Evaluation of Pediatric Appendicitis Score in Predicting Appendicitis

Maha A.Lattuf AL-Rudaini[*] , Kawthar Fakhri Khalaf Al-Bayati[**], Zaidoon Moayad Younis Altaee[***]

ABSTRACT:

BACKGROUND:

The diagnosis of acute appendicitis carries significant difficulties, particularly in very young ages on which the history and physical examination are difficult. The clinical challenge is to diagnose appendicitis early enough to prevent perforation, while minimizing the number of negative appendicitis that are performed. The diagnosis of acute appendicitis is primarily clinical and the clinical scoring systems have been investigated as alternatives or adjuncts to diagnostic imaging.

OBJECTIVE:

Is to establish the accuracy and applicability of using pediatric appendicitis scoring system (PAS) in evaluating acute appendicitis in pediatric age group.

METHODS:

A prospective cohort study was conducted in Al-Khansaa Teaching Hospital and Children Welfare Teaching Hospital, from January 2014 till November 2015. The study includes 143 patients aged from (3-13) years old referred from pediatric emergency unit or outpatient clinic with suspicion of acute appendicitis. All the obtained data were analyzed using pediatric appendicitis score (PAS) system which classifies the patients into 3 groups: Group (1): Patients with scoring (1-3) includes 38 patients, Group (2): Patients with scoring (4-6) includes 20 patients, while Group (3): Patients with scoring (7-10) includes 85 patients. Surgery was done to all patients of group 3 and thirteen patients of group 2. All removed appendices were sent for histopathological study.

RESULTS:

The median age of the 98 operated on patients was (8.9 years ± 2.6). The histopathological results of appendicitis were confirmed in 89 patients underwent surgery (five patients of group 2 and 84 patients of group 3), while negative histopathological result of appendicitis is seen in nine (9.2%) patients. There is significant association of positive histopathological findings with high PAS (≥7) scoring ($p<0.0001$). The 8 parameters of PAS system shows accuracy as following: the right lower quadrant tenderness, anorexia and hop tenderness shows accuracy of 90.8%, 87.8% and 86.7% respectively, while leukocytosis, fever and nausea/vomiting shows accuracy of 83.7%, 80.6% and 63.3% respectively. Migration of pain and PMN neutrophilia shows the lowest accuracy rate. The sensitivity of PAS system was 94.4%, the specificity was 88.9%, the PPV was 98.8%, the NPV was 61.5% with overall accuracy of PAS system was 93.9%.

CONCLUSION:

PAS system is easy, simple and useful tool in pre-operative diagnosis of acute appendicitis and can be used by pediatricians to reduce the number of admission to the hospital. Patients with scores of ≥ 7 show high probability of appendicitis and early operation is indicated, while patients with score of ≤3 rule out this disease. The CT scan and diagnostic laparoscopy is advocated for patients with score of (4-6).

KEYWORD: appendicitis, pediatric appendicitis scores (PAS).

INTRODUCTION:

Abdominal pain is common in children and may reflects variety of conditions, whenever it lasts for more than four to six hours and gets more intense, or it is associated with persistent vomiting and diarrhea, it must be taken seriously, and surgical cause ought to be excluded first [(1)]. Acute appendicitis is the most common cause of abdominal pain [(2)]. The diagnosis of acute appendicitis carries significant difficulties,

*Consultant Pediatric Surgeon in Children Welfare Hospital-Baghdad, Iraq.
**Specialist Pediatric Surgeon in Children Welfare Hospital-Baghdad, Iraq.
***Specialist Pediatric Surgeon in Al-Khansaa Teaching Hospital-Musil, Iraq.

particularly in very young ages on which the history and physical examination are difficult and often causes "diagnostic delay" [2, 3] which may result in a complicated disease process [4, 5].

Appendicitis is an uncommon entity in young children and rare in infants [5]. The clinical challenge is to diagnose appendicitis early enough to prevent perforation, while minimizing the number of negative appendicitis that are performed [6]. Proportion of appendices that are normal on histologic studies identifies this problem with a negative appendectomy rate of less than 20% [7].

The diagnosis of acute appendicitis is primarily clinical and the clinical scoring systems have been investigated as alternatives or adjuncts to diagnostic imaging [8]. There are several available scores, recently reviewed by Kulik et al [9], in this systemic review, the Alvarado score and the Pediatric Appendicitis Score (PAS) were considered the most reliable. Pediatric Appendicitis Score (Table1.1), composed by Samuel [10] in 2002; is the only score specifically developed for children between 4 and 15 years age, while other authors [9, 11] in their studies had included children less than 4 years of age. This scoring system was designed to improve the diagnosis of appendicitis and was devised by giving relative weight to specific clinical manifestations. The Table (1) lists eight specific indicators on which patients with score of ≥7 are almost certain to have appendicitis. Patients with score 4 to 6 have a suspicion of appendicitis; while scores of < 4 are compatible to exclude acute appendicitis [10].

AIM OF THE STUDY:

A prospective study was performed to establish the accuracy and applicability of using pediatric appendicitis scoring system in evaluating acute appendicitis in pediatric age group.

PATIENTS & METHODS:

A prospective cohort study was conducted from January 2014 till October 2014 in Al-Khansaa Teaching Hospital in Mosul City and continued then after till November 2015 in Children Welfare Teaching Hospital / Medical City; Baghdad, Iraq. This study includes 143 patients, their ages ranged from (3-13) years old referred from pediatric emergency unit or outpatient clinic with symptoms of less than three days duration in whom the treating physician suspected to have acute appendicitis. Children with urological, gynecological or surgical problems other than appendicitis were excluded from the study. All the patients were interviewed, examined and investigated; then data collection form was filled. The form contained information about patient's age, gender and the date of admission in addition to the date of operation and each of the eight PAS components that had mentioned in Table (1) which includes: nausea/vomiting, anorexia, migration of pain from periumblical to the right lower quadrant (RLQ) of the abdomen, fever of >38ºc, right lower quadrant tenderness and hop tenderness in the physical examination and leukocytosis of >10000/mm³ with PMN neutrophilia (left shift>7500/mm³) in laboratory investigations. Each parameter is assigned 1 score except the physical signs (right lower quadrant tenderness and hop tenderness) which are assigned 2 scores for each, giving a maximum score of 10. All the obtained data were analyzed using pediatric appendicitis score (PAS) which classified the patients into 3 groups:

- **Group (1):** Patients with scoring (1-3).
- **Group (2):** Patients with scoring (4-6).
- **Group (3):** Patients with scoring (7-10).

All patients in Group 2 and 3 were admitted to the hospital on which they kept on nothing per mouth and intravenous fluid, while patients of Group 1 were discharged and instructed to visit the outpatient clinic after one week to reassess and to ascertain the outcome. Surgery was done for all patients in group 3 and most of patients in group 2 after reassessing their scores 4 hours after admition. All removed appendices were sent for histopathological study.

Table 1: Pediatric appendicitis Score for the Diagnosis of acute Appendicitis [10].

HISTORY	Nausea / vomiting	1
	Anorexia	1
	Migration of pain (periumbilical to RLQ)	1
	Fever (>38ºc,oral)	1
EX AM	Tenderness in RLQ	2
	Cough, percussion, hop tenderness	2
LA BS	Leukocytosis (>10000/mm³)	1
	PMN neutrophilia	1
Total points: suspicious (4-6); obvious(≥7)		

***Statistical analysis*:** Each patient assigned a serial identification number. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.

- The continuous data were represented by mean and range.
- The categorical data presented as frequency and percentage tables.
- The Chi-square and Yates correction for chi tests were used to assess the association between variables.
- Reliability tests (Sensitivity, specificity, positive predictive value, negative predictive value and accuracy) were calculated.
- P – Value less than 0.05 was used as the alpha level of significance.

RESULTS:

According to pediatric appendicitis score (PAS), the patients were classified under three categories according to their scores: Group (1) includes 38 patients, they were unlikely to suffer from the disease and all were discharged home and instructed to visit the outpatient clinic after one week to reassess and to ascertain the outcome. Group (2) this includes 20 patients, they were doubtful but potential candidates suffering from the disease and so they were admitted and observed for 4 hours and reassess their scores again, seven patients of them converted their scores to Group 1 and were discharged home and instructed to visit the outpatient clinic after one week to reassess and to ascertain the outcome, while the other thirteen patients were operated on. Neither patients of group (1), nor the seven patients of group (2) need further surgical intervention. Finally Group (3) includes 85 patients and they were considered obvious patients of acute appendicitis and all were operated without delay.

The median age of the operated on patients is (8.9 years ± 2.6). The histopathological findings of the operated on patients shows forty six (47%) patients had acute non obstructive appendicitis, twenty two (22.4%) patients had obstructive acute appendicitis by faecolith and twenty one (21.4%) patients had perforated appendicitis. A negative histopathological result of appendicitis was seen in nine (9.2%) patients.

The Table (2) summarized the 8 parameters of PAS system and their accuracy, the right lower quadrant tenderness, anorexia and hop tenderness shows accuracy of (90.8%, 87.8% and 86.7%) respectively, while leukocytosis, fever and nausea/vomiting shows accuracy of (83.7%, 80.6% and 63.3%) respectively. Migration of pain and PMN neutrophilia shows the lowest accuracy rate (25.5% and 34.7%) respectively.

Table 2: The accuracy of the PAS parameters.

Parameters	Histopathological result No. (%)			SN	SP	Accuracy
	Positive	Negative	Total			
Nausea/vomiting	58 (65.2%)	5 (55.6%)	63 (64.3%)	65.2%	44.4%	63.3%
Anorexia	86 (96.6%)	9 (100%)	95 (96.9%)	96.6%	0.0%	87.8%
Migration of pain	17 (19.1%)	1 (11.1%)	18 (18.4%)	19.1%	88.9%	25.5%
Fever (>38ºc,oral)	72 (80.9%)	2 (22.2%)	74 (75.5%)	80.9%	77.8%	80.6%
Tenderness in RLQ	89 (100%)	9 (100%)	98 (100%)	100.0%	0.0%	90.8%
Cough, percussion, hop tenderness	83 (93.3%)	7 (77.8%)	90 (91.8%)	93.3%	22.2%	86.7%
Leukocytosis (>10000/mm³)	77 (86.5%)	4 (44.4%)	81 (82.7%)	86.5%	55.6%	83.7%
PMN neutrophilia, left shift (>7500/mm³)	27 (30.3%)	2 (22.2%)	29 (29.6%)	30.3%	77.8%	34.7%
SN (Sensitivity), SP (Specificity)						

The validity tests of PAS system in comparison with histopathological findings of the operated patients as following: There are 84 out of 85 patients with positive histopathological findings among the high PAS (7-10) scoring, while there are only 5 out of 13 patients with positive histopathological findings among the lower PAS (4-6) scoring as shown in table (3). The sensitivity of the PAS scoring for positive histopathological results is 94.4%, while the positive predictive value (PPV) is 98.8%. The specificity of the PAS scoring for negative histopathological results is 88.9%, while the negative predictive value (NPV) is 61.5%. The overall accuracy of the PAS scoring is 93.9%.

Table 3: Validity tests of the PAS system in comparison with histopathological finding.

		Histopathological results No. (%)		Total No. (%)
		Positive	Negative	
PAS scoring	7-10 (Positive)	84 (94.4)	1 (11.1)	85 (86.7)
	4-6 (Observation)	5 (5.6)	8 (88.9)	13 (13.3)
Total		89 (100)	9 (100)	98 (100)
Yates correction of Chi= 42.29, DF = 1, p<0.0001 (significant at 0.05 level)				

DISCUSSION:

Despite the fact that acute appendicitis is a common surgical emergency, it still carries significant diagnostic difficulties by the young trainee surgeons who are the first ones to face the condition. Diagnosis of acute appendicitis is not an easy task particularly in young children who found difficulty in communication and localization of the pathology precisely, in addition to that the presence of pathological process may render the child irritable and anxious.

The Pediatric Appendicitis Scoring (PAS) system [10] is the most recent score system used in predicting acute appendicitis in pediatric age group.

According to the histopathological results, there are twenty one (21.4%) patients having perforated appendicitis in this series, this percentage is similar to Samuel [10] who found (18-20)% perforation rate, but it is lower than Martin Salö et al [11] who found 33.3%

perforation rate. This might be because the last series includes younger (<4 years) and older (≥4 years) children with significantly more sever inflammation among the younger one [11], while the former series [10] were using nearly the same age group as this series. The negative appendectomy rate was (9.2%) and this result resembles to Maala Bhatt et al [6], Jawaid [12] et al and Martin Salö et al [11] who found 8.8%, 7% and 6.9% respectively. But it is lower than Richard et al [13] who found 16.4%. It is universally accepted that the current range of negative appendectomy is (13-17) % [14].

In this series, the PAS system shows accuracy of the right lower quadrant tenderness, anorexia and hop tenderness of 90.8%, 87.8% and 86.7% respectively, while leukocytosis, fever and nausea/vomiting shows accuracy of 83.7%, 80.6% and 63.3% respectively. PMN neutrophilia and migration of pain shows the lowest accuracy rate of 34.7% and 25.5% respectively. These readings showed that the physical signs like right lower quadrant tenderness and cough / hop tenderness are more important in diagnosis of acute appendicitis than the symptoms and laboratory tests and this is in agreement with Samuel [10] who assigned these variables as a single variable of score 2 for each. The high accuracy of anorexia elicit that hungry child rarely has appendicitis [15]. Migration of pain and PMN neutrophilia showed the lowest sensitivity rate of 19.1% and 30.3% respectively; contradict to Samuel [10] who found sensitivity rate of 98%, 81% respectively, this can be explained by limited number of patients in the current series comparing to Samuel [10]. The low accuracy of migration of pain can be explained by difficulty of a child to localize and describe pain [11].

There are 84 out of 85 patients with positive histopathological findings among the high PAS (7-10) scoring, while there are only 5 out of 13 patients with positive histopathological findings among the lower PAS (4-6) scoring. These readings show significant association of positive histopathological findings with high PAS scoring ($p<0.0001$). This result indicates that the cut point of 7 shows high probability of appendicitis and no need for further observation or investigations. Patients with scores of ≤3 rule out appendicitis as they visit the outpatient clinic after one week and no one of them need further surgical intervention during that period. Patients with (4-6) scoring should be admitted and re-evaluated after few hours of nothing per mouth and giving adequate intravenous fluid. If the score decreases; which were happened in 7 patients, they had been discharged and no one of them need further intervention during a week of follow up, while the 13 patients in whom the score remains the same or increase, they had underwent surgery. According to histopathological results, the high unnecessary appendectomy in the group 2 is imperative not to miss or delay a needed appendectomy as there is risk of perforation with greater morbidity in the short term potentially leading to late complications of adhesive intestinal obstruction and infertility (in females). Now the CT imaging [16] and diagnostic laparoscopy [17] are increasingly being advocated in this group of patients.

In the present series, the PAS sensitivity was (94.4%) which goes with Malaa Bhaat et al [6] and Samuel [10] who found sensitivity of 97.6% and 100% respectively. While Martin Salö et al [11] found sensitivity of 70.5% for older children (≥4 years old). The specificity was (88.9%) which is consistent with Samuel [10] and Malaa Bhaat [6] who found 92% and 95% respectively, while Martin Salö et al [11] found 14.2% specificity for older children (≥4 years old). These low sensitivity and specificity of Martin Salö et al [11] can be explained that they used the cut point at score 6, while Malaa Bhaat et al [6], Samuel [10] and this series are using the cut point of 7.

In this series, the positive predictive value was (98.8%) compared with Jawaid et al [12] and Chan MY et al [18] who found 97% and 97.6% respectively, while the negative predictive value was 61.5%, which is near the Subhajeet et al [19] who found 69.8%, but it is lower than Malla Bhaat et al [6] and Samuel [10] who found the NPV of 97.7% and 99% respectively.

CONCLUSION:

PAS system is easy, simple and useful tool in pre-operative diagnosis of acute appendicitis and can be used by pediatricians to reduce the number of admission to the hospital. Patients with scores of ≥ 7 show high probability of appendicitis and early operation is indicated, while patients with score of ≤3 rule out this disease. The CT scan and diagnostic laparoscopy is advocated for patients with score of (4-6).

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