

The Validity of Modified Alvarado Scoring System as a Predictor Tool for Diagnosis of Acute Appendicitis in a Low- Country; a Comparative Prospective Study

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Abstract

Background: Acute appendicitis is a disease with a well-known long history. The final diagnosis of acute appendicitis is only accurate with histopathological findings after appendectomy. However, the choice to carry out surgical treatment is based exclusively on clinical assessment which does not reach the precise diagnosis of appendicitis. Therefore, Different scoring systems have emerged in order to help physicians in decision making and diagnosis of suspicious individuals. **Aim:** To determine the diagnostic accuracy of the Modified Alvarado Scoring System in a low-income country in the diagnosis of appendicitis. **Patients and Methods:** This was a cross-sectional study that included 200 patients with right iliac fossa pain, suggestive of acute appendicitis. The patients were examined clinically and randomly allocated into 2 groups. The Modified Alvarado Scoring System (MASS) was calculated for the case group and listed and compared to another control group for which the operative decision was based on the clinical evaluation without relying on a scoring system. All the studied patients went through appendectomy according to overall clinical judgment and never based on MASS only. Specimens were sent to histopathological examination to verify the diagnosis. **Results:** The results showed that MASS at the cut-off value of ≥ 7 has a sensitivity of 93.33%, a specificity of 52.94%, and accuracy of 84.42%, and a negative appendectomy rate of 17 out of 95 patients (17.8%). **Conclusion:** MASS is a safe tool in the diagnosis of acute appendicitis due to its accepted sensitivity and higher specificity. It could be helpful in low-income countries, where resources are limited.

Keywords: Acute appendicitis, Modified Alvarado Score, diagnosis of appendicitis.

Introduction

Acute appendicitis (AA) is one of the commonest surgical emergencies worldwide. The gold standard treatment for acute appendicitis is appendectomy. However, a recent debate now is existing in order to treat AA medically⁽¹⁾. Delay in diagnosis of

AA may lead subsequently to several complications such as perforation, abscess formation, generalized peritonitis and even death⁽²⁾. Furthermore, the higher rate of negative appendectomy with its undesirable consequences such as post-operative adhesions and ileus⁽¹⁾. These drawbacks

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have implemented the use of several diagnostic modalities such as ultrasonography and computed tomography (CT) to reduce the rate of negative appendectomies and improve the diagnostic accuracy. Although this led to further financial burden and health care costs mainly in less developed countries with limited resources⁽³⁾. Appendicitis can advance to perforation, which in turn accompanied with greater morbidity and mortality. Consequently, surgeons are willing to operate when the diagnosis is most likely in lieu of delay till it is certainty⁽⁴⁾. An earlier decision to operate contributes to removing a normal appendix, which rates are from 15%-30% of patients. However, the number might be increased or decreased in particular demographic communities. This percentage can easily diminish by paying attention to equivocal subdivision for a certain interval followed by re-evaluation⁽⁴⁾. The Alvarado score permits risk stratification in individuals giving history of abdominal pain, attaching the possibilities of appendicitis to recommendations concerning discharge, observation or operative decision. Additional investigations, which include ultrasound and computed tomography (CT) scanning, are recommended when appendicitis risks are within the intermediate spectrum⁽⁵⁾. In low-resource nations, the high expenses and limitation in imaging modalities, imply that the scoring systems are of useful use in diagnosis of appendicitis as a cause of an acute abdomen, mainly, where imaging is not a choice⁽⁶⁾. Another tool that could be of value, when combined with scoring system or to achieve a better diagnostic accuracy of appendicitis is the computed tomography (CT) scan. It provides excellent radiological differential diagnostic ability to determine inflammation and complication of appendicitis in suspicious cases. The advancement in diagnostic modalities and availability of CT add more to the physician

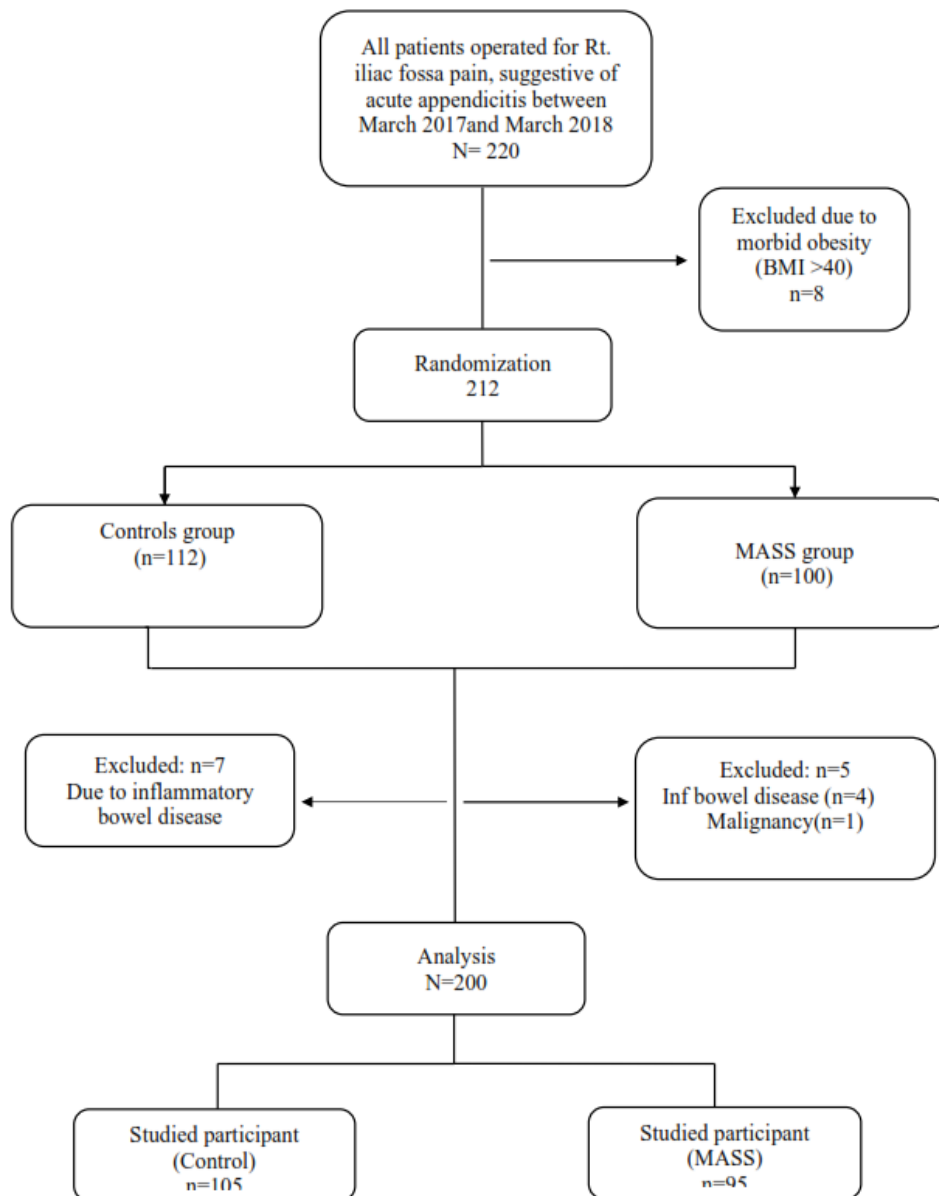
in establishment of diagnosis of Rt. Iliac fossa pain. However, CT scan was only available in diagnosis of appendicitis in <8% of a studied population in low income countries due to limitation of resources and unavailability of CT⁽⁷⁾. The aim of this research was to determine the diagnostic accuracy of Modified Alvarado Scoring System (MASS) in the diagnosis of acute appendicitis in a low-income country with limited resources.

Patients and Methods

A prospective randomized cross-sectional study was conducted between March 2017 and March 2018 at both Ain-Shams University Hospitals and Suez Canal University Hospitals. The study was reviewed by the Research Ethics Committee of the Faculty of Medicine at Ain-Shams University (reference number: #7681). Written and verbal informed consent was obtained from all the studied participant. The study was carried out on 200 patients presented with right iliac fossa pain, suggestive of acute appendicitis. Figure 1 shows the distribution of the studied population according to the inclusion and exclusion criteria. Patients were included of any ages and genders. Patients with any of the following were excluded: BMI 40 or more, pathologically diagnosed inflammatory bowel disease or malignancy. Patients were divided randomly into 2 groups, the first group was those patients who were enrolled into the study according to Modified Alvarado Scoring system (Table 1)⁽⁸⁾, while the controls were patients who have been operated based on clinical examination and surgeons decision without using any scoring system. The sensitivity and specificity of MASS was plotted against the control group. All patients were subjected to: 1) History taking and clinical examination, 2) Laboratory Investigation: Complete blood

picture with differential. Urine analysis and pregnancy test if suspicion of Urinary tract infection and female in childbearing age respectively. Patients in the patients' group were graded into three subtypes based on six clinical symptoms and two lab parameters each assessed by a score pad coefficient as follows:⁽⁹⁾ 1) Group (A): (score 1-4):

These patients with negative ultrasound after having scored with MASS, were discharged and sent home on antispasmodic medication with the proper instructions. They were operated when come back to hospital with recurring of symptoms or worsening of the condition. 2) Group (B): (score 5-6): Hospital admission.



These patients were reexamined and reassessed frequently, Their Modified Alvarado Score were recalculated again, and they

will join those of group (A) or those of group (C) and were be operated regardless of the subsequent scoring category. 3)

Group (C): (score 7-9): These patients were prepared for urgent operative intervention. All the patients were operated based on the hospital protocol. The specimen was submitted for histopathological examination and the operative findings along with the post-operative complications were documented. Modified Alvarado score correlated with histopathological findings.

Statistical analysis

Data were analyzed using IBM SPSS software package version 20.0 (Armonk, NY: IBM Corp) The Kolmogorov-Smirnov test was used to verify distribution normality. The mean and SD were used to characterize quantitative results. The importance of the findings obtained was calculated at the level of 5 percent.

Table 1: Modified Alvarado Scoring System (MASS)

Subjects	Score (yes / no)
Symptoms <ul style="list-style-type: none"> • Migratory pain • Anorexia • Nausea / vomiting 	<p style="text-align: center;">1</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p>
Signs <ul style="list-style-type: none"> • Rt lower quadrant pain • Rebound tenderness • Elevation of temperature 	<p style="text-align: center;">2</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p>
Lab Investigation <ul style="list-style-type: none"> • Leukocytosis 	<p style="text-align: center;">2</p>

Results

Two hundred patient were enrolled in the study. They were divided into 2 groups. Cases included those patients who underwent appendectomy after being subjected to MASS, while controls were limited to patients who were operated base on clinical findings. The study reported that the mean age of the studied patients was 24.5+16 and 26.6+81 respectively. About two thirds of the studied patients were of female gender 62.1% in case group and 60% in control one. The current study reported a statistically significant regarding the operative diagnosis of the studied patients. Those patients who were operated based on clinical evaluation showed a negative operative diagnosis of appendicitis in 28 patients

(26.6%) while the negative recorded cases in MASS group were only 17 patients (17.9%) with P value<0.001. The remaining patients were divided as 43.2% in catarrhal group, 26.3% in suppurative group and only 12.6% were a complicated appendicitis on the MASS group. One of the most important finding is the high statistically significant difference between cases and controls in the operative diagnosis, which revealed a high number of negative appendectomies in the control group 26.6% where no scoring system was used, in contrast to 17.9% only in MASS group. This finding supports the hypothesis of this study which asserted application of Modified Alvarado Scoring System is effective and acceptable in diagnosis of acute appendicitis due to further stratification inside the

Table 2: Demographic data of the studied groups.

Variables	Cases (n=95)	Controls (n=105)	χ^2	P value
Age years (mean + SD)	24.5+16	26.6+81		0.978
Gender (Male / Female)	36 (37.9%) / 59 (62.1%)	42 (40%) / 63 (60%)	1731.2	0.612
Operative diagnosis				
• Negative	17 (17.9%)	28 (26.6%)	18.93	<0.001*
• Catarrhal	41 (43.2%)	36 (34.3%)		
• Suppurative	25 (26.3%)	24 (22.9%)		
• Complicated	12 (12.6%)	17 (16.2%)		
Operation time- min (mean+SD)	54.32 ± 14.37	48.27 ± 12.81	1147.0 U	0.15
Hospital stay-days (mean+SD)	3.59 ± 6.51	3.15 ± 6.72	1406.0	0.329
Complications				
• NO	84 (88.4%)	85(81%)	4.309	0.750
• Wound infection	4(4.2%)	3(2.9%)		
• Chest infection	3(3.1%)	4(3.8%)		
• Prolonged ileus	3(3.1%)	7(6.7%)		
• Adhesive I.O	1(1.1%)	3(2.9%)		
• Incisional hernia	0	2(1.9%)		

I.O: Intestinal obstruction; U, p: U and p values for Mann Whitney test for comparing between the two groups

group that permit subsequent follow-up to avoid the increased number of negative appendectomies. Table 2 demonstrates the intraoperative data, which revealed that the mean operative time between the first and second group were of the same range (54.32 ± 14.37 versus 48.27 ± 12.81 minutes). A similar observation was noticed in the hospital stays with nearly a 3-day duration for discharge of the patients. There was no recorded statistically significant difference in the previous 2 variables (P value: 0.15 and 0.329 respectively). The study's principal concern is to focus on the MASS and its validity in accurate diagnosis of appendicitis. It detects that 43 patients (45%) were of MASS 7-9. However, these percentage was recorded as the large number of the studied population, their

negative operative diagnosis were recorded in 2 patients only. Thirteen patients (13.8%) were of 1-4 score, and the large number of the negative appendectomy were discovered in this group 9.5%. The middle group with a score 5-6 showed a negative appendicitis in 6 out of 42 patients. The findings in (Table 3) shows the relation between MASS and other studied variables. A statistically significant relation was recorded when correlating MASS to operative diagnosis (P<0.001). Given to these findings, dependence on MASS for diagnosis of acute appendicitis is of great value due to its ability to detect the positive cases according to the progress in the score. The conclusion of the current study is clearly evident in table 4 which analyze, the sensitivity, specificity, positive predictive value (PPV), negative predictive value

(NPV) and accuracy of MASS; 60%, 91%, 65%, 9% and 21% respectively. In ROC curve analysis (table 4) the sensitivity, specificity,

PPV, NPV and accuracy were 60%, 91%, 65%, 9% and 21% respectively.

Table 3: Relation between MASS and studied variables

Variables	MASS			U	p value
	1-4 (n=13)	5-6 (n=42)	7-9 (n=43)		
Frequency	13(13.8%)	43(45%)	39(41.2%)	0.069	1.000
Hospital stay days (mean±SD)	2.57 ± 3.36	1.95 ± 6.25	3.79 ± 7.01	113.0	0.801
Operative diagnosis (Cases)					
• Negative	8 (61.5%)	10 (25.6%)	3 (7%)	71.730*	<0.001*
• Catarrhal	5 (38.5%)	19 (48.8%)	16 (37.1%)		
• Suppurative	0	8 (20.5%)	9 (21%)		
• complicated	0	2 (5.1%)	15 (34.9%)		
Histopathology					
• Appendicitis	4 (30.7%)	36 (85.7%)	39 (90.7%)	82.974*	<0.01*
• Normal appendix	9 (69.3%)	6 (14.3%)	2 (4.7%)		
• Granulomatous lesion	0	0	1 (2.3%)		
• Mucinous lesions	0	0	1 (2.3%)		
Overall Negative appendectomies (n= 95)	9 (9.5%)	6 (6.3%)	2 (2.1%)	142.65	<0.001*

U, p: U and p values for Mann Whitney test

Discussion

Acute appendicitis is diagnosed clinically. A lot of patients continue to endure negative appendectomies despite the frequent utilization of highly developed imaging techniques and a quite few predictive scoring systems. Including the well-developed countries, there is really no outlined 'acceptable' Negative Appendectomy Rate (NAR)⁽¹⁰⁾. A percentage of 20-40% NAR have been described in the literature and surgeons accept negative appendectomy rate to refrain from 15-20% rate of perforated appendicitis. The primary purpose of the physician would be to achieve a precise diagnosis within the quickest and many economical possible ways, without submitting the individual to unnecessary surgical procedures or investigations. Therefore, the ultimate goal in treating suspected appendicitis is to try to minimize normal appendix removal without rising perforation

rate⁽¹¹⁾. The present study revealed that there was a statistical difference between different groups in MASS at different score ($p < 0.001$), Similarly, a study done by Özsoy and Yenidoğan,⁽¹²⁾ that was conducted on 156 patients were divided into three groups based on AS values, (Group 1: Patients with AS of ≤ 4 , appendicitis less likely, Group 2: individuals with AS of 5-7, moderate likelihood of appendicitis, and Group 3: Patients with AS of 8, high likelihood of appendicitis) in which they documented a negative appendectomy rates in the three categories were 78%, 15%, and 0%, respectively. The variation between the groupings was statistically significant ($p < 0.001$). Alvarado score (AS) helps to categorize the patients who would be wise to go through additional assessment, follow-up, or surgical intervention⁽¹³⁾. The scientific researches recommended that patients by having an AS of < 4 could go home without being hospitalized, for individuals having

an AS of 5-7, radiological evaluation can be utilised, and patients who have a score of >7 must be operated⁽¹⁴⁾. Alvarado score and its various modifications possess low sensitivity, specificity and even the negative appendectomy rate, as stated in literature, reaches up to 20-40% with 10% associated morbidities⁽¹⁵⁾. The value of modified Alvarado scoring system still in existence broadly addressed in several researches. In overview of 233 patients with right lower quadrant pain, Pouget-Baudry et al.⁽¹⁶⁾ revealed that Alvarado scoring was very helpful. The study revealed that a score of 6 is relevant with the history of appendicitis, and a score of 4 is associated with the lack of the diagnosis of appendicitis. They recommended that a score between 4 and 6 demands an observation or supporting investigations. Furthermore, the present study revealed that that Mean \pm SD of duration of surgery in case group was 54.32 ± 14.37 minute and 48.27 ± 12.81 in control group, and there was no statistically significant difference between case and control groups as regard duration of surgery. A greater duration of operation continues to be lately proven to become connected with elevated complication rates in appendectomy. Furthermore, an extended operative time is proven to relate to elevated complication rates and hospital stays⁽¹⁷⁾. The present study revealed that there was no statistical significant difference between the two studied groups according to hospital stay, compared to the study of Abd El Maksoud et al.⁽¹⁸⁾ stated that the mean duration of hospital stay was 2.39 ± 1.67 (range: 1–12 days) days. Even though appendectomy is regarded as a secure operation, it remains connected to complications, for example, local complications including wound infections and dehiscence, and major complications including peritonitis and intra-abdominal abscess. As a result, an attempt is

made to diagnose acute appendicitis accurately and appropriately among surgeons with the fastest and most affordable diagnostic resource⁽¹⁸⁾. The current study demonstrated that majority of participants 84% of cases and 85% of control had no complications, and there was no statistical significant difference between the groups regarding post-operative complications, also there was no reported cases of death, only 11 and 18 cases showed complications in both groups respectively and there was no statistical significant difference between the studied groups as regard outcomes, comparing to the study of Abou Merhi et al.⁽¹⁹⁾ in which Postoperative complications are shown in with peritonitis as the most common sequel (9.5%). There was a significant difference between occurrence of perforation and duration of symptom ($p=0.032$). In general, the present study revealed that there was highly statistically significant difference between MASS and both operative diagnosis and histopathology, and in ROC curve analysis, the sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 60%, 91%, 65%, 98% and 21% respectively. In agreement with our study, the study of Abd El Maksoud et al.⁽¹⁸⁾ published the MASS demonstrated poor sensitivity, inferior diagnostic accuracy DA, and superior specificity (having a sensitivity of 59.6%, specificity of 87.5%, PPV of 96.9%, NPV of 25%, and DA of 63.3%). Quite similar poor outcomes of the MAS put together in other studies that utilized the score for non-European populations⁽²⁰⁾. In contrast to our findings, the study of Kanumba et al.⁽²¹⁾ has proven that MASS offers great deal of sensitivity, specificity, PPV, NPV and precision in detecting acute appendicitis, in which the sensitivity and specificity of MASS within this study was 94.1% and 90.4% correspondingly. The PPV was 95.2% and NPV was 88.4%. The accuracy of MASS

was 92.9% that is in complete agreement with conclusions as reported by others⁽²²⁾, however in sharp contrast as to the was noticed in Kenya⁽²³⁾. To become helpful, a scoring system should be both sensitive and specific. This research indicates that the Modified Alvarado score works well in acute appendicitis detection, and modifications expressed to be better compared to left shift in Alvarado score. However, there are not any signs, symptoms or laboratory tests which are 100% efficient in detecting acute appendicitis. Modified Alvarado score can therefore be used as a preoperative accurate and appropriate score for detecting acute appendicitis. It determines if the patients require surgical procedures or observation; patients with score ≥ 7 more than likely have appendicitis based on our research; the surgical treatment is advised. Patients with score < 7 can be maintained under extrapolation and reassessment if score amplified, or the patient is not responding to medication, surgery is preferred. Patients with score < 4 are unbelievably and yet appendicitis is not unlikely.

Conclusion

Clinical common sense and increased clinical doubt are the most significant elements in treating patients with suspicion of acute appendicitis. Diagnosis of acute appendicitis starts with a detailed history, careful clinical examination, regular follow up of equivocal cases in association with blood tests and radiological studies. Modified Alvarado score is a simple, accurate and reproducible diagnostic test that can be used by the general practitioner and other physicians to assess anyone who has a right lower quadrant abdominal pain.

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