the correlation between histomorphologic results of surgery and PAS, the mean PAS was 6.94±1.02 in cases with a diagnostic result for appendicitis, while the mean PAS was 6.12±1.02 in cases with normal results ($p=0.003$ and $T=3$).

As a result of our analysis , we found the sensitivity and specificity of abdominal CT to be 0.86 and 0.97, respectively, and the sensitivity and specificity of abdominal ultrasound to be 0.97 and 0.20, respectively. According to the ROC curve, we drew to determine the ideal cutoff of the PAS score, the sensitivity was 0.70, and the specificity was 0.68 when PAS=6. The area under the curve was 0.721 (intermediate level) (Figure 1).

DISCUSSION

The aim of this study was to determine how effective the investigations are when performed in patients presenting to the pediatric emergency department with acute abdominal pain , especially in the diagnosis of AA. We analyzed the role of ultrasound in the diagnosis of appendicitis. Ultrasound was able to confirm the diagnosis of appendicitis 97% of the time; but it wasn't always enough to make a final diagnosis because of its limitations. In such cases, a PAS value of 7 or higher has been found to have a diagnostic sensitivity of 70%. However, the combination of young age, high PAS score, high WBC count, and diagnostic ultrasound has been shown to be extremely likely to indicate appendicitis. These findings emphasize the importance of using multiple tests and parameters together in the diagnosis of appendicitis, especially in children presenting with acute abdominal pain. Such results may make important contributions to clinical practice, as the combined use of multiple diagnostic tools may increase the chances of making the correct diagnosis and help prevent unnecessary surgeries. However, it should be kept in mind that each test alone may not be sufficient, and the specific situation of each patient should be taken into account.

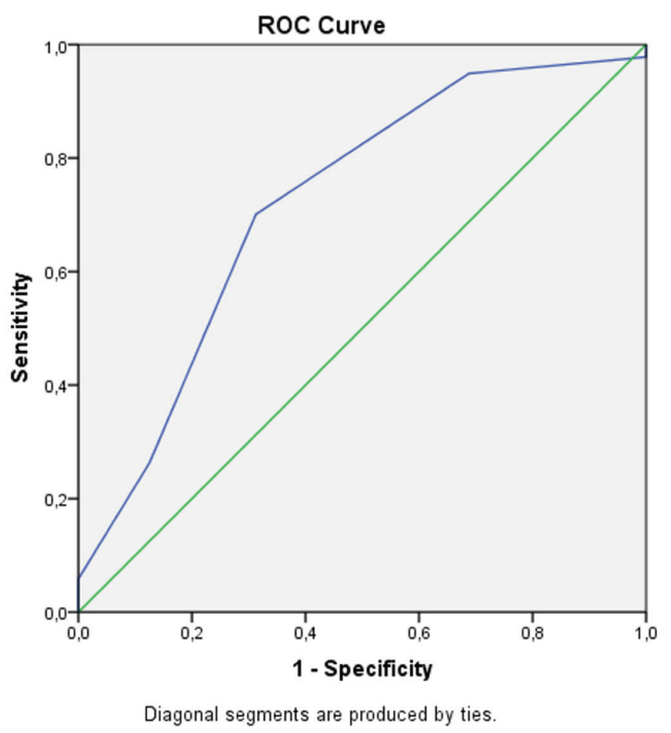

Figure 1. ROC curve for the pediatric appendicitis score

ROC: Receiver operating characteristic

In the study by Taşar et al.[6], the mean age of 220 patients diagnosed with AA was found to be 13 years. This finding is consistent with the studies in the literature on appendicitis in childhood, because these studies generally emphasize that appendicitis cases are more common in children in the second decade.[4,5] Similarly, in our study, the median age of the cases diagnosed with AA was found to be 13 years. This is in parallel with literature findings and suggests that appendicitis cases in childhood are more common in this age group.

In terms of gender, Sayed et al.[12] reported that 60% of the 140 cases diagnosed with AA were male. This finding is also compatible with the general trend in the literature because, in many studies, it has been reported that boys have 7-9 times higher risk of appendicitis than girls.[5] A similar result was obtained in our study. The number of male and female cases was found to be 99 and 54, respectively, and it was observed that boys were more common.

These findings support the idea that appendicitis cases are more common, especially in boys, and the average age is more concentrated in individuals in the second decade. Furthermore, this gender and age distribution suggests that they are important factors for the diagnosis and management of appendicitis in clinical practice.

In this study, we examined the validity of various laboratory tests and imaging methods to determine the diagnostic accuracy of AA. In a study conducted by Bal et al.[13] on 96 cases of AA, mean WBC, ANC, and CRP of the patients with histopathologic AA were 15.1, 12.1, and 14 mg/dL, respectively. In cases without histopathologic AA, the mean WBC was 11300, ANS was 8200, and CRP was 4.8 mg/dL. These findings indicate elevated acute phase reactants. Although the increase in these values is non-specific in inflammatory conditions such as AA, studies have found that inflammatory marker levels in such tests are significantly elevated.[19-24] Similarly, in our study, WBC, ANS, and CRP values were found to be significantly higher in the group with histopathologically positive results after appendectomy. This is an important finding that increases the accuracy of the diagnosis of AA.

The validity of ultrasound in the diagnosis of AA is also frequently discussed in the literature. On the other hand, a study by Taşar et al.[6] found that ultrasound had a 67.9% sensitivity, a 78.4% specificity, a 64.7% PPV, and an 80.7% NPV. The study by Bal et al.[13] also found that ultrasound had a sensitivity of 59%, a specificity of 75%, a PPV of 77%, and a NPV of 57%. Sayed et al.[12] found the sensitivity of ultrasound to be 55.6%, specificity to be 76.9%, PPV to be 76.9%, and NPV to be 68%. The literature reports that the sensitivity of ultrasound in diagnosing AA varies between 60% and 93.1%.[18,25-27] In our study, the sensitivity of ultrasound was found to be 97%, specificity was found to be 20%, PPV was found to be 60%, and NPV was found to be 87%. Although this high sensitivity indicates that ultrasound plays an important role in the diagnosis of appendicitis, the low specificity suggests that it may sometimes lead to false positive results.

CT, another imaging modality, has a very high sensitivity and specificity in the diagnosis of AA. Studies have shown that the sensitivity and specificity of CT vary between 94% and 100% and 93% and 100%, respectively.[14,28-32] However, the use of CT in children may lead to long-term health risks due to ionizing radiation. Therefore, it is emphasized that minimizing radiation use should be our focus. In our study, the sensitivity, specificity, positive predictive value, and NPV of CT were 86%, 97%, 86%, and 66%, respectively.

These results were found to be quite high, consistent with the literature. The findings of this study show that laboratory tests and imaging methods are important tools in the diagnosis of AA. In particular, high WBC, ANS, and CRP values are important parameters supporting the diagnosis of appendicitis. The tests, ultrasound with its high sensitivity and CT with its high accuracy, are important for provideing clinical decision support. However, considering the radiation risks of CT, it is concluded that alternative methods should be used to prevent its unnecessary use.

PAS is a practical, reproducible, and low-cost scoring system that can be easily applied in emergency departments. Many studies in the literature have shown that the PAS score is effectively used in the diagnosis of AA.[33,34]

The study by Schneider et al.[8] looked at 588 people who were suspected of having AA. They found that PAS ≥6 had 82% sensitivity and 65% specificity. Similarly, in two other studies in which PAS values of 7 and above were accepted, sensitivity ranged between 97.6% and 100%, and specificity ranged between 92% and 96%.[17,30] In the study by Bhatt et al.[16], PAS ≥8 values were considered significant, with selectivity for this value being 95.1 and PPV found to be 85.2%. In the study by Taşar et al.[6], sensitivity was calculated as 58.0%, specificity as 94.9%, PPV as 87.0%, and NPV as 79.5% in cases with a PAS above 8.6 In the study by Sayed et al.[12], when they took 5 as the cut-off point for PAS, sensitivity was 95%, specificity 84%, PPV 82%, and NPV 82%.

In our study, the sensitivity and specificity were 94% and 31% when the PAS score was 5 and above, 70.1% and 68% when PAS ≥6, 95% and 21% when PAS ≥7. These results are consistent with other studies in the literature and show that the sensitivity and specificity of the PAS score vary at different cut-off points. With its high sensitivity, the PAS score may be effective as a clinical decision support tool at an early stage in the diagnosis of appendicitis. However, the specificity of the PAS score may vary significantly depending on the cut-off point used. Therefore, the PAS score alone should not be used to confirm the diagnosis and should be evaluated in conjunction with other diagnostic tests (e.g., ultrasound). In our study, PAS scores of 7 or higher had higher sensitivity and lower specificity than lower scores. This suggests that a certain threshold value should be used for the PAS score in diagnosing appendicitis. Generally, the PAS score may be an important adjunctive tool in the diagnosis of AA, but it is recommended to integrate this score into an algorithm that evaluates it along with other clinical findings, before incorporating it into clinical practice.

In the study by Bal et al.[13], as in our study, a logistic regression analysis was performed based on the positive histopathological result of appendectomy. In their study, they concluded that a diagnostic ultrasound and a PAS greater than 7 were significant. Similarly, in our study, ultrasound, PAS, and even higher WBC count, and younger age increased the likelihood of diagnosis.

Study Limitations

The retrospective nature of this study inevitably introduces the risk of selection bias and data loss. Although all eligible patients were included based on explicitly defined inclusion criteria, the accuracy and completeness of the data relied heavily on the precision of entries in the hospital information system. Moreover, US outcomes may have varied depending on the operator's level of expertise, a factor not controlled for in the study design.

Finally, while the PAS was assessed, it was not applied in a standardized manner across all clinicians, which may have contributed to inter-observer variability in scoring.

Future multicenter, prospectively designed studies are warranted to enhance the validity and generalizability of the findings.

CONCLUSION

We have shown that the presence of a diagnostic ultrasound in combination with high PAS is useful in the diagnosis of AA. The contribution of this study to the literature is to draw attention to the increased frequency of performing abdominal CT in recent years. The protection of children from ionizing radiation should be the primary duty of all health professionals working in this field. We believe that the design of this prospective study with a radiation-free examination, such as MRI instead of CT, will fill a gap in the literature, if the appropriate funding is provided.

Ethics

Ethics Committee Approval: The study was approved by the İzmir Katip Çelebi University Non-Interventional Clinical Research Ethics Committee (decision number: 0478, date: 26.10.2023).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: E.B.Ç.K., Concept: T.N., Y.B., E.B.Ç.K., Design: T.N., G.G., E.E., Data Collection or Processing: T.N., Y.B., E.B.Ç.K., Analysis or Interpretation: G.G., E.E., Literature Search: G.G., Y.B., E.E., Writing: T.N.

Conflict of Interest: No conflict of interest was declared by the authors.

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