

Effectiveness of Modified Alvarado Scoring System for Diagnosis of Acute Appendicitis

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ABSTRACT

BACKGROUND

Acute appendicitis is very commonly diagnosed when a patient presents with acute abdomen. This is more commonly seen in the young and middle-aged individuals. The clinical signs and symptoms determine the diagnosis and management. Scoring systems are in plenty to diagnose acute appendicitis and mainly include the presenting signs and symptoms, but are not acceptable for all populations with different age groups. Modified Alvarado scoring system is a timed tested scoring system used in different populations and age groups with good efficacy and to provide a bedside clinical diagnosis of acute appendicitis. The purpose of this study was to assess effectiveness of modified Alvarado score in the early diagnosis of acute appendicitis.

METHODS

A prospective observational study was done which incorporated 50 patients presenting with the signs and symptoms pointing out to acute appendicitis, clinically. The patients were evaluated by Modified Alvarado score during admission and based on the treating surgeon's decision, were operated. Finally, the score was compared with the diagnosis achieved with a histopathological examination of the operated specimen.

RESULTS

The sensitivity of raja isteri penigran anak saleha appendicitis (RIPASA) score was 70.58 %, specificity was 68.75 %, positive predictive value (PPV) was 82.75 %, negative predictive value (NPV) of RIPASA score was 52.38 % and the diagnostic accuracy of RIPASA score was 70 %.

CONCLUSIONS

Modified Alvarado scoring system is simple scoring system which can be used in a bedside manner but uses specific and limited features for the diagnosis of acute appendicitis which limits the effectiveness of this scoring system.

KEY WORDS

Acute Abdomen, Clinical Scoring System, Modified Alvarado Scoring System

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BACKGROUND

The clinical presentation of acute appendicitis in a patient, maybe confused with many other similarly presenting emergencies of the abdomen. The clinical presentations of the appendix can show diverse presentations as there is the presence of numerous surrounding structures. Atypical signs and symptoms are usually seen in extremes age groups.¹

An amalgamation of clinical and imaging methods is used to diagnose acute appendicitis. In spite of advances in technological methods, the variety of presentations of acute appendicitis poses a challenge. In only about 50 % cases, clinical diagnosis is effective² which is completely dependent on the examining clinician and his clinical skills gathered with experience. The mortality associated with complications of acute appendicitis has been found to be between 0.2 and 0.8 %. the mortality rates can go up to 20 % due to delay in diagnosing the condition and the treatment which follows it.²

Due to many complications and the mortality associated with the complications, acute appendicitis is more often managed surgically than adapting a conservative management. Many conditions such as pregnancy and other gynaecological disorders and in the accompaniment of genitourinary disorders mask the presence of acute appendicitis and thus making the diagnosis difficult. Delay in the diagnosis of acute appendicitis raises the morbidity and mortality of the patient. Though mortality rate of acute appendicitis is < 0.1 percent in uncomplicated cases, the mortality rate raises to 0.6 percent when there is association with gangrene and 5 percent when accompanied by perforation.³

Many clinical scores were created over the decades⁴ due to high responsibility attached with fast and accurate diagnosis. The scores were created with the background that good clinical skills and modern technological advances, help to improve the accuracy in diagnosing acute appendicitis.⁴ A dependable scoring system should have high sensitivity, specificity and diagnostic accuracy and must be able to be applied over varied populations and must reproduce similar results. In this quest, numerous studies were conducted world-wide to compare different scoring systems.

The scoring system by Alvarado was first elucidated in 1986⁵ and is endorsed in adult surgical practice by various studies. By using scoring systems, the rate of unnecessary appendectomies can be reduced up to 5 %.⁵ The scoring system was aimed to decrease the rates of negative appendectomy keeping in mind the associated morbidity and mortality and was later altered by M. Kalan, D et al. in 1994.⁶ The modified Alvarado scoring system has been in use over the past few decades and has been applied over different populations and has been validated by many studies.

This study was done on the population in central India to know the validity and relevance of modified Alvarado scoring system in the diagnosis of acute appendicitis.

Aim

To assess effectiveness of modified Alvarado score in the early diagnosis of acute appendicitis.

Objectives

Observation of the outcome of modified Alvarado scoring system with respect to sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy.

METHODS

This was a prospective observational study. This study was done at a rural hospital in central India over a period of 2 years from September 2018 to August 2020. Following the approval of the Institutional Ethics Committee of Datta Meghe Institute of Medical Sciences, Sawangi (Meghe), Wardha in 2018, this study was done. The patients who presented to the rural hospital with pain in the right iliac fossa (RIF) were studied and operated for acute appendicitis, were included in this study. Patients lesser than 13 years, pregnant females and patients with associated complications like perforation and peritonitis were excluded from the study. The sample size was kept as 50 after consulting the statistician.

Sample Size Calculation

$$n = (Z\alpha/2)^2 p(1 - p)/d^2$$

Where $Z\alpha/2$ is the level of significance at 5 % i.e 95 % confidence interval = 1.96

P = is the proportion of number of cases with acute appendicitis, 6.3 %- 0.063

D = is desired error of margin = 7 % = 0.007

$$n = 1.96^2 \times 0.063 \times (1 - 0.063) / 0.07^2 = 46.28$$

Thus, the sample size was taken as 50 which was in conformance to Chaudhari YP, Jawale PG. Prevalence of appendicitis at surgery inpatient department (IPD) of a tertiary care hospital. *Int Med J.* 2015;2(11):768-0. After explaining the patients about the study and risks and consequences of the surgical intervention, informed written consent was taken. Additionally, demographically significant data like age, sex, any history of comorbidities were collected. A complete clinical examination of the patient and laboratory tests of the patients were done. Later, depending on the treating clinician's decision, the patients were subjected to surgical intervention. After the surgical intervention, the specimens were sent for histopathological examination. The final reports were correlated with the score of modified Alvarado scoring system and further a statistical analysis was done with these reports and scores.

Statistical Analysis

All the data that was collected was put into an organised master chart. The data was made into sections and spread over with individual tables made with graphs on Microsoft Excel worksheet (Microsoft, USA). IBM Statistical Package for Social Sciences was used for Statistical Analysis (Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.).

RESULTS

In the current study, 50 patients were included and modified Alvarado score was applied pre operatively. A total of 7 parameters were included in the modified Alvarado score which included pain migration to right iliac fossa, anorexia, nausea and vomiting, right iliac fossa tenderness, rebound tenderness, fever and raised white blood count (WBC) count.

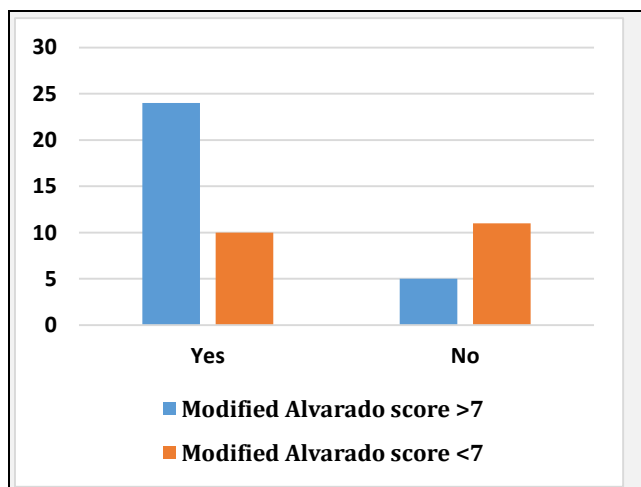
Features	Number of Patients (n)	Percentage %
Pain migration to RIF	27	54
Anorexia	36	72
Nausea and vomiting	35	70
RIF tenderness	50	100
Rebound tenderness	36	72
Fever	44	88
Raised WBC > 10000 cells/cumm	40	80

Table 1. Modified Alvarado Score Based on Clinical Presentation

Based on the parameters mentioned in the modified Alvarado scoring system, the scores were tabulated and have been shown in Table 1. In this study, it was found that 27 patients who constituted 54 % of study population had migration of pain to right iliac fossa. 36 patients (72 % of study population) had anorexia. 35 % (70 % of study population) had nausea and vomiting. Whilst eliciting the signs, all 50 patients (100 % of study population) had tenderness in right iliac fossa and 36 patients (72 % of study population) had rebound tenderness. 44 (88 % of study population) patients had fever. 40 patients (80 % of study population) had a raised WBC count more than 10000 cells per cumm.

Results of Modified Alvarado Score in Correlation with Histopathological Examination

The 50 patients were subjected to operative procedure and post operatively, the samples were sent for histopathological examination. The results of the histopathological examination were compared with the pre operative score determined by RIPASA scoring system.



Graph 1. Results of Modified Alvarado Score in Correlation with Histopathological Examination

A total of 50 patients who were evaluated initially with modified Alvarado score were compared with the histopathological analysis after being operated for appendicitis. A total of 24 patients (48 %) who showed appendicitis on histopathological examination had a score

more than 7. A total of 5 patients (10 %) who had a score more than 7 did not have appendicitis on histopathological examination. 10 patients (20 %) who had a score less than 7, showed appendicitis on histopathological examination. 11 patients (22 %) who had a score less than 7, did not have appendicitis on histopathological examination. This has been depicted in Graph 1.

True positive 24	True negative 11
False positive 5	False negative 10

Table 2. Outcomes of Modified Alvarado Score

Based on the outcomes derived from the modified Alvarado score applied on the 50 patients as shown in Table 2, the final results were calculated in terms of sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. The sensitivity of modified Alvarado score was 70.58 %, specificity was 68.75 %, positive predictive value was 82.75 %, negative predictive value of modified Alvarado score was 52.38 % and the diagnostic accuracy of modified Alvarado score was 70 %. The final results are shown in Table 3.

Modified Alvarado Scoring System	
Sensitivity	70.58 %
Specificity	68.75 %
PPV	82.75 %
NPV	52.38 %
Diagnostic accuracy	70 %

Table 3. Results of Modified Alvarado Score

DISCUSSION

Acute appendicitis is commonly encountered as a surgical emergency. The complications associated with acute appendicitis makes it a challenging diagnosis. In the earlier days, it was sufficient if a clinician had good clinical skills and experience to decide if a patient presenting with the signs and symptoms of acute diagnosis was to undergo appendectomy or be treated conservatively. Due to the technological advances, the use of ultrasound (USG) or computed tomography (CT) was used in the accurate diagnosis of acute appendicitis.

Over the decades, many scores such as Ohmann, Eskelinen, Fenyo, Samuel, Tzanakis etc were created to improve on the efficacy in diagnosing acute appendicitis in the bedside manner.

Amongst the scoring systems, Alvarado pioneered the scoring system for diagnosing acute appendicitis and the score was later modifies by M Kalan. This modified Alvarado scoring system is a well-studied scoring systems across the world and many studies validating it. This study is done with a view to evaluate the efficacy of the RIPASA scoring system.

In the present study, while evaluating clinical presentation based on modified Alvarado score, 7 parameters were used. Symptoms, signs and clinical parameters were included in this score. While anorexia (72 %) and nausea and vomiting (70 %) were seen frequently in patients, it was seen that pain migration to right iliac fossa (54 %) was less frequently seen. When evaluating the symptoms of the patient, it was observed that 100 % of patients had tenderness in right iliac fossa and 72 % patients had rebound

tenderness. Fever (88 %) and raised WBC count (80 %) were also commonly seen in the patients.

In a study conducted by Prabhu P et al. it was observed that 100 % of patients had migration of pain to right iliac fossa. 67 % patients had anorexia and 78 % had nausea and vomiting. 94 % of patients had tenderness in right iliac fossa and 60 % patients had rebound tenderness. 70 % patients had fever and 70 % patients had a raised WBC count.⁷ Similarly, Kumar PS et al. observed that 87 % of patients had migration of pain to right iliac fossa. 44 % patients had anorexia and 72 % had nausea and vomiting. 100 % of patients had tenderness in right iliac fossa and 46 % patients had rebound tenderness. 58 % patients had fever and 66 % patients had raised WBC count.⁸ While Mitra PK et al. observed that that 53.3 % of patients had migration of pain to right iliac fossa. 71.7 % patients had anorexia and 63.3 % had nausea and vomiting. 75.8 % of patients had tenderness in right iliac fossa and 46.7 % patients had rebound tenderness. 75 % patients had fever and 67.5 % patients had a raised WBC count.⁹

It was found in the present study that 24 patients who had a score > 7 had a positive histopathological diagnosis and 11 patients who had a score < 7 had a negative histopathological analysis. 10 patients who had scores less than 7 but were still operated due to the decision taken by the treating surgeon had a histopathological diagnosis of acute appendicitis. 5 patients who had a score more than 7 had a histopathological diagnosis of a normal appendix. This correlated with the false positives observed with the modified Alvarado score. Thus, the negative appendectomy rate was calculated to be 10 % in the current study using the modified Alvarado score.

A cut off of 7 was arrived at by M Kalan et al. in his study. Based on this cut off value, it was decided whether the patient was to be operated or to be treated conservatively. A score more than 7 on initial presentation was considered for surgery while those having scores less than 7 were considered for conservative management.⁶

Hence after categorizing as per the cut off level, it was seen in the present study that 48 % of the patients had a positive histopathology and a score > 7. Similarly, in studies done by Kothari D et al. found that 65 % of the population had a positive histopathology and a score more than 7.¹⁰ Jain S et al. found that 81 % of the population had a positive histopathology and a score more than 7.¹¹

In this study, it was found that 10 % of the patients had a negative histopathology and a score > 7.5 which was comparable to studies done by Kothari D et al. where it was found that 5 % of the population had a negative histopathology and a score more than 7.¹⁰ However, in studies done by Jain S et al. it was found that 1 % of the population had a negative histopathology and a score more than 7.¹¹

In the current study, it was found that 20 % of the patients had a positive histopathology and a score < 7 which was similar to studies done by Kothari D et al.¹⁰ who found that 21.25 % of the population had a positive histopathology and a score < 7. In studies done by Jain S et al. found that 13 % of the population had a negative histopathology and a score < 7.¹¹

In this study, it was found that 22 % of the patients had a negative histopathology and a score < 7. Studies done by

Kothari D et al. found that 8.75 % of the population had a negative histopathology and a score < 7¹⁰ and Jain S et al. found that 5% of the population had a negative histopathology and a score < 7.¹¹

Similar studies have been conducted in various populations thus supporting observed efficacy of modified Alvarado score, as in the current study, in detecting acute appendicitis.

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Diagnostic Accuracy
Current study	70.58 %	68.75 %	82.75 %	52.38 %	70 %
Barman MK ¹²	76.82 %	88.23 %	96.92 %	45.45 %	81.25 %
Naik AT ¹³	64.38 %	58.33 %	90.38 %	21.21 %	63.52 %
El Sherpiny WY ¹⁴	51.2 %	80 %	91 %	29 %	57 %

CONCLUSIONS

There has always been a view to reduce the unwanted surgeries with respect to acute appendicitis. With this view, several scoring systems were developed over the past decades with the Alvarado score and the modified Alvarado scores leading the way. The Alvarado and the modified Alvarado scores have stood the test of time but the results have not been the same in all studies. Modified Alvarado scoring system uses signs and symptoms and laboratory parameters for the diagnosis of acute appendicitis. Hence, it becomes easy to use and apply in emergency situations. Modified Alvarado scoring system uses specific and limited features for the diagnosis of acute appendicitis with a diagnostic accuracy of 70 % thus showing that it is not effective in diagnosing acute appendicitis alone. Thus, there may be a requirement of additional diagnostic tools to complement the modified Alvarado score to increase the diagnostic accuracy and thus the effectivity of the score.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

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