International Surgery Journal
Kothari D et al. Int Surg J. 2017 Aug;4(8):2439-2444
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20173142

Original Research Article

Modified Alvarado scoring system as a diagnostic tool for acute appendicitis at a tertiary care teaching hospital, Central India: a cross sectional study

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Received: 24 March 2017
Accepted: 24 April 2017

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ABSTRACT

Background: Acute Appendicitis forms an important emergency in the day-to-day surgical practice. It affects human beings irrespective of age, nationality and religion. Early diagnosis and prompt operative intervention is the key for successful management of acute appendicitis. However, the picture of acute appendicitis may not be classical, and in such situations, a policy of early intervention to avoid perforation may lead to high negative appendicectomy rates.
Methods: A total of 80 patients were enrolled in the present cross-sectional study. Their ages ranged from eleven to 72 years (mean 32.89 ± 15.87). A proforma containing general information about the patient plus eight variables based on the modified Alvarado scoring system was filled.
Results: Histological examination confirmed appendicitis in 54 patients (67.5%). The remaining 26 patients were found to have normal appendix giving a negative appendicectomy rate of 32.5% being 36.8% and 28.3% for males and females respectively.
Conclusions: This scoring system is easy, simple and cheap complementary aid for supporting the diagnosis of acute appendicitis. MASS can be used effectively in Indian 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.

Keywords: Acute appendicitis, Alvarado scoring, Modified Alvarado scoring system, Histopathology

INTRODUCTION

Acute appendicitis is one of the most common causes of abdominal surgical emergencies with a lifetime prevalence of approximately 1 in 7 worldwide.[1] It is associated with high morbidity and occasionally morbidity related to failure of making an early diagnosis. It has been estimated that approximately 6% of the population will suffer from acute appendicitis during their lifetime; therefore, much effort has been directed

toward early diagnosis and intervention.[2,3] In Asian and African countries, the incidence of acute appendicitis is probably lower because of dietary habits of the inhabitants of these geographic areas. Dietary fiber is thought to decrease the viscosity of faeces, decrease bowel transit time and discourage the formation of faecolith, which predispose individuals to obstructions of the appendiceal lumen.[4]

The incidence of appendicitis gradually rises from birth, peaks in the late 10 years and gradually declines in the geriatric years. It is most prevalent in the 10-19-year-old age group.[5] In recent years, the number of cases in patients aged 30-69 has increased to 6.3%.[6]

Despite the advances in diagnostic medicine and therapeutics, the accurate diagnosis of appendicitis and pain in the right iliac fossa remains a clinical challenge.

Symptoms of appendicitis overlap with a number of other conditions making diagnosis a challenge, particularly at an early stage of presentation.[7] Clinical prediction rules (CPRs) quantify the diagnosis of a target disorder based on findings of key symptoms, signs and available diagnostic tests, thus having an independent diagnostic or prognostic value.[8]

In 1986, Alvarado constructed a 10-point clinical scoring system, also known by the acronym MANTRELS, for the diagnosis of acute appendicitis as based on symptoms, signs and diagnostic tests in patients presenting with suspected acute appendicitis.[9] The Alvarado score enables risk stratification in patients presenting with abdominal pain, linking the probability of appendicitis to recommendations regarding discharge, observation or surgical intervention.[9] The Alvarado score was originally designed more than two decades ago as a diagnostic score; however, its performance and appropriateness for routine clinical use is still unclear.

A recent clinical policy document from the American College of Emergency Physicians reviews the value of using clinical findings to guide decision making in acute appendicitis.[10] Under the heading of the Alvarado score, they state that 'combining various signs and symptoms into a scoring system may be more useful in predicting the presence or absence of appendicitis'. Although not a strong recommendation, the Alvarado score is the only scoring system presented in the document. This study shows that the Alvarado score accurately predicts appendicitis and is well calibrated in men. As a decision rule for observation/admission, the Alvarado score performs well as a 'rule out' criterion (high sensitivity). As a decision rule in relation to surgery the Alvarado score cannot be used to 'rule in' a diagnosis of appendicitis without surgical assessment and further diagnostic testing. Patients presenting in the emergency department and in primary care settings, especially in low-resource countries, could benefit from the implementation of the Alvarado score as a triage decision rule.[11]

A negative appendicectomy rate of 20-40% has been reported in literature and many surgeons advocate early surgical intervention for the treatment of acute appendicitis to avoid perforation, accepting a negative appendicectomy rate of about 15-20%.[12] Removing normal appendix is an economic burden on both patients and health resources. Misdiagnosis and delay in surgery can lead to complications like perforation and finally peritonitis.[13] Many scoring systems for the diagnosis of acute appendicitis have been tried, but most of these are complex and not feasible in emergency setting.[14]

The MASS has been shown by recent studies to be easy, simple and cheap diagnostic tool for supporting the diagnosis of acute appendicitis especially for junior surgeons.[3,9,14] Decision-making in patients with acute appendicitis poses a diagnostic challenge worldwide, despite much advancement in abdominal surgery. The modified Alvarado scoring system (MASS) has been reported to be a cheap and quick diagnostic tool in patients with acute appendicitis. However, differences in diagnostic accuracy have been observed if the scores were applied to various populations and clinical settings. The purpose of this study was to evaluate the diagnostic value of modified Alvarado scoring system in patients with acute appendicitis in Indian setting.

METHODS

This was a cross sectional study to evaluate the diagnostic value of MASS in patients presenting with acute appendicitis admitted in surgical unit of a tertiary care teaching hospital, Indore, Madhya Pradesh with the clinical diagnosis of acute appendicitis between January 2015 to December 2016. Patients of any age group and both sexes presenting to emergency department with symptoms of acute appendicitis were included in the study. All consecutive patients admitted in that period with pain in the right lower abdomen were considered. Institutional ethics committee permission was taken. Individual written consent was sought before enrolling the study participants. Patients with urological, gynecological or surgical problems other than appendicitis and especially patients with mass in right iliac fossa or those patients with incomplete documentations in the case sheets were excluded from the study. All the patients were admitted. Baseline investigations, Hb, TLC, DLC, RFT, urine examination, X-ray chest, X-ray KUB and ECG were done. A proforma containing general information about the patient plus eight variables based on the modified Alvarado scoring system was filled.[3]

The investigator scored all the patients according to the variables of MASS (Table 2) and then divided them into two groups.[3] Group I included patients with MASS of seven and above (patients likely to have acute

appendicitis) and Group II were patients with MASS below seven (patients unlikely to have acute appendicitis).

The Investigator did not influence the management of the patient and the decision to operate was not based on MASS but the clinical impression by the clinician taking charge of the patient. Abdominal ultrasound was performed in case of atypical presentation. All patients underwent emergency appendicectomy and all appendices removed at operation were sent for histopathology. The diagnosis of acute appendicitis was confirmed by histopathological examination. Data was collected using a coded, pre-tested questionnaire and analyzed using SPSS statistical software version 20.

The MASS groups were compared against histology, the gold standard. Then, the sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) and accuracy were determined in males and females.

Table 1: Appendicitis by the Alvarado score, its risk strata and subsequent clinical management strategy.[9]

Alvarado score	
Feature	**Score**
Migration of pain	1
Anorexia	1
Nausea	1
Tenderness in right lower quadrant	2
Rebound pain	1
Elevated temperature	1
Leucocytosis	2
Shift of white blood cell count to the left	1
Total	10
Interpretation of Scores	
1-4	Discharge
5-6	Observation /admission
7-10	Surgery

Table 2: Modified alvarado scoring system (mass) F.[3]

Symptoms	Score
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/ vomiting	1
Signs	
Tenderness in right lower quadrant	2
Rebound pain	1
Elevated temperature	1
Laboratory findings	
Leucocytosis	2
Total	9

RESULTS

A total of 80 patients were enrolled in the present cross-sectional study. Their ages ranged from eleven to 72 years (mean 32.89±15.87). There were 49 (61.25%) males and 31 (30.75%) females (M: F = 1.58:1). The duration of illness of the study population ranged from 1 day to 42 days with a mean of 2.58 days and standard deviation of 9.86 days. There was a significant association between the duration of illness and perforation rate [Odds Ratio = 8.462, 95% C.I. (1.629-42.761), p-value = 0.003]. The MASS of the study population ranged from 3 to 9. (Mean 6.88±1.72). The median and the mode were 7.00 and 8.00 respectively. In this study, 56 patients (70%) had a MASS of seven and above and the remaining 24 patients (30%) had MASS below seven (Table 3, 5).

Table 3: Frequency of patient distribution according to modified Alvarado score.

Score	No. of the patients	Percentage
1	0	0
2	1	1.25
3	2	2.5
4	6	7.5
5	4	5
6	11	13.75
7	26	32.5
8	17	21.25
9	9	11.25
10	4	5

Table 4: HPE and operative findings.

Findings	Frequency	Percentage
Appendix inflamed	53	66.25
Gangrenous appendix	5	6.25
Perforated appendix	7	8.8
Appendicular abscess	4	5
Others	11	13.75
Meckel's diverticulitis	2	2.5
Mesenteric lymphadenitis	2	2.5
Twisted ovarian cyst	1	1.25
Ic tb	1	1.25
Salpingitis	1	1.25
Pathology not found	4	5

All patients in this study underwent appendectomy. Of these, inflamed appendix (Figure 1 and 2) was the most

common operative findings affecting 53 patients (66.25%). Seven patients (8.8%) had perforated appendices, five patients (6.25%) had gangrenous appendices and four patients (5%) had appendicular abscess. None of these appendicular complications was missed by MASS. Other operative findings in the study occurred in 11 patients (13.75%) (Table 4).

Table 5: MASS versus histological findings.

MASS	Histological findings		Total
	Appendicitis	No appendicitis	
≥7	52	4	56 (70%)
< 7	17	7	24 (30%)
Total	69	11	80

Histological examination confirmed appendicitis in 54 patients (67.5%). The remaining 26 patients were found to have normal appendix giving a negative appendicectomy rate of 32.5% being 36.8% and 28.3% for males and females respectively. It was noted that those patients who underwent delayed appendicectomies were either due to increased severity of symptoms and clinical deterioration or on revised computation of the scoring they were fitting into the next group, ≥7.

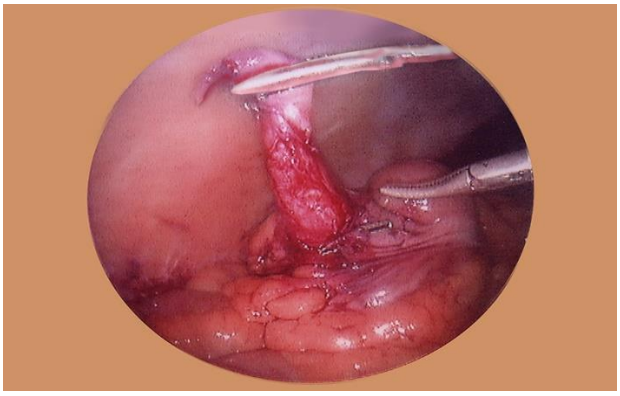

Figure 1: Inflamed appendix during laparoscopic appendectomy.

Figure 2: Inflamed appendix post laparoscopic appendectomy.

The sensitivity and specificity of MASS in this study was 93.2% (males 95.8% and females (90.6%) and 92.2% (males 93.6% and females 90.8%) respectively. The PPV (the proportion of subjects with a positive test result who actually have the disease) was 95.2% (males 95.8% and females 90.6%) and NPV was 87.6% (males 88.2% and females 79.4%. The accuracy of MASS was 92.8% (males 91.9% and females 87.9%).

DISCUSSION

Decision making in cases of acute appendicitis poses a clinical challenge especially in developing countries where advanced radiological investigations do not appear cost effective and so clinical parameters remain the mainstay of diagnosis.[15] Through history and clinical examination still remains the mainstay for the diagnosis, but misdiagnosis and negative appendicectomy still do occur at quite a high rate. It is the surgeon who has to decide the best management and at a cost-effective manner. The decision to operate or not is very important as surgical intervention in acute appendicitis is not without the risk of morbidity and mortality. Even though, a negative appendicectomy has a negligible mortality and morbidity of around 10%.[16,17]

The use of MASS in the diagnosis of acute appendicitis has been reported to improve the diagnostic accuracy and consequently reduces negative appendicectomy and complication rates.[9,14] This study was conducted to evaluate the diagnostic value of modified Alvarado scoring system in patients with acute appendicitis in Indian setting. The age distribution in this study was similar to other studies.[3,9,13,14,17] The female preponderance in this study is not in agreement with other studies.[3,13,17] Studies in Kenya, Nigeria and Ethiopia found a male dominance which are in agreement of our study.[18-21] The reason for the difference in sex distribution in these studies may be attributed to the fact that female patients with right iliac fossa pain have a wide range of differential diagnoses as a result acute appendicitis may be over-diagnosed in this gender group. In this case, therefore, additional investigations may be required in female patients to confirm the diagnosis of acute appendicitis.

In this study, the duration of illness in majority of patients was four days and majority of patients reported to the hospital and seen by the admitting doctor in more than 24 hours after the onset of illness. This observation concurs with other reports.[3,13,18] The reasons for delay in seeking medical consultation in this study may be attributed to delay in referral from peripheral hospitals, lack of money to pay for the medical services and for transport. Delayed presentation may also be due to misdiagnosis or fear of surgery as a result they are treated conservatively with analgesics and antibiotics to mask the symptoms. Delayed presentation is associated with increased morbidity and mortality due to appendiceal perforations and peritonitis.

The rate of perforation in our study was 8.8%, which is comparable to other reported rates.[3,17,22] In developing countries, rates of between 6-65% have been quoted.[23] Delayed presentation, fulminate disease, misdiagnosis, or failure to accept surgical treatment, are contributory factors to high perforation rates.[3,17] Perforation rates are much higher in the very young and the elderly, where diagnosis is often difficult leading to perforation rates as much as 80% in some reported series.[24,25] In this study, the perforation of appendices occurred mostly in patients with MASS ≥ seven and in the children aged 6-15 years. Therefore, a more aggressive approach should be used in patients with high scores and in advanced age individuals and children.[24,25] The results of this study are comparable with the relevant literature. This study shows a positive predictive value of 95.2% comparable with literature reports of 86.9%, 97%, 97.6% and 83.5%.[3,15,18,26]

Histological examination in the present was confirmed appendicitis in 54 patients (67.5%). The remaining 26 patients were found to have normal appendix giving a negative appendicectomy rate of 32.5% being 36.8% and 28.3% for males and females respectively. It was noted that those patients who underwent delayed appendicectomies were either due to increased severity of symptoms and clinical deterioration or on revised computation of the scoring they were fitting into the next group, ≥7. Similar reports were documented in literature; 21%, 15.6% and 7%.[15,18,26] There are even opinions and evidences that if negative appendicectomy rates are below 10-15%, the surgeon is operating on too few patients thus increasing the risk of complications.13 Negative predictive value of our series was 87.6% as compared to 77%.[26] Study figures for negative appendicectomy rate in the present study were found to be slightly higher in females (36.8%) than in males (28.3%). This is because misdiagnosis may have occurred in females of reproductive age group where other pelvic diseases could make diagnosis difficult. In such cases, MASS should be complemented with diagnostic procedure like laparoscopy or imaging such as Ultrasound scan or CT scan to minimize the rate of negative appendectomy.[27] However, a large population based study suggested that the rate of negative appendicectomy (15-20%) has not declined for 15 years despite the increasing use of such tests.[28]

The present study has shown that MASS provides high degree of sensitivity, specificity, PPV, NPV and accuracy in the diagnosis of acute appendicitis, which is in agreement with findings reported by others, but in sharp contrast to what was observed in Kenya.[3,19,29] Present study also revealed that MASS is more helpful in male patients by showing lower negative appendicectomy rate and high positive predictive value for male patients as compared to females. In females, additional investigations may be required to confirm the diagnosis. Literatures of different studies also support this observation.[30-32]

The use of MASS in the diagnosis of acute appendicitis in female patients should be supplemented by additional investigations like abdominal ultra sound or laparoscopy.[3] A MASS score above 7 should indicate appendectomy without the need for further imaging.[3]

Therefore, the MASS should be used in clinical practice for determining the most probable management option in patients with different scores and clinical suspicion. However, the scoring system is not 100% reliable and diagnostically accurate, but it can be used as a complimentary aid to decide which management option is particularly suitable for the patient's benefit.[33]

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.[33] 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.

CONCLUSION

The cross-sectional present study has shown that MASS provides high degree of sensitivity (93.2%), specificity (92.2%0, PPV (95.2%), NPV (87.6%) and accuracy in the diagnosis of acute appendicitis. This study shows that the Modified Alvarado Scoring System [MASS] accurately predicts appendicitis and is well calibrated in men. As a decision rule for observation/admission, the Alvarado score performs well as a ‘rule out’ criterion (high sensitivity). As a decision rule in relation to surgery the MASS cannot be used to ‘rule in’ a diagnosis of appendicitis without surgical assessment and further diagnostic testing. Patients presenting in the emergency department and in primary care settings, especially in low-resource countries, could benefit from the implementation of the MASS as a triage decision rule.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Kothari D, Kothari A, Kalantri A, Bhambani P. Modified Alvarado scoring system as a diagnostic tool for acute appendicitis at a tertiary care teaching hospital, Central India: a cross sectional study. Int Surg J 2017;4:2439-44.