VALIDITY OF MODIFIED ALVARADO SCORING SYSTEM (MASS) IN THE DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT

Objective: To determine the validity of Modified Alvarado Scoring System (MASS) in the diagnosis of acute appendicitis.

Study Design: Cross sectional validation study.

Place and Duration of Study: Department of Surgery Combined Military Hospital (CMH) Kohat Pakistan, from Nov 2013 to Oct 2014.

Material and Methods: A total of 248 patients fulfilling the inclusion criteria were enrolled in the study after getting the informed written consent. Modified Alvarado Score of all patients was calculated on a proforma which included migratory right iliac fossa pain, anorexia, nausea/vomiting, tenderness in right iliac fossa, rebound tenderness, elevated temperature and leucocytosis (>10 x 10^9/L). Surgeries were performed by residents and consultant surgeons. Decision to operate upon was not only on the MASS of the patients rather it was on overall clinical condition of the patients using different scoring systems. Where required aid of different laboratory investigations, ultrasonography, CT scan and laparoscopy was also taken. After surgery histopathological examination of resected specimens was performed. Pre operative modified alvarado score and post operative histopathological results were endorsed on a proforma. A two by two table was used to determine the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of MASS.

Results: Out of total 248 patients, 183 (73.8%) patients were males and 65 (26.2%) were females. Male to female ratio was 2.8:1. Sensitivity of MASS in this study was 89.39%, Specificity 84.06%, positive predictive value 93.57%, negative predictive value 75.32% and diagnostic accuracy was 87.90%.

Conclusion: Modified alvarado score is a highly sensitive test with fair degree of specificity for the early diagnosis of acute appendicitis especially in the adults. It is particularly helpful for young doctors and in the peripheral hospitals where more sophisticated investigations are not available.

Keywords: Acute appendicitis, Appendectomy, Modified Alvarado Scoring System (MASS).

INTRODUCTION

Acute appendicitis is one of the most common abdominal surgical emergencies, with a lifetime prevalence of approximately one in seven[1]. Life time risk of appendectomy is about 12% in males and 25% in females, making it the most commonly performed operation worldwide[2]. There are about 250,000 new cases of acute appendicitis each year in the United States[3].

Fitz first established a clinical diagnosis of acute appendicitis and then suggested early appendectomy[4]. Despite advances in diagnostic modalities and being a common surgical problem, acute appendicitis still remains a difficult diagnosis to establish particularly in the children, elderly and females of reproductive age[1].

Although many attempts have been made to improve the diagnostic accuracy of acute appendicitis by using different investigations for example abdominal ultrasonography, helical abdominal computed tomography (CT), laparoscopy and magnetic resonance imaging (MRI). These investigations are either not readily available or are associated with a delay in

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diagnosis especially in the developing countries[3,5]. No radiological investigation has 100% diagnostic accuracy for acute appendicitis[5]. A delay in diagnosis is associated with appendix perforation and sepsis leading to morbidity of approximately 10% and mortality of approximately 1-5%[6].

Despite the fact that acute appendicitis is a common surgical problem, still a negative appendectomy rate of 20-40% and perforation rate of 10-30% exists in many parts of the world[7]. The outcome after false positive diagnosis is less life threatening than false negative diagnosis but both are associated with their own drawbacks[7].

Keeping in view the burden of disease many efforts have been made to improve the diagnostic accuracy of acute appendicitis so that both false positive and false negative cases are minimized. Among these different diagnostic modalities clinical diagnosis is the fastest and cheapest method for acute appendicitis. Different scoring systems for example Alvarado, Modified Alvarado, Eskelinen, Ohhmann, Fenyo-Lindberg and Raja Isteri Pengiran Anak Saleha (RIPASA) based upon clinical assessment have been devised over the years[8,9].

Modified Alvarado Scoring System (MASS) was established by Kalen et al after slightly altering the alvarado scoring system (table-I). As in many laboratories counting the white blood cell (WBC) differential is not a routine practice, Modified Alvarado Score was developed by omitting the shift to left of leucocytes in alvarado scoring system[9,10]. Some studies have shown very high sensitivity and specificity of MASS; however others have variable results showing low sensitivity and specificity of MASS[10,11].

Usefulness of MASS had not been evaluated in our setup earlier and as previous studies show variable results regarding the diagnostic accuracy of MASS so rationale of this study is to determine the validity of MASS keeping histopathology as gold standard so that it may be recommended for the early diagnosis of acute appendicitis.

MATERIAL AND METHODS

This cross sectional validation study was conducted after the approval of hospital ethical committee, at the department of general surgery, Combined Military Hospital Kohat, Pakistan, from Nov 2013 to Oct 2014. Total 248 (n=248) patients were included in the study. Sample size (n=248) was calculated by sensitivity and specificity calculator using consecutive non probability sampling. All patients (aged 12 to 60 years) who came in the emergency department with right iliac fossa pain and underwent appendectomy were enrolled in the study. Patients found to have evidence of generalized peritonitis or palpable right iliac fossa mass on examination and the patients with previous history of appendectomy were excluded from the study. Informed written consent for participation in the study was taken after explaining the objectives, benefits and drawbacks of the study.

Each patient received routine medical attention for acute appendicitis including detailed medical history, complete physical examination and required investigations. Modified alvarado score of all patients who were included in the study was calculated on a proforma which included migratory right iliac fossa pain, anorexia, nausea/vomiting, tenderness in right iliac fossa (2 Points), rebound tenderness, elevated temperature and leucocytosis (>10 x 10^9/L, 2 Points)[10-13] (table-I). All patients who were included in the study were assessed by the consultant surgical specialists and residents in surgery.

Decision to operate upon was based on overall clinical condition of the patients. Help of Alvarado, Modified Alvarado, Ohhmann, Fenyo-Lindberg Scoring system, ultrasound abdomen, CT scan abdomen and diagnostic laparoscopy was taken by different surgeons in different cases depending upon diagnostic difficulty and consultant's preference. It was not based only on the Modified Alvarado Score of the patients. Surgeries were performed by consultant surgeons and residents in surgery. Post operatively three

doses of antibiotics were used in the uncomplicated cases and these patients were discharged on the second post operative day while antibiotics were used for prolonged duration in complicated cases and these patients had a longer post operative hospital stay.

Specimens were sent to histopathology department Combined Military Hospital Peshawar, Armed Forces Institute of Pathology (AFIP) and Army Medical College Rawalpindi. Diagnosis of acute appendicitis was confirmed by histopathology results and these results were entered on a proforma.

Data was entered and analyzed using SPSS version 20.0. Mean and standard deviation were described for quantitative data like age while frequency and percentage were calculated for qualitative data like gender.

RESULTS

A total of 248 patients were included in the study during the study period. Out of total 248 patients 183 (73.8%) patients were males and 65 (26.2%) were females. Male to female ratio was 2.8: 1. Age distribution ranged from 12–60 years. Mean age was 29.35 years (SD = 13.18), median 25 years. Most of the patients belonged to third and fourth decades of life. Among the components of Modified Alvarado Scoring System tenderness in right iliac fossa was the most common clinical finding in 97.6% patients having acute appendicitis.

Statistical analysis of the study was done using a 2 x 2 table for comparison of MASS with histopathological diagnosis of appendix (table-II). In our study all 248 cases were diagnosed as acute appendicitis without using MASS.

Table-I: Modified alvarado scoring system (mass)[10-13].

	Mnemonic	Score
Symptoms	Migratory right iliac fossa pain	1
	Nausea/Vomiting	1
	Anorexia	1
Signs	Tenderness in right iliac fossa	2
	Rebound tenderness in right iliac fossa	1
	Elevated temperature	1
Laboratory	Leukocytosis ≥ $10x10^9$	2
Total Score		9

Table-II: Comparisons of MASS and histopathology using 2x2 table.

		Histopathology of Appendix		
		Inflamed appendix	**Normal appendix**	**Total**
MASS	>6	True Positive (a) (160)	False Positive (b) (11)	171
	≤6	False Negative (c) (19)	True Negative (d) (58)	77
	Total	179	69	248

Table-III: Validity of MASS.

Diagnostic Accuracy	Calculation based upon 2 x 2 table	Percentage (%)
Sensitivity	a / a +c x 100	89.39
Specificity	d / b + d x 100	84.06
Positive predictive value	a / a + b x 100	93.57
Negative predictive value	d / c + d x 100	75.32
Diagnostic accuracy	a + d/ a + b + c + d x 100	87.90

However post operative histopathology revealed acute appendicitis only in 179 cases (72.18%) and 69 patients did not have acute appendicitis showing a negative appendectomy rate of 27.82%. If we apply MASS to these patients, keeping a score of 7 as cut off, negative appendectomy rate decreased to 4.43% (11 out of 248). Similarly false negative appendectomy rate was 7.66% (19 out of 248). It means acute appendicitis would have been missed in 7.66% patients if we had relied on MASS only. In our study sensitivity of MASS was 89.39%, specificity 84.06%, positive predictive value 93.57%, negative predictive value 75.32% and diagnostic accuracy was 87.90% (table-III). High positive predictive value of MASS means a score of 7 or more of MASS strongly suggests acute appendicitis and negative predictive value shows that MASS less than 7 is in favor of absence of acute appendicitis in most of the patients, this group of patients can be observed for some time, reassessed, further investigated and then can be operated upon or discharged.

DISCUSSION

There has been lot of work to improve the diagnostic accuracy of acute appendicitis but it can still pose a great challenge to the treating surgeon because different abdominal and pelvic conditions can mimic acute appendicitis especially in children, elderly and female patients of reproductive age. Modified Alvarado Scoring System (MASS) was developed by slightly altering the Alvarado Scoring System[13,14]. It is based upon history, physical examination and basic laboratory investigation (table-I).

We evaluated validity of MASS in our set up because acute appendicitis is the most common abdominal surgical emergency[1] and a diagnostic error is associated with increased morbidity and mortality. Secondly, more sophisticated investigations like ultrasonography, CT scan, MRI and laparoscopy are not usually available readily in many peripheral hospitals. Thirdly, Modified Alvarado Scoring System (MASS) was not previously studied in our hospital. We found that use of MASS for acute appendicitis increases the diagnostic accuracy and decreases the negative appendectomy and complication rate.

In our study sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were 89.39%, 84.06%, 93.57%, 75.32% and 87.90% respectively using a score of 7 as cut off. Two other studies conducted earlier in Pakistan by Arain et al and Kamran et al showed comparable results for Modified Alvarado Scoring System[15,16]. Arain et al recorded sensitivity of 97.2%, specificity of 84.6% and positive predictive value of 85.5%. Kamran et al recorded positive predictive value of 89.66%. In another study by Horzic et al Modified Alvarado

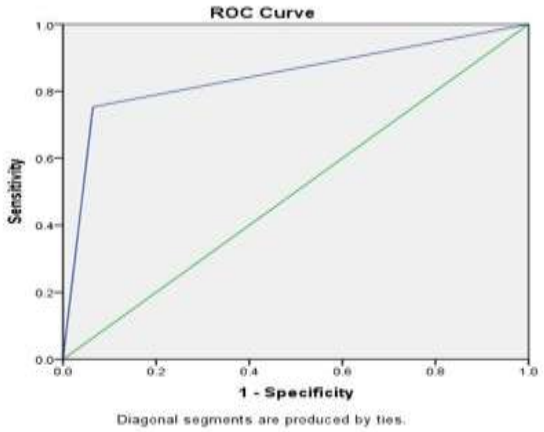

Figure: The area under the curve is 0.844 with a standard error of 0.031 and confidence interval of 0.783 to 0.906.

Score had specificity near 100% when cut off value was 7, they suggested that surgery should be performed immediately on patients who have Modified Alvarado Score 7 or more to avoid perforation and post operative complication rate[17].

Sensitivity of MASS in my study was also in comparison with the results of Ramachandra et al in India[18]. In their study sensitivity of MASS was 88.63%[18]. Similar results were also recorded by Kurane et al in India showing sensitivity of 78.26%, specificity 83.78%, positive predictive value 75.00%, negative predictive value 86.11% and diagnostic accuracy 81.00%[13]. Fente et al in

Nigeria showed sensitivity of 92.93% and specificity of 92.93% for MASS[19].

On the other hand some studies have shown very low sensitivity and specificity of MASS. For example in studies by Yegane et al in Iran, sensitivity of MASS was 59% and 55% respectively and specificity was 63% and 59% respectively[20]. They also concluded that only Modified Alvarado Scoring System is not a good criterion for the diagnosis of acute appendicitis.

Overall negative appendectomy rate, without using MASS in our study was 27.82%. If we apply MASS to these patients, keeping a score of 7 as cut off, negative appendectomy rate decreased to 4.43% (11 out of 248). Studies by Yegane et al, Maral et al showed overall negative appendectomy rate of 14% and 9.1% respectively[20,21]. Studies by Kanumba et al and Horzic et al found negative appendectomy rate of 33.1% and 33% respectively[11,17]. So such patients need additional investigations for example Ultrasound, CT scan, MRI and laparoscopy to confirm the diagnosis[11]. Similarly false negative appendectomy rate was 7.66% (19 out of 248). It means acute appendicitis would have been missed in 7.66% patients if we had relied on MASS only. High positive predictive value (93.57%) of MASS in our study means that a score of 7 or more of MASS strongly suggests acute appendicitis and such patients do not need further investigations to confirm the diagnosis. In our study negative predictive value was 75.32%. It means that MASS less than 7 suggest absence of acute appendicitis in most of the patients.

One limitation of our study was that study population was not a true representation of the society as most of the patients belonged to a particular age group and military background. We recommend that Modified Alvarado Score should be combined with ultrasound abdomen and pelvis in patients where diagnostic ambiguity arises for example in patients with low Modified Alvarado Score, obese patients, females of reproductive age and children.

CONCLUSION

Modified alvarado score is a highly sensitive test with fair degree of specificity for the early diagnosis of acute appendicitis especially in adults. It is particularly helpful for young doctors working in peripheral hospitals where more sophisticated investigations are not available.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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