

## Original Research Article

# Use and relevance of modified alvarado scoring system in diagnosis of acute appendicitis: a cross sectional study from West Bengal, India

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## ABSTRACT

**Background:** For successful management of acute appendicitis, early diagnosis and intervention is needed. Incorrect diagnosis may allow significantly increased morbidity and mortality. Several studies across the globe shows that Modified Alvarado Scoring System (MASS) does not need high end instrument and can be done in emergency situation for accessing acute appendicitis and reducing the chances of unnecessary surgery. To access the efficacy of MASS for diagnosis of acute appendicitis in remote areas with primary health care facilities, present study was done at Siliguri of Darjeeling district of West Bengal which was 580 km distant from state capital (Kolkata).

**Methods:** A cross sectional study over a period of 16 months was conducted among the patients admitted at North Bengal Medical College and Hospital suspected to have acute appendicitis. The diagnosis was confirmed by histopathological examination. Written consent was obtained from the patients before commencement of the study. MASS was applied to the patients and the results were compared with histopathological findings. Appropriate statistical analysis has been done by SPSS (version 16.0).

**Results:** A total of 75 patients (44 males and 31 females) were considered. The sensitivity and specificity of MASS in this study were 75.86% (71.43% for males and 80% for females) and 82.61% (80% for males and 87.5% for females) respectively. Study revealed statistically significant ( $p < 0.000$ ) association between Histopathological report and MASS.

**Conclusions:** To reduce the chances of negative appendectomy and for better diagnosis of appendicitis, MASS may be more useful at primary health care centres those are located in remote areas as it was very simple, easy and cost effective.

**Keywords:** Acute appendicitis, Histopathology, Modified Alvarado Scoring System

## INTRODUCTION

Acute appendicitis is one of the commonest clinical presentations that require emergency surgery.<sup>1-3</sup> The symptoms of acute appendicitis include different etiologies of acute guts making it hard to make right conclusion at the beginning of introduction.<sup>4</sup> High

morbidity is associated with acute appendicitis and failure of making an early diagnosis is related to occasionally morbidity.<sup>5</sup> For this reason, proper diagnosis of acute appendicitis, patients' history and physical examination is very important.<sup>6,7</sup> Enhanced diagnostic accuracy helps in executing early medical administration choices as well as abridges negative appendectomy rates.

A scoring system developed by Alvarado in 1896, on the basis of eight predictive clinical factors to improve the accuracy of physician's clinical assessments in diagnosing acute appendicitis.<sup>8-12</sup>

It was 10-point scoring system includes clinical symptoms, signs and laboratory findings, where Alvarado recommended an operation for all patients with score 7 or more.<sup>9-12</sup> Later in 1994, the last point of the original score was omitted.<sup>13</sup> Nowadays the Modified Alvarado Score has been widely assessed as to its accuracy in the pre-operative diagnosis of acute appendicitis.<sup>11-17</sup>

However, few subsequent studies have suggested that Modified Alvarado Score is inadequate as a diagnostic tool, but it has been advocated as a means of selecting patients who should undergo imaging.<sup>9,10,18</sup> Therefore, present study has been attempted to assess the diagnostic efficacy of Modified Alvarado Scoring System and its relevance in present day in patients with acute appendicitis from Siliguri of Darjeeling district of West Bengal, India.<sup>2,3</sup>

## METHODS

The present study was conducted as a cross sectional study in the Department of Surgery, North Bengal Medical College and Hospital, Darjeeling, West Bengal, India during the period from April 2013 to August 2014.

Total 75 patients (44 males and 31 females) under the age group 15-50 years were considered as participants enrolled as clinically suspected acute appendicitis and undergone appendectomy in the Hospital. Informed consent was taken from each and every patient. The clinical diagnosis of acute appendicitis was done by consultants of Department of Surgery, North Bengal Medical College and Hospital, Siliguri through evaluation of clinical details, investigation and histopathological examination.

### Exclusion criteria

- Patients who had no histopathological report were excluded from the study.

Then depending on the clinical details and investigation, the cases were evaluated by using Modified Alvarado Scoring System (Table 1).<sup>14</sup> Researchers of the present study scored all the patients according to the variable of MASS. Modified Alvarado Score more than or equal to 7 were considered as acute appendicitis i.e. positive and scores less than 7 were considered as negative in the present study. True positive, true negative, false positive and false negative cases were obtained through comparison between Modified Alvarado Score and histopathological findings. The MASS groups were tabulated against histopathological findings as the gold standard.

**Table 1: Modified Alvarado Score.**

| Modified Alvarado Score |                                      |       |
|-------------------------|--------------------------------------|-------|
|                         | Manifestations                       | Value |
| Symptoms                | Migratory right iliac fossa pain     | 1     |
|                         | Anorexia                             | 1     |
|                         | Nausea/vomiting                      | 1     |
| Signs                   | Tenderness right lower quadrant      | 2     |
|                         | Rebound tenderness right iliac fossa | 1     |
|                         | Pyrexia >37.3°C                      | 1     |
| Investigations          | Leucocytosis                         | 2     |
| Total                   |                                      | 9     |

Sensitivity, specificity, positive predictive value, negative predictive values were calculated by using the following formulas:

$$\text{Diagnostic sensitivity} = [a / (a + c)] \times 100$$

$$\text{Diagnostic specificity} = [d / (b + d)] \times 100$$

$$\text{Positive Predictive value} = [a / (a + b)] \times 100$$

$$\text{Negative Predictive value} = [d / (c + d)] \times 100$$

[a= true positive; b= false positive; c= false negative; d= true negative]

### Statistical analysis

The data were entered in data sheet using coding and all statistical analyses were undertaken by using the IBM SPSS (version 16.0). Chi-square ( $\chi^2$ ) test, contingency coefficient and receiver operating characteristic (ROC) curve were performed as required. The p-values of <0.05, p<0.01 and <0.001 were considered to be statistically significant. Age group was categorized by using percentile (25<sup>th</sup> and 50<sup>th</sup>).

## RESULTS

Total 75 adult patients including 44 males and 31 females have been considered in the present study. Here maximum number of patients (52.0%) with MASS score  $\geq 7$  fallen under the age group 26-31 years and lowest number of patients that was 25% fallen under the age group  $\geq 32$  years. Again, the patients with <7 showed highest frequency (75%) under the age group  $\geq 32$  years and lowest frequency (48.0%) within the age group 26-31 years. The chi square ( $\chi^2$ ) value was 0.149 which was statistically not significant; therefore, the Table 2 have not shown any statistical association between age group of patients and cut-off value of MASS. Table 3 demonstrated age group wise distribution of MASS finding. Highest numbers (40.0%) of true positive cases have been reported under the age group 26-31 in years and lowest (16.7%) under the age group  $\geq 32$  years. Similarly, true negative cases were highest (53.8%) within the age group  $\geq 32$  years and lowest (44.0%) under the age group 26-31 years.

**Table 2: MASS findings among different age groups (years) of patients.**

| MASS  | Age group (years) |           |           | Total     | CC    | P value            |
|-------|-------------------|-----------|-----------|-----------|-------|--------------------|
|       | ≤25               | 26-31     | ≥32       |           |       |                    |
| <7    | 15 (57.7)         | 12 (48.0) | 18 (75.0) | 45 (60.0) | 0.220 | 0.149 <sup>N</sup> |
| ≥7    | 11 (42.3)         | 13 (52.0) | 6 (25.0)  | 30 (40.0) |       |                    |
| Total | 26 (100)          | 25 (100)  | 24 (100)  | 75 (100)  |       |                    |

MASS=Modified Alvarado Scoring System, N=Not significant.

**Table 3: Age groups (years) wise distribution of MASS findings among patients.**

| MASS findings  | Age group (years) |           |           | Total     | CC    | P value            |
|----------------|-------------------|-----------|-----------|-----------|-------|--------------------|
|                | ≤25               | 26-31     | ≥32       |           |       |                    |
| True positive  | 8 (30.8)          | 10 (40.0) | 4 (16.7)  | 22 (29.3) | 0.255 | 0.518 <sup>N</sup> |
| True negative  | 13 (50)           | 11 (44.0) | 14 (53.8) | 38 (50.7) |       |                    |
| False positive | 3 (11.5)          | 3 (12.0)  | 2 (8.3)   | 8 (10.7)  |       |                    |
| False negative | 2 (7.7)           | 1 (4.0)   | 4 (16.7)  | 7 (9.3)   |       |                    |
| Total          | 26 (100)          | 25 (100)  | 24 (100)  | 75 (100)  |       |                    |

Percentages are presented in the parenthesis, MASS=Modified Alvarado Scoring System; N=Not significant.

**Table 4: Modified Alvarado Scoring System versus histopathological findings.**

| Histopathological findings | Modified Alvarado Score |                | Total     | χ <sup>2</sup> | P value              |
|----------------------------|-------------------------|----------------|-----------|----------------|----------------------|
|                            | Positive (+ve)          | Negative (-ve) |           |                |                      |
| Positive(+ve)              | 22 (73.3)               | 7 (15.6)       | 29 (38.7) | 25.337         | 0.000 <sup>***</sup> |
| Negative (-ve)             | 8 (26.7)                | 38 (84.4)      | 46 (61.3) |                |                      |
| Total                      | 30 (100)                | 45 (100)       | 75 (100)  |                |                      |

Percentages are presented in the parenthesis; \*\*\* p<0.001.

Total 8 (10.7%) cases were reported as false positive and 7 (9.3%) cases were false negative. The present study has not revealed any statistically significant association between age group of participants and MASS findings. In Table 4, total number of true positive cases 73.3% and true negative cases were 84.4%, false positive cases 26.7%, false negative cases 15.6%. Present study revealed statistically significant (p<0.000) association between histopathological report and MASS. Table 5 represents different variables of Modified Alvarado Score in diagnosis of acute appendicitis.

**Table 5: Sensitivity, specificity, PPV and NPV among studied cases.**

| Variables                       | Male  | Female | Combined |
|---------------------------------|-------|--------|----------|
| Sensitivity                     | 71.43 | 80.00  | 75.86    |
| Specificity                     | 80.00 | 87.50  | 82.61    |
| Positive predictive value (PPV) | 62.50 | 85.71  | 73.33    |
| Negative predictive value (NPV) | 50.00 | 82.35  | 84.44    |

Percentages are presented in the parenthesis.

It has been shown sensitivity of 75.86%, specificity 82.61%, positive predictive value 73.33%, negative predictive value 84.44% in case of both sexes. Interestingly, all the variables have shown comparatively

higher value in case of females than males. Specificity of MASS has shown moderately higher value among all the variables in case of male (80.00%), female (87.50%) and combined (82.61%).

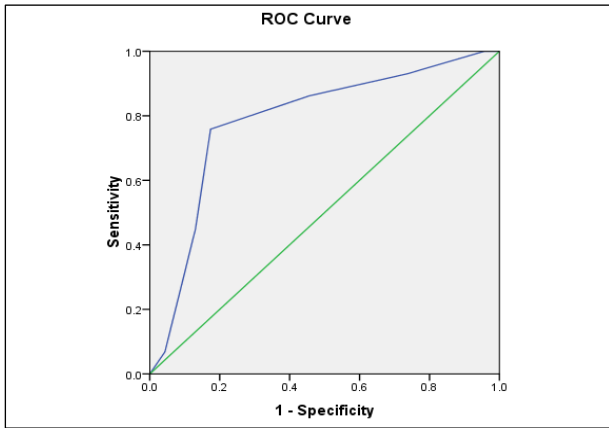
**Table 6: Distribution of studied patients according to gender among MASS.**

| MASS  | Sex       |          | Total     |
|-------|-----------|----------|-----------|
|       | Male      | Female   |           |
| 3     | 2 (4.5)   | 0        | 2 (2.7)   |
| 4     | 6 (13.6)  | 6 (19.4) | 12 (16.0) |
| 5     | 8 (18.2)  | 7 (22.6) | 15 (20.0) |
| 6     | 12 (27.3) | 4 (12.9) | 16 (21.3) |
| 7     | 7 (15.9)  | 4 (12.9) | 11(14.7)  |
| 8     | 7 (15.9)  | 8 (25.4) | 15 (20.0) |
| 9     | 2 (4.5)   | 2 (6.5)  | 4 (5.3)   |
| Total | 44 (100)  | 31 (100) | 75 (100)  |

Percentages are presented in the parenthesis, MASS=Modified Alvarado Scoring System.

In Figure 1, the area under the curve is 0.786 with a standard error of 0.056 and confidence interval (95%) of 0.675 to 0.897. Distribution of studied patients according to gender among MASS Scoring has been depicted in Table 6. Scores of Modified Alvarado Scoring System has been mentioned as 3-9. The prevalence of patients in case of both sexes was higher (21.3%) in MASS score 6

than other MASS scores. MASS score 3 have shown only 2 (4.5%) male patients but eventually no female patients. The prevalence of female patients was highest (25.4%) in MASS score 8 followed by 22.6% in MASS score 5. Similarly, it has been observed that the highest number (27.3%) of male patients have been fallen under the MASS score 6.



**Figure 1: ROC curve for diagnosis of acute appendicitis according to the Modified Alvarado scoring system.**

**DISCUSSION**

The present study has demonstrated total 40% of patients with MASS score  $\geq 7$  were reported in hospital where maximum number of patients (52.0%) belonged to the age group 26-31 yrs. Again, this study also revealed sensitivity and specificity of 75.86% and 82.61% respectively in case of both males and females. The result has been shown a comparatively higher percentage of sensitivity and specificity in comparison with other global studies conducted among different populations (Table 7). The table demonstrated that the study conducted in Tanzania, Africa revealed highest sensitivity and specificity of 94.1% and 90.4% respectively followed by an Indian study conducted in the year 2016 where sensitivity and specificity was reported as 93.24% and 84.21% respectively.<sup>5,19-21</sup>

**Table 7: Comparison of sensitivity and specificity of present study with other global studies.**

| Sample size | Sensitivity (%) | Specificity (%) | Study area                 |
|-------------|-----------------|-----------------|----------------------------|
| 127         | 94.1            | 90.4            | Tanzania <sup>5</sup>      |
| 75          | 65.7            | 37.5            | Tehran <sup>19</sup>       |
| 125         | 53.8            | 80.0            | Saudi Arabia <sup>20</sup> |
| 93          | 93.24           | 84.21           | India <sup>21</sup>        |
| 75          | 75.86           | 82.60           | India, Present study       |

Though the present study revealed a moderately high predictive value of Modified Alvarado Scoring System in

combined cases of both male and females, nevertheless, it has been suggested that this scoring system may be complemented with other diagnostic procedure like laparoscopy or imaging such as ultrasound scan or CT scan and the indispensable clinical judgement to minimize the rate of negative appendectomy and to enhance the diagnostic accuracy.<sup>22,23</sup>

Keeping perspective of the seasonal pattern of acute appendicitis, the present investigation would like to prescribe that, in limited resource areas, the primary health centres can implement Modified Alvarado Scoring System as cost effective, simple, noninvasive tool and can be repeated with almost no cost.<sup>24,25</sup>

Therefore, patients from low economic group as well as residing in remote low resource areas could be benefitted by implementation of MASS for avoiding misdiagnosis and improving emergency department evaluation and management in case of occurrence of typical symptoms of acute appendicitis.

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