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Modified Alvarado Scoring System in diagnosing acute appendicitis in a tertiary care centre in upper Assam

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Abstract:

Background*: The most frequent acute abdominal condition is acute appendicitis (AA), and the most prevalent course of treatment is appendicectomy. Despite significant advancements in abdominal surgery, making decisions for patients with acute appendicitis is a global diagnostic challenge. The Modified Alvarado Scoring System (MASS) is a quick and affordable diagnostic tool for people with acute appendicitis. However, if the scores were applied to various populations and clinical situations, differences in diagnostic accuracy were seen.This study aimed to assess the Modified Alvarado Scoring System's diagnostic utility in patients with acute appendicitis in our setting.*

Materials and Methods*: A hospital based cross-sectional study involving 90 patients suspected to have acute appendicitis at General Surgery Wards of Assam Medical College and Hospital, Dibrugarh over a period between June 1st 2021 and May 31st 2022 was conducted. All patients who met the inclusion criteria were consecutively enrolled in the study. They were evaluated on admission using the MASS to determine whether they had acute appendicitis or not. All patients underwent appendicectomy according to the hospital protocol. The decision to operate was based on overall clinical judgment and not the MASS alone. The diagnosis was confirmed by histopathological examination.*

Results*:A total number of 90 patients were studied. Their ages ranged from 12 to 72years. There were 49 (54.44%) males and 41 (45.56%) females (M: F = 1.195:1). All patients in this study underwent appendicectomy.Histopathological examination confirmed appendicitis in 79 patients (87.8%) and the remaining 11 patients had normal appendix giving a negative appendicectomy rate of 12.2%.The sensitivity and specificity of MASS (score 7-9) in this study were 82.27% (males 79.5% and females 85.7%) and 72.7% (males 80% and females 66.6%) respectively. The Positive Predictive Value and Negative Predictive Value were 95.58% (males 97.2% and females 93.7%) and 36.36% (males 30.76% and females 44.44%) respectively. The accuracy of MASS was 81.11% (males 79.59% and females 82.9%).*

Conclusion:*.The study shows that use of MASS in patients suspected to have acute appendicitis provides a high degree of diagnostic accuracy and can be employed to improve the diagnostic accuracy of acute appendicitis. MAASS also helps to reduce negativeappendicectomy and their complication.*

Key Word*: Acute Appendicitis (AA); Appendicectomy; Modified Alvarado Scoring System (MASS).*

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I. Introduction

One of the most frequent causes of abdominal surgical emergencies is acute appendicitis, which affects roughly 1 in 7 people globally over the course of a lifetime [1]. It is linked to high morbidity and unexpected morbidity that results from delayed detection. Many efforts have been made to promote early diagnosis and intervention because it is predicted that 6% of the population will experience acute appendicitis in their lifespan [2, 3].Acute appendicitis must be diagnosed and treated surgically as soon as possible for effective management. A strategy of early intervention to prevent perforation may result in high negative appendicectomy rates in situations where the acute appendicitis picture is not classic [4, 5]. Due to their propensity for atypical presentations and the fact that many other conditions can resemble acute appendicitis in these patients, diagnosis challenges are more common in very young, elderly, and female patients as well as those who are in the

reproductive age group [6].Many surgeons recommend early surgical intervention for the treatment of acute appendicitis to prevent perforation, accepting a negative appendicectomy rate of about 15-20% [7]. Today, a variety of grading systems are accessible that help us recognise an acute appendicitis case. The RIPASA, ALVARADO, and Modified ALVARADO scoring systems, among others, can identify acute appendicitis with sensitivity ranging from 88% to 93.5% and specificity ranging from 67% to 80.6%. [8,9] The Modified Alvarado score is the most widely used scoring system, and researchers generally agree that it is a non-invasive, safe diagnostic method that is straightforward, reusable, and repeatable and can effectively guide the clinician in making the diagnosis and implementing subsequent management. The current research aims to evaluate the performance of the modified ALVARADO scoring system in the diagnosis and management of acute appendicitis in a tertiary centre in upper Assam.

II. Material And Methods

This hospital based cross sectional study was carried out in the Department of General Surgery, Assam Medical College and Hospital, Dibrugarh, Assam from 1st June 2021 to 31st May 2022. A total of 90 adult subjects (both male and females) of aged ≥ 12, years were enrolled for this study.Sample size calculation was done bytaking 95% confidence interval with an absolute error of 10%, prevalence of 46% and sensitivity of Modified Alvarado Score to be 88%[10]; the sample size for the present study is calculated to be 90.

Subjects & selection method: The study population wasPatients undergoing Appendicectomyduring the specified period of study. Patients were divided into two groups according to Modified Alvarado Score.

Group A– MASS 7-9;

Group B–MASS <7

Inclusion criteria:

1. All operated patients in various surgical units of AMCH with pre-operative diagnosis of Acute Appendicitis diagnosed with the aid of USG, CT scan and Modified Alvarado score.
2. Patients willing to participate in the study
3. Age above 12 years.

Exclusion criteria:

1. Pregnant women;
2. Patients not willing for surgery or conservatively managed cases.
3. Patients not getting clearance for surgery due to underlying diseases.

Procedure methodology

For this study we use the Modified Alvarado Scoring System where the 'Shift to Left of Neutrophils' is omitted. The modified scoring system is based on 3 signs, 3 symptoms and 1 laboratory finding. The patients were classified as males and females. These were further grouped based on the scores 7 – 9 and <7.

MODIFIED ALVARADO SCORING SYSTEM

SYMPTOMS	SCORE
1. MIGRATORY RIF PAIN	1
2. ANOREXIA	1
3. NAUSEA VOMITING	1
SIGNS	
1. TENDERNESS RIF	2
2. REBOUND TENDERNESS RIF	1
3. FEVER	1
LABORATORY FINDINGS	
1. LEUCOCYTOSIS	2
TOTAL	9

Modified Alvarado scoring system is a simple noninvasive diagnostic procedure. It is reliable, safe, repeatable and economical, and can be used in an emergency setting. It can be easily applied by emergency medicine resident or general surgery resident, and there is no statistical difference in diagnosis of acute appendicitis in terms of application of the scoring system.

For statistical analysisdata were presented in terms of frequency and percentages. Sensitivity, specificity, positive predictive value, negative predictive value, accuracy of Modified Alvarado Score was calculated using the standard formula. Pictorial presentations were also made using bar diagrams.

III. Results and Observations

90 cases with suspicion of acute appendicitis were taken up for surgery based on the clinical scoring system (MAS more than 4). Among the 90 cases that were operated 79 cases had acutely inflamed appendix. The percentage of inflamed appendix found on operation was 87.78% and normal looking appendix was 12.22%.

Table 1

Age in Years	No. of Cases		
	Males	Females	Total
12-21	14	16	30
22-31	24	16	40
32-41	8	5	13
42-51	1	1	2
52-61	1	1	2
62-71	1	1	2
72 and above	0	1	1
TOTAL	**49**	**41**	**90**

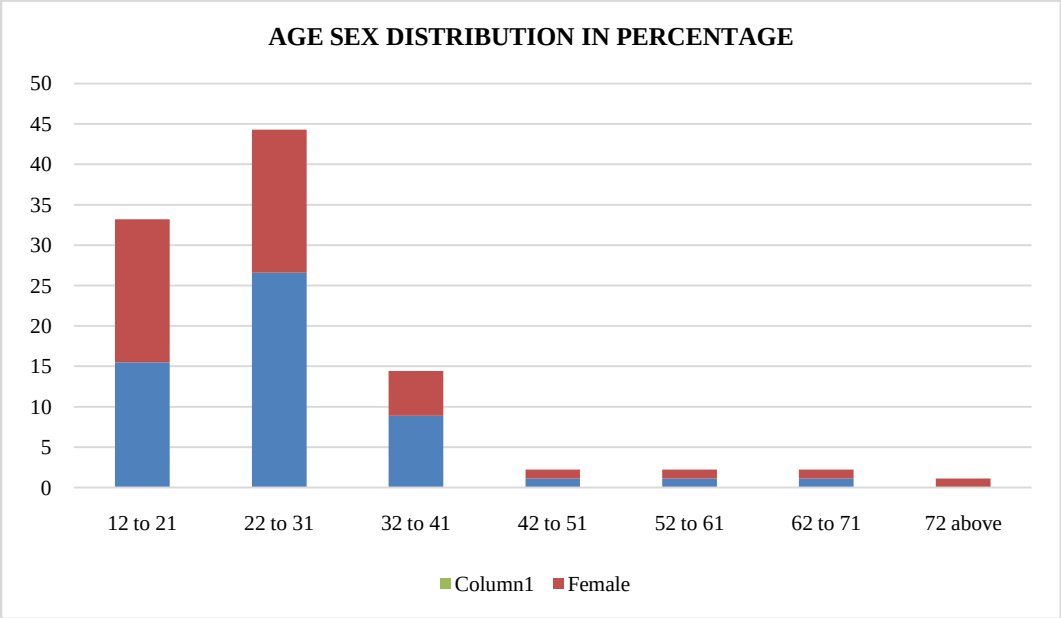

Fig 1

The age and sex distribution of 90 cases are as follows. There are 14 males (15.5%) and 16 females (17.7%) in the age group of 12-21, 24 males (26.6%) and 16 females (17.7%) in the age group of 22-31, 8 males (8.87%) and 5 females (5.56%) in the age group of 32-41, 1 male (1.1%) each and 1 female (1.11%) each in the age group of 42-51, 52-61 and 62-71 while only 1 female (1.1%) in age group 72 and above.

SYMPTOMATOLOGY AND PHYSICAL SIGNS

Table 3

Clinical	Number	Percentage
Pain Abdomen	90	100
Tenderness at Rt Iliac Fossa	86	96
Fever	67	74.4
Rebound tenderness	78	86.6
Rovsing's sign	20	22
Hyperaesthesia at Sherren's triangle	16	18
Mass in RIF	11	12
Vomiting	56	62.2
History of previous attacks	35	39
Urinary symptoms	17	19
Diarrhoea	12	14
Muscle-Guarding	68	76

Most common symptomatology found is Pain abdomen with 90 patients (100%), Tenderness at Right iliac fossa with 86 patients (96%), Rebound Tenderness 78 patients (86.6%), Muscle Guarding 68 patients (76%), Fever with 67 patients (74.4%),vomiting with 56 patients (62.2%), History of Previous Attacks 35 patients (39%), Rovsing's sign 20 patients (22%), Urinary symptoms 17 patients (19%), Hyperaesthesia at Sherren's triangle 16 patients (18%), Diarrhoea 12 patients (14%) and Mass in R.I.F 11 patients (12%) respectively.

MODIFIED ALVARADO SCORE ANDINFLAMED APPENDIX

Table 4

MODIFIED ALVARADO SCORE	INTRAOPERATIVELY INFLAMED		NOT INFLAMED	
	Male	Female	Male	Female
7-9	**35**	**30**	**1**	**2**
5-6	**9**	**5**	**4**	**3**
≤4	**0**	**0**	**0**	**1**

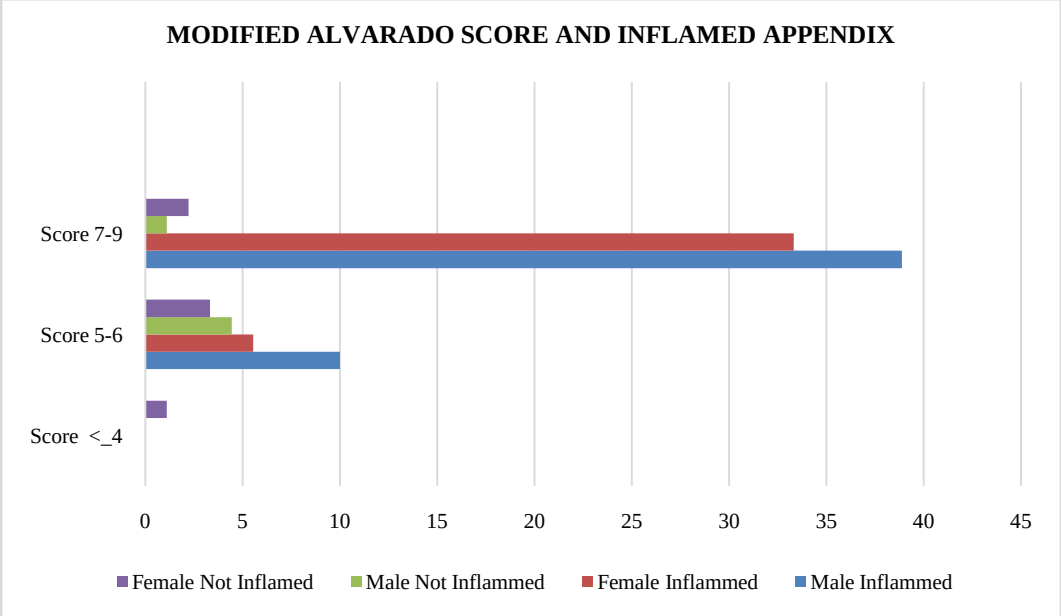

Fig 4

The total number of patients have been divided into 3 groups according to Modified Alvarado Score, Score of 7-9 have 35 male and 30 female with inflamed appendix while 1 male and 2 female with normal looking appendix intra operatively, Score of 5-6 have 9 male and 5 female with inflamed appendix while 4 male and 3 female with normal looking appendix intra operatively and Score of $\leq$ 4 have only 1 female with normal looking appendix intra operatively respectively.

MODIFIED ALVARADO SCORE AND HISTOPATHOLOGY

Table 5

MAS	HISTOPATHOLOGICALLY PROVEN INFLAMED(ACUTE)	HISTOPATHOLOGICALLY NORMAL FINDING
7-9	65	3
<7	14	8

The table shows Modified Alvarado score divided into two groups. One with Score 7-9 and other with Score <7. In patients with M.A.S score 7-9, 65 out of 68 had acute appendicitis and 3 out of 68 had histopathologically normal finding; and with M.A.S Score <7, 14 out of 22 had acute appendicitis and 8 out of 22 had histopathologically normal finding. Overall Sensitivity for M.A.S is 82.27%, Specificity is 72.7%, Positive Predictive Value 95.58%, Negative Predictive value 36.36% and Accuracy is 81.11%.

M.A.S AND HISTOPATHOLOGY IN MALE

Table 6

MALE	Inflamed Appendix	Normal Appendix
Score 7-9	35	1
Score <7	9	4

M.A.S in Males divided into 2 groups. One group with score 7-9 and another group with M.A.S score <7. In group with score 7-9, 35 out of 36 patients had acute appendicitis while 1 out of 36 patients had normal appendix in histopathology. In group with score <7, 9 out of 13 patients had acute appendicitis while 4 out of 13 patients had normal appendix in histopathology. The Sensitivity in Males is 79.5%. Specificity in Males is 80%. Positive Predictive Value in Males is 97.2%. Negative Predictive Value in Male is 30.76%, Accuracy of M.A.S in Males is 79.59%.

M.A.S AND HISTOPATHOLOGY IN FEMALE

Table 7

FEMALE	Inflamed Appendix	Normal Appendix
Score 7-9	30	2
Score <7	5	4

Table shows M.A.S in Females divided into 2 groups. One group with M.A.S score 7-9 and another group with M.A.S score <7. In group with score 7-9, 30 out of 32 had acute appendicitis while 2 out of 32 had normal appendix in histopathology. In group with M.A.S score <7, 5 out of 9 patients had acute appendicitis while 4 out of 9 patients had normal appendix in histopathology. Sensitivity in Females is 85.7 %, Specificity in Females is 66.6%, Positive predictive value in Females is 93.7%, Negative predictive value in Females is 44.44%, Accuracy of M.A.S in Females is 82.9%.

MODIFIED ALVARADO SCORE AND PRESENTATION

Table 8

Sl No	MAS	Male	Female	Total	Percentage
1.	MIGRATORY RIF PAIN	**24**	**21**	**45**	**50**
2.	ANOREXIA	**40**	**30**	**70**	**77.7**
3.	NAUSEA VOMITING	**30**	**26**	**56**	**62.2**
4.	TENDERNESS RIF	**49**	**37**	**86**	**96**
5.	REBOUND TENDERNESS RIF	**42**	**36**	**78**	**86.6**
6.	FEVER	**39**	**28**	**67**	**74.4**
7.	LEUCOCYTOSIS	**42**	**36**	**78**	**86.6**

Table shows M.A.S and Clinical Presentation. Most common presentation is tenderness in R.I.F with 86 patients (96%), Leukocytosis with 78 patients (86.6%), Rebound Tenderness R.I.F with 78 patients (86.6%), Fever with 67 patients (74.4%), Anorexia with 70 patients (77.7%), Nausea Vomiting with 56 patients (62.2%) and Migratory R.I.F Pain with 45 patients (50%) respectively.

IV. Discussion

The present study covered cases undergoing appendicectomy which fulfills inclusion and exclusion criteria in the Department of General Surgery, Assam Medical College & Hospital, Dibrugarh. There were 90 cases that underwent appendicectomy and out of those 79 had acute appendicitis diagnosed by histopathology. In M.A.S score group of 7-9, there were 68 patients out of which 65 patients had acute appendicitis while the group with M.A.S <7, there were 22 patients out of which 14 had acute appendicitis. The result and observations of our study were compared and analyzed with other relevant studies made by other authors.

The peak incidence of appendicitis was in age group 22-31 years with male to female ratio 1.5:1 and overall male to female ratio 1.19:1, which is like previous studies by other authors like Umar Mukthar et al[11], A.S. Oguntola et al[12] and. Mungadi IA et al[13]

Various Studies	Peak Incidence Age Group	Male: Female in Peak Incidence Group	Male: Female Overall
Umar Mukthar et al[11]	20-24 years	1.5:1	1.4:1
A.S. Oguntola et al[12]	20-30 years	-	1.08:1.
Mungadi IA et al[13]	20-29 years	1.4:1.	-
Our Study	22-31 years	1.5:1	1.19:1

Most common symptomatology found in our study is Pain abdomen with 90 patients(100%), Tenderness at Right iliac fossa with 86 patients (96%), Rebound Tenderness 78 patients (86.6%), Muscle Guarding 68 patients (76%), Fever with 67 patients (74.4%),vomiting with 56 patients (62.2%), History of

Previous Attacks 35 patients (39%), Rovsing's sign 20 patients (22%), Urinary symptoms 17 patients (19%), Hyperaesthesia at Sherren's triangle 16 patients (18%), Diarrhoea 12 patients (14%) and Mass in R.I.F 11 patients (12%) respectively which is similar to other studies by Matthew J et al[14], Pouget et al[15]and Mukthar et al[11]

Study conducted by K Vagholkar[16] shows negative appendectomy rate for female patients (12.5%) and zero per cent for male patients. In another study by Khalid Al et al[17] overall positive and negative appendectomy rates were 95.1% and 4.9%, In the study by Khalid et al[17]negative appendectomy at a score of >7 was 1.6%. InMatija et al. study, revealed no case of removal of the normal appendix at a score of >7[18]. Studies conducted by Saidi HS, etal[19] (19.7%) and Mc Kay R et al[20](22.22%)shows higher negative appendectomy rate.

Various Studies	**Negative Appendicectomy Rates (M.A.S more than seven)**
Saidi HS, etal[19]	19.7%
K Vagholkar[16]	6.25%
Khalid et al[17]	1.7%
Our Study	4.41%

The overall percentage of negative appendectomy in our study with MAS 7-9 was 4.41% including one male and two female patients. The percentage of negative appendicectomy in males with M.A.S 7-9 is 2.77%. The percentage of negative appendicectomy in females with M.A.S 7-9 is 6.25%. The slightly higher rate of negative appendectomy in female patients is attributed to a case of ruptured right ovarian cyst and one with ileocaecal tuberculosis. In female patients other investigations like ultrasound or laparoscopy may be required to score lower negative appendectomy rate. Lamparelli MJ, et al[21] combined the Alvarado score with selective laparoscopy in adult female to increase the diagnostic accuracy and to avoid negative appendectomy. In his study Khan I et al[22] ,it was 0%. and Malik AA [23]reported high negative appendectomy rate in female patients. However, in male patients the scoring system was fairly acceptable, with no significant failure[24,25]

Thus, the Modified Alvarado score showed a good correlation with the histopathological results: "the higher the score, the greater the incidence of histologically proven acute appendicitis." Moreover, applying Modified Alvarado's clinical scoring among the patients presenting with clinical manifestations of acute appendicitis in the emergency setup prevents false-negative operation [26]. Different studies from literature shows positive predictive values of 82.7%, 83.5%, 85.3%, and 87.4%.[22,27-29]. Positive predictive value in our study (MAS 7-9) is 95.58%, and negative predictive value is 36.36%. The overall sensitivity for Modified Alvarado score in our study (MAS 7-9) is 82.2% and specificity is 72.7%. The accuracy of our study with M.A.S (7-9) is 81.1%. The sensitivity and specificity in males with M.A.S (7-9) were 79.5% and 80% respectively. While the sensitivity and specificity of females with M.A.S (7-9) is 85.7% and 66.6% respectively. Study by Hattabi et al[17], found that the application of Alvarado scoring provides 94.9% sensitivity, 72.7% specificity, 98.4% positive predictive value, and 44.4% negative predictive value in the diagnosis of acute appendicitis, taking histopathology as the gold standard. Our results match those of Kanumba et al[30]. who observed the sensitivity, specificity, positive predictive, negative predictive values, and accuracy of the Alvarado score to be 94.1%, 90.4%, 95.2%, and 88.4% respectively.

V. Conclusion

From our study we conclude that, men are more affected than women with acute appendicitis. Modified Alvarado score is very effective in diagnosis of acute appendicitis in men, but some other diagnostic modality is necessary to ascertain the diagnosis in females along with the clinical scoring system. Higher the Modified Alvarado Score, lesser the number of negative laparotomies. It can work effectively in routine practice as an adjunct to surgical decision making in doubtful cases. As it is cost effective it can be routinely used in all primary health centers or any hospital with basic lab-facilities and particularly where facilities of USG scan or CT scan are not available.

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