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Original article

Comparative Study between Modified Alvarado Score and Abdominal Ultrasound Diagnostic Value of Acute Appendicitis in Children

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ABSTRACT

Background: Diagnosis of acute appendicitis depends mainly on clinical diagnosis. However, the high negative rate remains a challenge and different aids for diagnosis had been proposed.

The aim of the work: The current work aimed to assess the sensitivity of Modified Alvarado Score [MAS] in diagnosis of acute appendicitis.

Patients and Methods: One hundred children with clinical manifestations of acute appendicitis were included. Patients were categorized into two groups according to MAS: [group A] included 50 patients with [MAS] ≥ 7 regardless of sonography results. The second group [group B] included another 50 patients with MAS <7 and abdominal ultrasound study suggestive for appendicitis. Intraoperative diagnosis had been performed for 100 patients with postoperative histopathological study for all cases.

Results: Tenderness in right iliac fossa was the most frequent sign in the study population [98%]. Histopathology revealed positive results among 49 patients [47 in group A and 2 in group B] with significant difference between groups A and B. The overall sensitivity and specificity of ultrasonography were 89.4% and 33.3% respectively and were 96.0% and 20.0% respectively of MAS score.

Conclusion: In acute appendicitis, MAS is a good diagnostic [sensitive] tool. Sensitivity increased when combined with ultrasound, as the number of negative appendectomies was reduced.

Keywords: Appendicitis; Modified Alvarado; Ultrasound; Diagnosis; Children

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* Main subject and any subcategories have been classified according to the research topic.

INTRODUCTION

Acute abdomen represents about 9% of childhood primary care visits. The likelihood of the diagnosis of surgical etiology increased with the presence of the following manifestations: fever, bilious vomiting, bloody diarrhea, absent sounds of bowel, voluntary guarding, abdominal rigidity and rebound tenderness. Patient age could help in the differential diagnosis. For example, congenital anomalies are more suspected diagnoses in infants. However, respiratory tract infections, gastroenteritis, colitis and urinary tract infections are more expected for school-aged children. Gynecological causes must be considered in female adolescents. The most common surgical etiology among children and adolescents is the acute appendicitis [1].

The pathophysiology of appendicitis is usually described as a process of five stages completed over 24 to 36-hours, starting by appendiceal lumen obstruction and distension as a result of inability to drain. Its etiology is widely different and multi-factorial. However, lymphoid hyperplasia, fecaliths, malignancy, foreign bodies and parasitic infestations have all been described. The obstruction may occur at any point of the appendix during its course [5-25 cm] from the tip to its colic junction [2].

After obstruction, the second stage manifested by neurogenic pain due to stimulation of the 8^{th}–10^{th} visceral afferent thoracic nerves. Clinically, it is a mild to moderate pain, located at the peri-umbilical region and typically lasts for 4–6 hours [3].

With continuous increase of the intraluminal pressure, there is a reduction of appendiceal wall perfusion due to arterial insufficiency. This third stage leads to tissue ischemia. Bacteria are then able to invade the luminal wall, leading to transmural inflammation [the fourth stage] [4].

Despite considerable advances of knowledge related to appendicitis, the accurate diagnosis remains suboptimal, particularly in children. Initial misdiagnosis reported rates range between 28% to 57% for 12 years old or younger children to nearly 100% for children 2 years or younger irrespective of the availability of multiple diagnostic tools [5].

The clinical diagnosis of acute appendicitis classically depends on the history and clinical examination of the patients. The classic symptoms include a central [para umbilical] pain or colic which will shift to the right iliac fossa, accompanied with anorexia and nausea, while the signs of clinical examination include mild fever, tenderness localized in the right iliac fossa, guarding of the abdominal muscles, and rebound tenderness [6].

The clinical diagnosis is required for the laboratory and radiological tests to increase the suspicion of acute appendicitis. The leucocytic count is the laboratory information mostly included for diagnosis of non-complicated acute appendicitis [usually ranged between 10,000–18,000 cells/cc with predominancy of polymorphic nucleocytes]. But, if the white cells >18,000 cells/cc, it indicated a higher suspicion of complicated acute appendicitis [7].

Alvarado described a scoring system that was modified by kalan *et al*. The system involves clinical and laboratory manifestations with a total score of 9. A score of 7 or more is considered high probability for acute appendicitis [8].

Acute appendicitis remains a clinical diagnosis, but with uncertainty, abdominal ultrasound represents a helpful imaging tool. It is a cheap and noninvasive modality with reported accuracy 70–95% [9].

Ultrasonographic criteria for diagnosis of acute appendicitis include blind-ended, non-compressible, a peristaltic tube, with a diameter of more than 6 mm, arising from the tip of cecum with a gut signature. The presence of an appendicolith, is a positive test regardless of the appendiceal diameter [10].

The histopathological diagnosis of acute appendicitis would be based on the finding of neutrophilic infiltration of the muscularis propria which can confirm pre-operative diagnosis and exclude missed one [11].

Here, we tried to reach the optimal diagnostic method for acute appendicitis in children. We intended to compare the most acceptable and widely used methods to discover which of them could be used as a standard diagnostic method.

THE AIM OF THE WORK

The current work aimed to assess the sensitivity of Modified Alvarado Score in diagnosis of acute appendicitis in children compared to abdominal ultrasound, correlated with the histopathological study postoperatively.

PATIENTS AND METHODS

This prospective study included 100 patients presented with acute abdomen suspected of acute appendicitis at Al-Azhar University Hospital [New Damietta]. All guardians of patients participate in this study signed an informed written consent. In addition, the study protocol had been approved by the local institutional review board [IRP] for its ethical considerations.

Patients with the following criteria had been included in the study: age up to 18 years, who underwent appendectomy. Alternatively, patients who had one or more of the following criteria were excluded from the study; age > 18 years, the right iliac fossa swelling, generalized peritonitis, gynecological or urological causes of acute abdomen & iliac fossa pain, history of previous operation of right iliac fossa, history of immune compromised patient or immune suppressive drugs, and history of abdominal radio-therapy.

Patients in the current study were divided into two groups; the first group [group A] included 50 patients with Modified Alvarado Score [MAS] ≥ 7, regardless the results of the abdominal ultrasound study [the appendectomy was carried out on the basis of MAS score, and compared to results of histopathology]. The second group [group B] included another 50 patients with MAS <7 and abdominal ultrasound study suggestive for appendicitis [the appendectomy decision based on the results of ultrasounds].

Intraoperative diagnosis had been performed for 100 patients with postoperative histopathological study for all cases. All patients underwent full preoperative assessment by history taking, clinical examination and laboratory investigations [complete blood count [CBC], serum creatinine and international normalized ratio [INR].

The radiological evaluation had been performed through pelvi-abdominal ultrasound. Modified Alvarado score had been calculated as described by Kalan *et al*.[12].

Briefly, the score assesses six signs and symptoms and one laboratory result. Each of migratory right iliac fossa pain, anorexia, nausea/vomiting, rebound tenderness and fever, assigned a score of one and each of tender right iliac fossa and leukocytosis assigned a score of two. The total score is 9. Th score equal to more than 7 is considered positive. However, score < 7 is considered quarry appendicitis.

All surgical interventions had been accomplished by open surgery in the supine position under general or spinal anesthesia. The follow up composed of calculation of operative time, duration of hospital stay and any complications were documented. Finally, the sensitivity of ultrasound and MAS were calculated according to the histopathological diagnosis.

RESULTS

Patient's age ranged from 6- 18 years with a mean age of 13.7±3.0. The male gender has the highest frequency with 56% of the total number of the study population. There was no statistical difference between the two groups according to the age and gender [Table 1].

Tenderness in the right iliac fossa was the most frequent sign in the study population [98%] while the migration of pain to the right iliac fossa was the least frequent symptoms in the study population [45%] [Table 2].

In the current work, the histopathology revealed positive results among 49 patients [47 in group A and 2 in group B] with a significant difference between groups A and B [X^2= 81.03, p < 0.001]. The overall sensitivity and specificity of ultrasonography were 89.4% and 33.3% respectively. Otherwise, the sensitivity and specificity of Modified Alvarado score were 96.0% and 20.0% respectively as shown in Tables [3, 4]. Finally, no significant difference between males and females regarding studied variables except a significant increase of the rebound tenderness in males compared with females [60.7% vs 38.6%, p = 0.028].

Table [1]: Patient demographics among groups A and B

Variable		Group A	Group B	Over all	P value
Age		14.2 ± 2.7	13.3 ± 3.1	13.7 ± 3	0.47
Gender	Male	29 [58%]	27 [54%]	56 [56%]	0.69
	Female	21 [42%]	23 [46%]	44 [44%]	

Table [2]: Presenting symptoms and signs in relation to MAS

Symptoms and signs	MAS [1-4]	MAS [5-6]	MAS [7-9]	Total [%]
Tenderness in right iliac fossa	8	40	50	98 [98%]
Leukocytosis	8	42	48	95 [95%]
Anorexia	2	39	46	87 [87%]
Nausea and vomiting	2	29	31	62 [62%]
Temperature >37.2°C	3	22	36	61 [61%]
Rebound tenderness	1	14	34	49 [49%]
Migration of pain to right iliac fossa	2	13	30	45 [45%]

Table [3]: Overall distribution of U/S finding regarding histopathology in the study population

		Ultrasound	
		Negative [6]	Positive [94]
Histopathology	Negative	2[33.3%]	10[10.6%]
	Positive	4 [66.7%]	84[89.4%]
Sensitivity		89.4%	
Specificity		33.3%	

Table [4]: Overall distribution of Modified Alvarado Score [MAS] regarding to histopathology in the study population

		MAS	
		>= 7 [50]	<7 [50]
Histopathology	Negative	2[4.0%]	10[20.0%]
	Positive	48[96.0%]	40[80.0%]
Sensitivity		96.0%	
Specificity		20.0%	

DISCUSSION

The Alvarado scoring system was first introduced in 1986 for pregnant females, and then used for general populations. It had a maximum score of ten and based on six clinical parameters and two laboratory variables. Leukocytosis and tender right iliac fossa are the most important variables and thus assigned two points [13].

Regarding clinical results of the current work, it is comparable to those reported by Peyvasteh *et al*. [14] who reported that, the most common clinical manifestations in children with appendicitis were rebound tenderness, anorexia, nausea and vomiting.

Results of the current work, the sensitivity and specificity of MAS were 96.0% and 20.0% respectively which is comparable to Gujar *et al*. [15] study which showed sensitivity and specificity of MAS were 98.44, while they reported 94.44% specificity which is higher than the current work.

On the other side, current results different than Nautiyal *et al*. [16] who showed sensitivity of 77% and specificity of 87%. All these studies besides current one, showed that, both MAS and abdominal ultrasound are sensitive diagnostic tools.

Kariman *et al*. [17] stated that, to have a good specificity, MAS must be followed or combined by laparoscopy, which elevated the specificity to 97.9% or even 100.0% and PPV 95%.

In the current work, MAS had better sensitivity than ultrasound, but specificity is lower [however, both were low in specificity]. Ozkan *et al*. [18] reported comparable results, as MAS had better sensitivity than US [71.2% vs 46.7% respectively]. They interestingly used computed tomography and reported a sensitivity of 97.2% and 62.5% specificity.

Peyvasteh *et al*. [14] reported MAS sensitivity of 91.3% and specificity of 38.4% [their reported sensitivity is lower than the current study, whereas specificity is higher].

Khanafer *et al*. [19] reported 83.3% sensitivity and 32.0% specificity. At the same cutoff point score as the current one [≥7 was] the sensitivity was 76.37 and specificity 78.8% specificity.

In addition, Peyvasteh *et al*. [14] reported that, all children with MAS score > 7 had appendicitis on histopathological specimens. Kanumba *et al*. [20] reported 97.3% of children with MAS score >7 had appendicitis

Ultrasound is a cheap, portable and non-irradiating diagnostic tool, and can be rapidly performed without special patient preparation. Thus, it is an ideal non-invasive tool to image the abdomen. In addition, it is safe to be used in children [21].

In our study, ultrasound showed sensitivity of 89.4% and specificity of 33.3%.

Gujar *et al*. [15] showed ultrasound sensitivity of 98.44% and specificity of 94.44%, while Nautiyal *et al*.[16] reported sensitivity was 97.14% and specificity of 88.57%.

These results are widely different from the current study and could be explained by different inclusion criteria and operator experience. Also, ultrasound could be complementing to clinical scores and judgment because in some cases, an inflamed appendix could not be visualized due to bowel gases[22].

Kurane *et al*. [23] carried one-year prospective study comparing MAS to ultrasound and reported that, although MAS score is a useful tool in clinical decision making, it is not advantageous than ultrasound, when each tool is used alone. The use of ultrasound in their opinion improves the diagnostic accuracy.

The unique design of the current work revealed the value of MAS score and children with lower mass score [<7], the ultrasound played an important role in decision making and provided a good sensitivity.

Conclusion: In acute appendicitis, MAS is a good diagnostic tool, and it is highly sensitive in diagnosis. However, it is not specific [it could elicit positive cases, but negative patients need confirmation by other tools] and when combined with ultrasound, it decreases the numbers of negative appendicectomies.

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None

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