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Review Article

DIAGNOSTIC ACCURACY OF ALVARADO SCORING SYSTEM IN ACUTE APPENDICITIS

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ABSTRACT

Appendicitis is a global disease with higher incidence in developing countries. This report aimed to understand more about the diagnostic accuracy of Alvarado score and its components. The study sought to assess the discrimination (diagnostic accuracy) and calibration performance of the Alvarado score and to evaluate its usefulness in reducing the percentage of negative appendectomy in our hospital. A cross-sectional study was conducted, comprising 104 patients, admitted to general surgery department at Misurata Medical Center, from 1st January 2022 to 31 December 2022 with a preliminary diagnosis of acute appendicitis. Children younger than 6 years and pregnant ladies were exclude from the study. All patients were given specific scores according to the variables of the Alvarado scoring system and then divided into 3 groups: Group 1: score 3 or less (unlikely acute appendicitis), Group 2: score 4–6 (probably acute appendicitis), and Group 3: score 7 or more (likely acute appendicitis). The efficacy of Alvarado scoring system was assessed by calculating sensitivity, specificity, positive predictive value, negative predictive value and negative appendectomy rate. Out of 104 cases, 71 were males and 33 females. At score of 7 or more, appendicitis was confirmed in 94 patients out of 95 patients (99%), while at scores < 7 appendicitis was confirmed in 5 patients out of 9 patients (56%). The sensitivity was 94%, the specificity was 75%, the positive predictive value was 98% and the negative predictive value was 33%. In the present study, negative appendectomy rate was 3.7%. Alvarado score can be used effectively in our setup to reduce the incidence of negative appendectomies. The scoring system is a useful diagnostic tool regarding sensitivity and positive predictive value. It is cheap, reliable, and can be easily applied.

KEYWORD: Appendicitis, Alvarado score, Diagnostic accuracy

INTRODUCTION

Acute appendicitis is one of the most common surgical emergencies [1]. The diagnosis is particularly challenging due to the absence of typical symptoms and suggestive laboratory data in approximately 20–33% of cases [2]. A prompt and accurate diagnosis followed by early appendectomy is crucial to avoid complications arising from perforation [3]. Acute appendicitis (AA) requires emergency management due to its potentially severe consequences. If left untreated, it carries a high risk of complications including perforation, peritonitis, and abscess formation, along with surgical procedure-related complications [3]. The mortality rate is particularly concerning in elderly patients with perforated appendicitis, ranging between 2.3% and 10% [4].

While various diagnostic approaches exist, routine history-taking and physical examination remain the most

practical diagnostic modalities [5]. The definitive diagnosis, however, can only be established during surgery and subsequent histopathologic examination of the specimen [6]. The negative appendectomy rate (NAR), defined as the proportion of histologically normal appendices in patients undergoing appendectomy, is a significant concern. Many surgeons accept a NAR of up to 30% as unavoidable [7], though this places unnecessary strain on both individuals and healthcare resources [8].

Multiple diagnostic modalities have been proposed to improve diagnostic accuracy, including:

-Clinical scoring systems
-Computer programs
-Ultrasonography (US)
-Computed tomography (CT) scans
-Magnetic resonance imaging (MRI)
-Laparoscopy [9,10]

While imaging techniques offer reasonable precision [11], they come with significant limitations. These include potentially harmful ionizing radiation with CT, examiner-dependent efficacy in ultrasonography, and technique-associated morbidity in diagnostic laparoscopy [12,13].

- In 1986, Alvarado developed a 10-point scoring system (ASS), also known by the acronym MANTRELS, for diagnosing acute appendicitis. This system assigns weighted scores to various clinical and laboratory findings (Table 1)

1- Migrating right iliac fossa pain
2-Nausea and vomiting
3-Anorexia
4-Rebound tenderness
5-Elevated temperature
6-Shift of white blood cells to the left
One point each
7-Tenderness
8-Leukocytosis
Two points each [15,16].

Table 1:The Alvarado scoring system

	The Alvarado scoring system		Alvarado score
1	Symptoms	Migratory RIF pain	1
2		Nausea/vomiting	1
3		Anorexia	1
4	Signs	Right iliac fossa tenderness	2
5		Elevation of temperature	1
6		Rebound tenderness RIF	1
7	Laboratory findings	Leukocytosis	2
8		Neutrophilic shift to the left (>75%)	1

The Alvarado scoring system has proven to be simple, effective, and easy to use, providing an accurate tool to rule out appendicitis [17]. Based on the scoring:

-Scores 5-6: Likely to have acute appendicitis
-Scores 7-10: Most likely suffering from acute appendicitis

Management recommendations suggest that patients with scores of 7-10 should undergo appendectomy, while those with scores of 4 , 5 or 6 are candidates for CT scanning , abdominal ultrasonography and further diagnostic confirmation [18].

MATERIALS AND METHODS

A cross-sectional study comprising consecutive patients (n = 104) was conducted over a period of 1 year at general surgery department MMC from 1st January 2022 to 31 december 2022. The study included patients of both sexes and all age groups, except those younger than 4 years, who were presented with pain in the right lower quadrant or paraumbilical pain shifting

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to the right iliac fossa. Patients who were clinically diagnosed as cases of acute appendicitis were enrolled in the study, and their Alvarado scores were calculated into three groups: Group 1 included patients with scores of 3 or less (unlikely acute appendicitis), Group 2 comprised those with scores of 4–6 (probably acute appendicitis), and Group 3 consisted of patients with scores of 7 or more (likely acute appendicitis) (Table 2).

Table 2. Risk stratification of patients by utilizing the Alvarado Scoring system.

Alvarado Scoring System	Probability of AA	Included in study or not
< 4	Less likely	No
4–6	Likely	Yes
7–10	Most likely	Yes

This study was conducted to analyze the diagnostic accuracy of the ASS relative to histopathological analysis in the prediction of acute appendicitis.

In our setup, the decision to operate on the patient was taken by the senior physician provided the history and findings were consistent with the diagnosis of appendicitis. Alvarado score was calculated and then compared once the histopathological report was available, which is considered as a gold standard in diagnosis of acute appendicitis. Various scoring systems have been developed to help improve the diagnosis of acute appendicitis. Many of them are difficult to apply in a clinical setting in emergency department primary care setting, especially in low resource countries. Alvarado score is simple, effective and can be easily applied. It provides an accurate and consistent triage tool for ruling out appendicitis and identifying those at higher risk.

The Alvarado scoring system, based on three symptoms, three signs, and two laboratory findings, was applied to all patients. The decision for admission and surgical intervention was made by the surgeon independent of the Alvarado score and was based on patients' history and clinical examination. Prior to appendectomy, abdominal ultrasound was performed on all patients to exclude other pathologies. Management options included conservative treatment, which was provided to all patients, and surgical intervention through either open or laparoscopic appendectomy, performed according to the surgeon's preference. All surgically removed specimens underwent gross examination during operation and were subsequently subjected to histopathological assessment, which is considered the gold standard for final diagnosis of acute appendicitis. The efficacy of the Alvarado scoring system was evaluated by calculating sensitivity, specificity, positive predictive value, and negative predictive value. Additionally, the reliability of the scoring system was assessed by calculating the negative appendectomy rate, defined as cases showing no signs of inflammation on histopathological examination of the surgically removed appendix.

RESULTS

One-hundred and four patients with clinical features suggestive of acute appendicitis were included in the study. The largest age group was 10–20 years. The symptoms at presentation included pain in right iliac fossa (99%), nausea and vomiting (84.6%), and anorexia (50%). Clinical examination revealed tenderness in right iliac fossa in 103 cases (99%), rebound tenderness in 41cases (39.4%), and elevated temperature in 59 cases (56.7%). Laboratory analysis showed raised total leukocyte count in 96 cases (92.3%) with neutrophilia in 81 cases (77.8%).

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Table 3: Clinical examination results

Feature	No.	%
Tender in RLQ	103	99
Leucocytosis	96	92.3
Nausea	88	84.6
Rebound pain	41	39.4
Anorexia	52	50
Shift of WBC	81	77.8
Elevated temperature	59	56.7
Migration of pain	33	31.7

Analysis of the subjects based on the Alvarado score indicates that 95 of the subjects exhibited a score of 7 or more, and 6 of the subjects had a score of between 4 and 6. Only 3 of the subjects had a score of between 1 and 3. Operative findings reveal that the rate of negative appendectomy was very minimal, representing a percentage of 3.8% (Table 4).

Table 4: Appendectomy operative finding

Variables	No.	%
Negative appendectomy	4	3.8
Positive appendectomy	100	95.2

On histopathological confirmation, 98.9% of patients had an acutely inflamed appendix with an Alvarado score ≥7, 83.3% with a score of between 4 and 6, and 33.3% with a score ≤3 (Table 5). The sensitivity, specificity, positive predictive value, negative predictive value, were 94 %, 75%, 98.95%, 33.3%, respectively.

Table 5. Correlation of Alvarado score with histopathology

Alvarado score	No.	Positive	Negative
7–10	95	94 (98.9%)	1 (1.1%)
4–6	6	5 (83.3%)	1 (16.6%)
1–3	3	1 (33.3%)	2 (66.6%)

DISCUSSION

Acute appendicitis remains the most common abdominal condition requiring surgical intervention worldwide [8]. Various scoring systems were designed to decrease the negative appendectomy rate and increase the positive diagnostic rate of appendicitis [10]. Among them, a comprehensive scoring developed by "ALVARADO" in 1986 provides a practical diagnostic aid in interpreting the diagnosis of acute appendicitis [8]. The Alvarado's scoring system was introduced initially as an adjuvant to diagnose appendicitis to correct the previous false-positive diagnostic rate [11]. The Alvarado scoring system was simple, easily applicable, and useful in emergency surgical hospitals [12].

Epidemiological studies have shown that appendicitis is more common in the age 10–30 year group [13,14]. Our study also revealed a high incidence in the age <30 year group, [13]. In our study, males were more frequently affected than females. The diagnosis of acute appendicitis still represents one of the most controversial tasks in general surgery, and can humble even the most experienced medical practitioner. This may be due to variable presentations of the disease and lack of a reliable diagnostic test [13]. Early surgical intervention in the course of the disease to limit complications, leads to too many negative appendectomies being performed, with an associated mortality rate of 10%.14 The removal of a healthy appendix is associated with a greater risk of abdominal adhesions as compared to acute appendicitis [15]. This contrasts with an increasing rate of appendiceal perforations associated with delayed surgical interventions for the purpose of increasing diagnostic accuracy at the opposite end of spectrum. An appropriate approach towards the

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diagnosis of acute appendicitis is reached mainly by good history and proper clinical examination [2,3].
However, it is reliable mainly for cases with classical presentation. Atypical cases present a diagnostic dilemma. Therefore, clinical diagnosis should be complemented with other diagnostic modalities such as ultrasound, computed tomography (CT), and laparoscopy levels to reduce negative appendectomy rate in equivocal cases. [17,18].
To discriminate between acute appendicitis and nonspecific abdominal pain, various diagnostic scores have been advocated to reduce the frequency of negative surgeries, one of which is the Alvarado scoring system. Alvarado devised this in 1986, and it has been validated in adult surgical practice [12], by giving relative importance to specific clinical manifestations often found in such patients [15]. It is simple, easy, extremely affordable, and relatively accurate in aiding clinical diagnosis especially in interpreting the extremes of score range. Various studies have shown promising results by incorporating this system in the diagnostic process with significant reduction in false negative cases [6]. The reason for the high rate of negative appendectomy in our setup may be that appendectomies were performed on almost all patients presented with conditions mimicking acute appendicitis. However appendiceal perforations were also seen in our study due to delayed diagnosis and referral in some cases. When considering the approaches to appendectomy, both open and laparoscopic procedures are appropriate for all patients. Patients treated with a laparoscopic appendectomy have significantly fewer wound infections, less pain, and a shorter duration of hospital stay. This high level of sensitivity (93.5%) suggests Alvarado score to be an effective diagnostic aid in acute appendicitis.

CONCLUSION

In conclusion, the Alvarado score can be used effectively in our setup to reduce the incidence of negative appendectomies. The patients are not unduly exposed to risks of delay in intervention or significant increase in number of false negative cases. Its use is economical and can be applied easily even by junior surgeons with limited diagnostic facilities available to them. However its role in females was not satisfactory and needs to be supplemented by other means to improve the diagnostic accuracy. Ultrasound is the most commonly used investigation for this purpose. It helps to make prompt decision in suspected cases especially in patients at extreme of ages and females but it cannot be relied upon to the exclusion of the surgeon's careful and repeated evaluation. Our recommendations are: false results are unlikely in patients with a high score (9 or 10) and no further investigation is needed; those with scores of 7 or 8 may require further investigations—especially female patients or those at age extremes; and those with scores of 5–6 may have the disease and further observation or investigations are needed.

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