MODIFIED ALVARADO SCORING SYSTEM IN THE DIAGNOSIS OF ACUTE APPENDICITIS

[1]Binni John, [2]*Geo Paul Kurikkattayil Jose, [3]Ebitha Kalarikkal Elias and [4]Rosin George Varghese

[1]MS General Surgery, Additional Professor, Department of General Surgery, Government Medical College, Kottayam.
[2]MS General Surgery, Senior Resident, Department of General Surgery, Government Medical College, Kottayam.
[3]MS Ophthalmology, Senior Resident, Department of Ophthalmology, Government Medical College, Kottayam.
[4]MD Social and Preventive Medicine, Senior Resident, Department of Social and Preventive Medicine, Government Medical College, Kottayam.

*Corresponding Author: Geo Paul Kurikkattayil Jose

MS General Surgery, Senior Resident, Department of General Surgery, Government Medical College, Kottayam.

ABSTRACT
Background: In any case of acute appendicitis, arriving at correct diagnosis is essential, because simple appendicitis can progress to perforation. Study aims to find out the sensitivity, specificity and predictive value of Modified Alvarado Scoring System in cases of acute appendicitis. **Methodology:** A prospective study was carried out from 1st September 2015 to 31st august 2016 among 150 consecutive patients undergoing appendicectomy for acute appendicitis in the Department of General Surgery, in a tertiary care centre. Modified Alvarado Scoring (MAS) system and ultrasound scan was applied to all cases Sensitivity, specificity and predictive values of MAS system calculated and cut off value of MAS for the diagnosis of acute appendicitis found out using Receiver Operating Characteristic Curve. **Results**: Modified Alvarado Scoring System was found to have a sensitivity, specificity, positive predictive value and negative predictive value of 86.3%, 54.5%, 96% and 24% respectively. Diagnostic accuracy was 84%. Cut off score for diagnosis is 5.5. **Conclusions:** Modified Alvarado score (MAS) is a sensitive tool in finding out cases of acute appendicitis, however it is not specific enough in confirmation of the diagnosis.

KEYWORDS: Appendicitis, Modified Alvarado Score (MAS), Sensitivity, Specificity.

INTRODUCTION
In any case of acute appendicitis, arriving at correct diagnosis is essential, because simple appendicitis can progress to perforation. Surgeons therefore are inclined to operate when diagnosis of acute appendicitis is probable rather than wait until confirmed. But clinical decision to operate a suspected case of appendicitis leads to removal of normal appendix in 15% to 30% of cases.[1,2] Modified Alvarado scoring (MAS) system and ultrasonography have aided in confirming suspected acute appendicitis.

This study is aimed to find out the sensitivity, specificity and predictive value of MAS in cases of acute appendicitis. Also, to find out the MAS giving optimum sensitivity and specificity in acute appendicitis.

METHODOLOGY
A prospective study was carried out over a period of 12 months (1st September 2015 to 31st august 2016) among 150 patients undergoing appendicectomy for acute appendicitis in the Department of General Surgery, in our institution. Acute appendicitis with mass formation,

cases without histopathology results, sonological evaluation or modified Alvarado score and cases with appendicular abscess undergoing surgery were excluded. Approval was attained from the Review board of the institution and consent obtained from all patients before commencement of the study.

The study involved application of Modified Alvarado Scoring system and ultrasound scan in all cases included in the study. Modified Alvarado scoring system had following factors and scores - Migratory pain(1), anorexia(1), nausea/vomiting(1), right iliac fossa tenderness(2), rebound tenderness(1), elevated temperature(1) and leucocytosis(2). The total score was 9.

Modified Alvarado score (MAS) was obtained by proper history, clinical examination and laboratory values. Following appendicectomy, the specimen was send for histopathological diagnosis.

The collected data was entered in Microsoft Excel and analysed using SPSS software (version16.0). Sensitivity,

specificity and predictive values of MAS system were calculated. Statistically significant MAS factors in diagnosis of acute appendicitis were also found out. Percentage of the categorical data were calculated. Numerical data was represented as mean+/-Standard Deviation. Chi-square test and cross tabs were used to compare categorical and numerical variables respectively. Probability less than or equal to 0.05 ($P</=0.05$) was considered significant. The optimum cut off value of Modified Alvarado Score for the diagnosis of acute appendicitis was also found out using Receiver Operating Characteristic Curve (ROC Curve).

RESULTS
The study included 150 patients of which 96 were males (64%) and 54 were females (36%).

Table 1: Showing distribution of study Population based on age.

Age	Frequency	Percent
$</=15$ years	34	22.7
16-30 years	69	46.0
31-45 years	25	16.7
$>/=46$ years	22	14.7
Total	150	100.0

The commonest age group of presentation was between 15-30yrs, (46% of patient). Mean age of presentation was 27.17+/-14.24yrs. The range of age in study group was 6-72yrs. (Table.1).

Among 150 patients in study population 139 had histologically proven appendicitis (92.7%). Rest 11 (7.3%) were found to have no features of appendicitis.
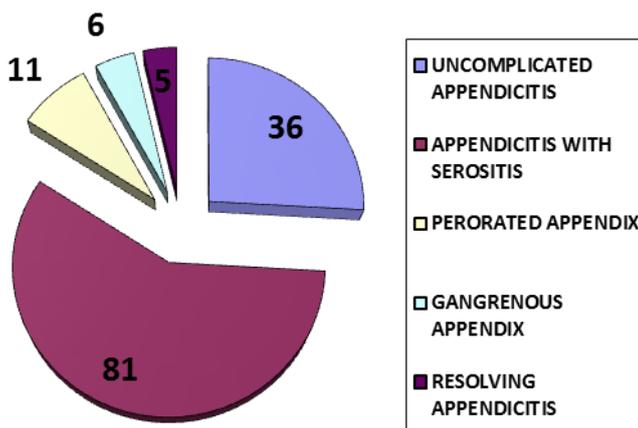

Fig. 1: Showing distribution of appendicitis cases based on Histopathological examination findings.

Most common histopathological finding in 139 appendicitis cases was 'Appendicitis with serositis'- 58.3% (n=81). Least common was 'resolving appendicitis'- 3.6% (n=5). (Fig.1).

Among 150 patients, MAS system detected 125 patients (83.3%) to have acute appendicitis. Whereas, USG detected 104 patients (69.3%) to have acute appendicitis.

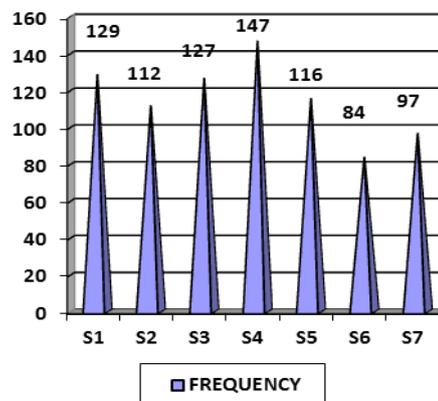| Code	MAS
S1	Migratory pain
S2	Anorexia
S3	Nausea
S4	RIF Tenderness
S5	Rebound Tenderness
S6	Elevated Temperature
S7	Leucocytosis

Fig. 2: Showing distribution of MAS factors among appendicitis cases.

Most common MAS finding was Right iliac fossa tenderness, seen in 147 patients (98%). Least common finding was elevated temperature, seen in 84 patients (56%). (Fig.2).

**Table 2: Statistical parameters of MAS.**

PARAMETERS	MAS score
Sensitivity	86.3%
Specificity	54.5%
PPV[*]	96%
NPV[†]	24%
LR + [‡]	1.9
LR- [§]	0.25
Diagnostic Accuracy	84%

*- positive predictive value, †- negative predictive value,

‡- positive likelyhood ratio, §- negative likelyhood ratio.

MAS system in diagnosis of appendicitis:

Fig. 3: ROC curve.				
Area	**Std. Error[a]**	**Asymptotic Sig.[b]**	**Asymptotic 95% Confidence Interval**	
			Lower Bound	**Upper Bound**
0.773	0.076	0.003	0.625	0.921

In the study of 150 patient 2 MAS findings, that is 'rebound tenderness' (Chi-Square value = 16.971, *P* value = 0.0001) and 'migratory pain' (Chi-Square value =9.755, *P* value=0.002) were found to have significant relation in diagnosis of acute appendicitis.

ROC Curve

Diagonal segments are produced by ties.
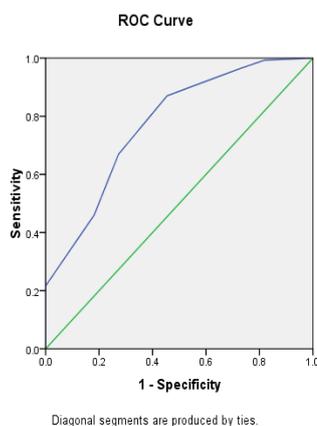
The optimal cut off value for predicting acute appendicitis using Modified Alvarado scoring system was found to be a score > 5.5 with an area under the ROC (fig.3) of 0.773, with sensitivity of 87.05% and specificity of 55.55%.

DISCUSSION

A study was conducted in our institution, to assess the usefulness of Modified Alvarado Scoring system in diagnosis of acute appendicitis in patients admitted in general surgery wards. Study was conducted for a duration of 12 months among 150 patients.

The study showed that the most common age group affected by appendicitis was from 15 to 30 yrs age (46%). More than two third of cases (68.7%) of appendicitis was below 30 yrs of age.

These figures were similar to the age group affected in the prospective study done by J.P. Dave et al on 100 patients over a period of 24 months from September 2013 to September 2015, in P.D.U. Medical College and civil hospital, Rajkot. That study showed a peak incidence of appendicitis between 21 to 30 years.[3] The retrospective study done by Brahmachari et al in a tertiary care teaching hospital in Central India between January 2009 and December 2010 with patients suspected to be having acute appendicitis, found out the most common age group affected by appendicitis as 20-30 years (40.5%), with 62% cases occurring between 10-30 year age group.[4]

In our study among 150 patients in study population 96 were males (64%) and 54 were females (36%). The male to female ratio was found to be 1.78:1. Similar gender distribution was seen in the study done by Jawad Kadhim et al in a hospital in Iraq among 110 patients (during september 2015 - june 2016). The study showed a gender distribution as; 67 males (60.1%) and 43 females (39.1%).[5] Talukder DB et al conducted a prospective study, from July 2005 to June 2008 at Bangladesh Rifles (BDR) hospital, Dhaka, on 100 patients with acute appendicitis. In the study the male to female ratio was found to be 1.38:1.[6]

In our study 139 patients had histologically proven acute appendicitis which means there were 11 negative appendicectomies (7.3%). This negative appendicectomy

rate is far better than acceptable limits. The surgeons have traditionally accepted a 20% rate of negative appendectomy. Study done by Jawad Kadhim et al among 110 patients showed a negative appendicectomy rate of 11% (n=12).[5] Study done by Lee et al in 766 patient showed a negative appendicectomy rates of 15.7%.[7] Compared to these studies the low rate of negative appendicectomy in our study may be due combined use of MAS and USG in assessing patients with suspected appendicitis.

`On histopathological examination most common finding was appendicitis with serositis, in 81 patients (58.3%). Uncomplicated appendicitis constituted 36 patients (25.9%), perforated and gangrenous appendix constituted only 16 patients (12.2%) and five patients were having resolving appendicitis (3.6%).

The study was able to found out 'Right iliac fossa tenderness as the most common MAS factor, it was present in 147 cases (98%). It was followed by 'Migratory pain' which was present in 129 cases (86%). Least common MAS factor was 'elevated temperature' which was only present in 84 cases (56%).

But the study done by Ashish Jadhav et al between January 2012 and November 2013 on 80 patients showed most common MAS factor as Migratory right iliac fossa pain (100%), followed by Right iliac Fossa Tenderness (96.3%).[8] The least common MAS factor was Rebound tenderness (47.5%). This difference may be due to investigator bias or due to difference in clinical assessment of the patient.

But among all MAS factors considered in our study statistical significant relation was only found for 'migratory pain' (Chi-Square value =9.755, *P* value =0.002) and 'rebound tenderness' (Chi-Square value = 16.971, *P* value = 0.0001). No significant relation was established with other MAS factors probably due to low sample size.

When the sensitivity of MAS system was found to be 86.3%, the specificity was 54.5%. The positive predictive value was found to be 96%, where as the negative predictive value was only 24%. The diagnostic accuracy was 84%.

In comparison, the study done by Nishikant Gujar et al at Al Ameen medical college between 2010 and 2015 found the sensitivity and specificity of MAS to be 98.44% and 94.4% respectively.[9]

The study done by Jawad Kadhim between September 2015 and June 2016 showed MAS system with cutoff point 6 had sensitivity of 89%, specificity of 33%, Positive Predictive (PPV) of 91%, Negative Predictive Value (NPV) of 28% and accuracy rate of 83%.[5]

Study by Satyajeet Kumar Singh et al with 55 patients published in 2014 showed the following results. The sensitivity and specificity of Modified alvarado score was 82.05% and 81.25% respectively, with PPV 91.42% and NPV 65% and diagnostic accuracy of 81.82%.[10] This minimal difference in sensitivity and specificity of MAS may be attributed to investigator bias in appreciating various clinical findings.

In the study done by Harsha et al at Sri Devaraj Hospital, Kolar, Karnataka, among 100 patients (during November 2009 to december 2010) showed MAS to have a sensitivity of 98.8%, specificity of 93.3%, Positive predictive value 89.3% and negative predictive value 83.3%.[11]

According to our study the diagnostic accuracy of MAS was 84%. MAS can be used as a screening tool in appendicitis suspected patient as it has got high sensitivity of 86.3%. But for confirmation of diagnosis it is better to have a USG abdomen or CT abdomen which has got a better specificity compared to a low specificity of 54.5% for MAS.

The optimal cut off value for predicting appendicitis using Alvarado score was found to be a score > 5.5 with an area under the ROC of 0.773, with sensitivity of 87.05% and specificity of 55.55%. So rounding to nearest whole number a Modified Alvarado score of 6 can be kept as the cut off for diagnosis of appendicitis. A score of 6 or more gives an optimum sensitivity and specificity.

Study done by Jawad Kadhim et al among 110 patients support the cut off value of MAS system as 6 and has sensitivity and accuracy rate higher than those of MAS system with cutoff point of 7 and USG.[5] Thus, MAS system with cutoff point 6 reduces delayed diagnosis of acute appendicitis and subsequent complications.

CONCLUSION
Modified Alvarado score is a sensitive tool in finding out cases of acute appendicitis, however it is not specific enough in confirmation of the diagnosis. A MAS score of 6 or more, kept as cut off for diagnosis of appendicitis gives an optimum sensitivity and specificity.

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