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Original Research Article

Identifying Acute Appendicitis in Pediatric Patients using the Pediatric Appendicitis Scores in Subjects Visiting the Emergency Department with Acute Abdominal Pain

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Conflict of interest: Nil

Abstract:

Background: Acute appendicitis is one of the most common causes of acute abdominal pain in pediatric patients and needs immediate surgical management. It is usually assessed with PAS (pediatric appendicitis scores) to minimize radiation exposure in pediatric patients. The literature data is conflicting concerning the accuracy of PAS in assessing acute appendicitis in child subjects.

Aim: The present study aimed to assess the diagnostic accuracy of PAS (pediatric appendicitis scores) in diagnosing acute appendicitis in pediatric patients visiting the emergency department with acute abdominal pain.

Methods: The present study retrospectively assessed the institutional data of children in the age range of 4 years to 18 years having the clinical suspicion of acute appendicitis and presenting to the pediatric emergency department. Negative predictive value, positive predictive value, specificity, and sensitivity were used to assess the diagnostic accuracy of pediatric appendicitis scores.

Results: in 52 child subjects, the mean age was 10.7±3.3 years. There were 75% (n=39) male and 25% female subjects. Moderate to high PAS scores of ≥4 was seen in 90.38% (n=47) cases and biopsy-proven appendicitis was reported in 98.07% (n=51) cases. The likelihood ratio for high, equivocal, and low-risk pediatric appendicitis scores was 2.51, 2.15, and 0.12 respectively. The positive predictive value, specificity, and sensitivity for equivocal PAS were 98.7%, 80%, and 96.6% respectively in the prediction of acute appendicitis.

Conclusion: The present study concludes that pediatric appendicitis scores have high diagnostic accuracy in the prediction of acute appendicitis in pediatric patients visiting the emergency department with acute abdominal pain.

Keywords: Acute appendicitis, abdominal pain, pediatric appendicitis scores, perforation.

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Introduction

Acute appendicitis is one of the most common diagnoses in pediatric patients presenting with acute abdominal pain to the emergency department of Pediatrics. Acute appendicitis is an emergency clinical condition that requires immediate surgical intervention in some cases. It is vital in pediatrics to timely and accurately diagnose the pediatric patients presenting with acute appendicitis as acute appendicitis can lead to the increased risk of perforation with high evidence reported to be nearly in 12% to 30% of acute appendicitis cases. Also, there are high chances of misdiagnosis of acute appendicitis in nearly 25% to 56% of the pediatric patients the acute appendicitis has been reported to be misdiagnosed. [1,2]

Generally, acute appendicitis is diagnosed with ultrasonography and CT (computed tomography) scans. However, these imaging modalities may not be available immediately and CT scan exposes child with still developing and maturing organs to a high-exposure of ionizing radiations. Hence, to rule out the subjective nature of ultrasonography and its

limitations in child subjects with high body mass, and to limit the exposure of ionizing radiations used in CT scans, various scoring systems are utilized in pediatric patients to diagnose acute appendicitis. [3] The most commonly used scoring systems in child subjects are PAS (pediatric appendicitis scores) and Alvarado scoring systems. Both these scoring systems give point values for data collection derived from laboratory tests, physical examination, and history of the subject that gives the cut-off values to diagnose the presence of appendicitis. [4,5]

The existing literature data is conflicting concerning the efficacy of pediatric appendicitis scores and Alvarado scores in the diagnosis of acute appendicitis in child subjects. The use of these scores is advantageous in developing nations that have limited accessibility to different diagnostic measures in the majority of the health care centers. [6] Hence, the present study aimed to assess the diagnostic accuracy of PAS (pediatric appendicitis scores) in diagnosing acute appendicitis in pediatric subjects visiting the emergency department with acute abdominal pain. The study also aimed to assess the association between pediatric appendicitis scores and ultrasound imaging and gold-standard histopathology.

Materials and Methods

The present retrospective assessment study aimed to assess the diagnostic accuracy of PAS (pediatric appendicitis scores) in diagnosing acute appendicitis in pediatric patients visiting the emergency department with acute abdominal pain. The study also aimed to assess the association between pediatric appendicitis scores and ultrasound imaging and gold-standard histopathology. The study was done at Tertiary care center of North Maharashtra.

The inclusion criteria for the study were subjects presenting with acute abdominal pain with clinical suspicion of acute appendicitis and subjects with complete data to assess appendicitis. The exclusion criteria for the study were subjects with previously confirmed diagnoses of appendicitis, abdominal trauma, lymphoproliferative disorder, ectopic pregnancy, and incomplete data for assessment.

The data for the study were collected from the previous data of the institute. The data were gathered from the records of the Pediatric Department of the Institute. The data collected were histopathology results, laboratory findings, clinical symptoms, signs, and demographics of the included subjects. The initial data collected from the records were recorded in a file by an examiner blinded to the assessment protocol. The records were further reevaluated by the senior Pediatrician expert in his field. The Pediatric appendicitis score (PAS) [7] was assessed for all the included subjects that were clinically diagnosed with acute appendicitis with the data gathered at the initial presentation of the subject to the institute. The appendicitis, for the present study, was defined as appendectomy with positive gold-standard results, and histopathology. The association between histopathology results and PAS scores was then assessed.

The data gathered were then assessed statistically using SPSS software version 25.0 (IBM Corp, Armonk, NY, USA). PAS was assessed as a continuous variable with scores in the range of 0-10 for acute appendicitis. The data were expressed as mean and standard deviation and frequencies and percentages. Association was established between PAS and clinical outcomes including histopathology results, CT, and ultrasound.

Results

The present retrospective assessment study aimed to assess the diagnostic accuracy of PAS (pediatric appendicitis scores) in diagnosing acute appendicitis in pediatric subjects visiting the emergency department with acute abdominal pain. The study assessed 52 subjects with a mean age of 10.7±3.3 years. There were 75% (n=39) males and 25% (n=13) females. Lower right abdominal pain was seen in 75% (n=39) subjects and pain migration was reported in 65.38% (n=34) subjects. Leukocytosis and fever were reported in 82.69% (n=43) and 46.15% (n=24) study subjects respectively. Cough/hoping and pain on percussion were seen in 23.07% (n=12) subjects, tenderness of the lower right quadrant was seen in 92.30% (n=48) subjects, vomiting and nausea were seen in 84.61% (n=44) subjects, anorexia was seen in 38.46% (n=20) subjects, and WBC differential left shift was seen in 86.53% (n=45) study subjects as shown in Table 1.

In the present study, imaging of the abdomen was done in all the study subjects. However, a CT scan was done in 3.84% (n=2) subjects where ultrasound did not suggest appendicitis but had clinical suspicion of acute appendicitis. In these subjects, computed tomography was done before any surgical intervention.

In all 52 subjects, surgery was performed in the department of Surgery. Among these 52 subjects, in 94.23% (n=49) of study subjects biopsy confirmed the presence of appendicitis. In high-risk, equivocal, and low-risk pediatric appendicitis score subjects, appendicitis on biopsy was confirmed in 48.07% (n=25), 40.38% (n=21), and 5.76% (n=3) study subjects respectively.

The comparison of PAS was done in high-risk, equivocal, and low-risk study subjects, and for each group, negative predictive value, positive predictive

Table 1: Clinical and demographic characteristics of child subjects with clinical suspicion of acute appendicitis

Characteristics	Number (n=52)	Percentage (%)
Mean age (years)	10.7±3.3	
Gender		
Males	39	75
Females	13	25
Right lower abdomen pain	39	75
Pain migration	34	65.38
Leukocytosis	43	82.69
Fever	24	46.15
Percussion pain/hopping/cough	12	23.07
Tenderness of lower right quadrant	48	92.30
Vomiting/nausea	44	84.61
Anorexia	20	38.46
WBC differential left shift	45	86.53

value, specificity, and sensitivity were assessed. Also, the comparison of PAS was done with histopathology and ultrasound groups. The accuracy in point estimates (95% CI) for PAS <4, PAS 4-6, and PAS >6 was 92.1 (85.2-96.64), 95.94 (89.96-98.87), and 75.2 (66.53-82.95) respectively. The negative predictive value for PAS <4, PAS 4-6, and PAS >6 respectively 33.1 (14.84-58.94), 57.12 (28.74-81.54), and 13.77 (8.44-21.76). Positive predictive values for PAS <4, PAS 4-6, and PAS >6 respectively 97.87 (94.05-99.25), 98.93 (94.01-99.83), and 98.65 (92.72-99.75). Specificity for PAS <4, PAS 4-6, and PAS >6 was 60.2 (14.64-94.71), 80.2 (28.34-99.47), and 80.2 (28.34-99.47) respectively. Sensitivity was 93.92 (87.25-97.72), 96.83 (90.94-99.32), and 74.73 (65.04-82.92) for PAS <4, PAS 4-6, and PAS >6 respectively (Table 2).

Table 2: Efficacy of pediatric appendicitis scores at different cut-off values

Variable	PAS <4	PAS 4-6	PAS >6
Accuracy	92.1 (85.2-96.64)	95.94 (89.96-98.87)	75.2 (66.53-82.95)
Negative predictive value	33.1 (14.84-58.94)	57.12 (28.74-81.54)	13.77 (8.44-21.76)
Positive predictive value	97.87 (94.05-99.25)	98.93 (94.01-99.83)	98.65 (92.72-99.75)
Specificity	60.2 (14.64-94.71)	80.2 (28.34-99.47)	80.2 (28.34-99.47)
Sensitivity	93.92 (87.25-97.72)	96.83 (90.94-99.32)	74.73 (65.04-82.92)

Discussion

The present retrospective study assessed 52 subjects with a mean age of 10.7±3.3 years. There were 75% (n=39) males and 25% (n=13) females. Lower right abdominal pain was seen in 75% (n=39) subjects and pain migration was reported in 65.38% (n=34) subjects. Leukocytosis and fever were reported in 82.69% (n=43) and 46.15% (n=24) study subjects respectively. Cough/hoping and pain on percussion were seen in 23.07% (n=12) subjects, tenderness of the lower right quadrant was seen in 92.30% (n=48) subjects, vomiting/nausea were seen in 84.61% (n=44) subjects, anorexia was seen in 38.46% (n=20) subjects, and WBC differential left shift was seen in 86.53% (n=45) study subjects. These data were similar to the studies of Doria AS et al [8] in 2006 and Kulik DM et al [9] in 2013 where authors assessed subjects with similar clinical presentation following appendicitis.

It was seen that the imaging of the abdomen was done in the majority of the study subjects 88.46% (n=46) study subjects. The most preferred imaging modality was an ultrasound of the abdomen preferred by 65.38% (n=34) of study subjects. However, a CT scan was done in 3.84% (n=2) subjects where ultrasound did not suggest appendicitis but had clinical suspicion of acute appendicitis. In these subjects, computed tomography was done before any surgical intervention. These results were consistent with the studies of Ebell MH et al [10] in 2014 and Sayed A et al [11] in 2017 where ultrasonography and CT scans were considered reliable for diagnosis of acute appendicitis.

The study results showed that in all 52 subjects, surgery was performed in the department of Surgery Among these 52 subjects, in 94.23% (n=49) of study subjects biopsy confirmed the presence of appendicitis. In high-risk, equivocal, and low-risk pediatric appendicitis score subjects, appendicitis on biopsy was confirmed in 48.07% (n=25), 40.38% (n=21), and 5.76% (n=3) study subjects respectively. These findings were in agreement with the findings of Kim DY et al [12] in 2016 and Bhatt M et al [13] in 2009 where high reliability was seen in biopsy and PAS scores as seen in the present study.

For the present study, a comparison of PAS was done in high-risk, equivocal, and low-risk study subjects, and for each group, negative predictive value, positive predictive value, specificity, and sensitivity were assessed. Also, the comparison of PAS was done with histopathology and ultrasound groups. The accuracy in point estimates (95% CI) for PAS <4, PAS 4-6, and PAS >6 was 92.1 (85.2-96.64), 95.94 (89.96-98.87), and 75.2 (66.53-82.95) respectively. The negative predictive value for PAS <4, PAS 4-6, and PAS >6 respectively 33.1 (14.84-58.94), 57.12 (28.74-81.54), and 13.77 (8.44-21.76). Positive predictive values for PAS <4, PAS 4-6, and PAS >6 respectively 97.87 (94.05-99.25), 98.93 (94.01-99.83), and 98.65 (92.72-99.75). Specificity for PAS <4, PAS 4-6, and PAS >6 was 60.2 (14.64-94.71), 80.2 (28.34-99.47), and 80.2 (28.34-99.47) respectively. Sensitivity was 93.92 (87.25-97.72), 96.83 (90.94-99.32), and 74.73 (65.04-82.92) for PAS <4, PAS 4-6, and PAS >6 respectively. These results were in line with Rehman S et al [14] in 2014 and Goldman RD et al [15] in 2008 where high sensitivity and specificity of PAS scores were reported by the authors in their respective studies.

Conclusion

Considering its limitations, the present study concludes that pediatric appendicitis scores have high diagnostic accuracy in the prediction of acute appendicitis in child subjects visiting the emergency department with acute abdominal pain. The study assessed subjects of a single geographical region and a smaller sample size with a short monitoring period. Hence, further prospective longitudinal studies are needed with large sample sizes and longer monitoring periods.

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