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Accuracy of Modified Alvarado Score in Diagnosing Acute Appendicitis versus Relevant Appendicular Biopsies

Dr. Anas Ahmed Abbas Jathabat[1] and Dr. Ahmed Hazim Ibrahim Al-Darraji[2]

[1]Specialist General Surgeon, Fellow of the Arab Board of Medical Specializations, Department of Surgery, Fallujah Teaching Hospital, M.B.Ch.B, C.A.B.S.

[2]Specialist General Surgeon, Fellow of the Iraqi Board of Medical Specializations, Department of Surgery, Fallujah Teaching Hospital M.B.Ch.B, FICMS.

Abstract: Background: Making the diagnosis of acute appendicitis is difficult, and it is important to reduce the incidence of perforation of the inflamed appendix and to help reduce the rate of negative appendectomy with subsequent negative results. The modified Alvarado score can be used to classify patients with clinical features suggestive of acute appendicitis. **Objective:** To compare the frequency of biopsy proven acute appendicitis in suspected patients with acute appendicitis who have a modified Alvarado score (MAS) of 7 or more with patients having MAS of 6 or less depending on the biopsy results of all appendectomized specimens. **Design**: Randomized prospective study of 200 patients in Fallujah Teaching Hospital for a seven-month period (Sep. 2025 to April 2026). **Patients & Method**: This study involved 200 patients with a provisional diagnosis of acute appendicitis who were operated upon**.** Modified Alvarado Score (MAS), Gender distribution, Age distribution and duration of the complaints were taken into consideration. Preoperatively, the MAS of each patient was calculated, and the patients were divided into two groups. Group I has MAS of 7 or more, while Group II has MAS of 6 or less. Operative findings, biopsy results of the two groups were recorded analysed and compared. Sensitivity and specificity for each group were calculated. P-value for each patient group was also calculated using the Chi-square test. **Result**: *Group I:* - a total number of 167 patients operated upon on clinical diagnosis. 156 positively inflamed appendices on histopathology (Sensitivity rate = 93.41 %). Negative appendicectomy was 11 patients (Specificity rate = 6.59 %). *Group II:* - a total of 33 patients operated upon on clinical diagnosis. 8 positive inflamed appendices on histopathology (Sensitivity = 24.24 %). Negative appendicectomy rate was for 25 patients (Specificity rate = 75.76 %). The study revealed a statistically significant difference of positive appendicectomy rate between the two groups with (P-value <0.001) using our MAS. **Conclusions**: Frequency of inflamed appendix is more in patients having MAS of seven or above. The number of negative appendicectomies can be reduced by using MAS in clinical practice.

Keywords: Acute Appendicitis, Modified Alvarado Score, Fallujah Teaching Hospital.

INTRODUCTION

Acute appendicitis is the most common abdominal emergency surgical operation in developed countries 1. The incidence of appendicitis raised greatly in the first half of last century, particularly in Europe, America and Australia, with appendicectomy rate up to 16% (Brunicardi, F. C. *et al*., 2010; Guan, L. *et al*., 2023).

In the past 30 years, the incidence has fallen dramatically in these countries; with lifetime risk of appendicectomy is 8.6% and 6.7% among males and females respectively (Brunicardi, F. C. *et al*., 2010; Guan, L. *et al*., 2023).

Appendicitis is rare in rural parts of developing countries, but in the cities the incidence approaches that of the West. This different susceptibility in people of similar ethnic origin is probably related to a much-reduced intake of dietary fibres in city-dwellers (Guan, L. *et al*., 2023; Ahmad, M. *et al*., 2002).

Acute appendicitis is relatively rare in infants, and becomes increasingly common in childhood and early adult life, reaching a peak incidence in the teens and early 20s. After middle age, the risk of developing appendicitis is quite small. The incidence of appendicitis is equal among males and females before puberty. In teenagers and young adults, the male–female ratio increases to 3:2 at age 25; thereafter, the greater incidence in male declines (Fenyö, G. *et al*., 1997; Dahabreh, I. J. *et al*., 2016).

Recognition of acute appendicitis as a clinical entity is attributed to Reginald Fitz, who presented a paper to the first meeting of the Association of American Physicians in 1886 entitled 'Perforating inflammation of the vermiform appendix'. Soon afterwards, Charles McBurney described the clinical manifestations of acute appendicitis including the point of maximum tenderness in the right iliac fossa that now bears his name. McBurney in 1889 pioneered early diagnosis and was the first to point out the importance of early surgical intervention (Saud, A. H. 1999).

Early diagnosis of appendicitis was the joint goal of surgical publications. Failure to make an early diagnosis is a primary reason for persistent rate of

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*Corresponding Author: Dr. Anas Ahmed Abbas Jathabat

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morbidity and mortality (Saud, A. H. 1999; Elniel, M. *et al*., 2018).

Perforation rates ranged from 4% up to 45% in adult and from 30% up to 60% in children were reported in literatures (Bukhari, S. A. H., & SH, R. 2002; Horžić, M. *et al*., 2005).

Mortality rate ranged from 0.17% to 7.5%. Mortality in children less than two years old is surprisingly high and reaching a level of 20%. Morbidity rate following negative laparotomy was estimated as 15% (Al-Hashemy, A. M., & Seleem, M. I. 2004; Sadiq, M., & Amir, S. 2002).

There is a tendency of over diagnosis of the condition to avoid complications. Different studies have found a very high negative appendicectomy rate (11-30%). In another study the proportion of negative appendicectomy rate was 32.66% (Horžić, M. *et al*., 2005).

As a result of this, surgeons created for themselves a "surgical security zone" which allows them to accept a 15-20% negative laparotomy rate with impunity (Saud, A. H. 1999).

The hospital stays, loss from school and work and cost as a result of negative appendicectomy constitute a significant financial outlay to the patient, to the health service, and to the society (Amer, S. 2004; Bhattacharjee, P. K. *et al*., 2002).

The policy of surgical principle "when you are in doubt, take it out", could not justified as complication of negative appendicectomy is not low (Saud, A. H. 1999).

The diagnosis relay on the basis of clinical skills practice and laboratory data to make the diagnosis of acute appendicitis. The highest accuracy standard of early diagnosis of appendicitis is about 80% - 90% (Ohmann, C. *et al*., 1999; Lintula, H. *et al*., 2005).

Diagnosis of acute appendicitis is sometimes difficult. Decision making may be especially difficult for junior doctors who might get confused by a long list of conditions mimicking this clinical scenario. Equivocal cases usually require in-patient observation and this delay may increase the morbidity and costs (Ohmann, C. *et al*., 1999).

In eighties investigators started to develop several scoring systems that have not gained acceptance due to their complex methodological characteristic and limited availability (Dahabreh, I. J. *et al*., 2016).

Recently a number of scoring systems have been advocated to minimize the number of negative appendectomies.

Tzanakis and colleagues, in 2005 published a simplified system called the "Tzanakis scoring system" 38. It incorporates four variables made up of specific signs and symptoms: (right lower abdominal tenderness = 4 points, rebound tenderness = 3), laboratory findings (presence of white blood cells greater than 12,000 in the blood = 2), and ultrasound findings (presence of positive ultrasound scan findings of appendicitis = 6). The maximum score is a total score of 15; where a patient scores 8 or more points, there is greater than 96% chance of appendicitis (Ramirez, J. M., & Deus, J. 1994; Fujita, W. *et al*., 1985).

The Ohmann score includes 7 clinical variables and a WBC count (Nozoe, T. *et al*., 2002; Ohmann, C. *et al*., 1999). The score was developed in a group of 870 patients at German and Austrian hospitals and was validated four months later in a second group of patients at the same hospitals. In the prospective validation, the Ohmann score successfully identified patients at low, moderate, and high risk of appendicitis (Nozoe, T. *et al*., 2002; Ohmann, C. *et al*., 1999).

In 1985 Dr. Alvarado from Plantation General Hospital in Florida described a scoring system which has been validated in adult surgical practice. He developed this score from a retrospective study and detailed statistical analysis of 305 patients admitted with suspicion of appendicitis (Saud, A. H. 1999; Alvarado, M. A. 1986).

The classical Alvarado score includes left shift of neutrophil maturation (score 1) yielding a total score of 10, which is not routinely done in many laboratories. Table (Ferris, M. *et al*., 2017).

Table1: The Classic ALVARADO (MANTRELS) Score

	Predictors	***Score***
Symptoms	Migratory RIF Pain	1
	Anorexia	1
	Nausea & Vomiting	1
Sings	Tenderness (RIF)	2
	Rebound Tenderness	1

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	Elevated Temperature	1
Laboratory	Leucocytosis	2
	Shift to Left (Neutrophils)	1
	Total Score	**10**

In our Modified Alvarado Score (MAS) the left shift of neutrophil has been neglected and yielding a total score equal to 9 which is more practical, reliable and easily done. Table (Brunicardi, F. C. *et al*., 2010).

Table 2: The Modified Alvarado (MANTRELS) Score

	Predictors	***Score***
Symptoms	Migratory RIF Pain	1
	Anorexia	1
	Nausea & Vomiting	1
Sings	Tenderness (RIF)	2
	Rebound Tenderness	1
	Elevated Temperature	1
Laboratory	Leucocytosis	2
	Total Score	**9**

CLINICAL FEATURES OF CLASSIC APPENDICITIS

Acute appendicitis classically begins with poorly localized, colicky central abdominal visceral pain; this results from smooth muscle spasm as a reaction to appendiceal obstruction. Anorexia and vomiting often accompany the pain at this stage. As inflammation advances over the ensuing 12–24 hours, it progresses through the appendiceal wall to involve the parietal peritoneum (which is innervated somatically). At this stage the pain typically becomes localized to the right iliac fossa. Signs of local peritonitis, i.e. tenderness and guarding, can be elicited at this stage1.

The classic visceral–somatic sequence of pain is present in only about half of those patients subsequently proven to have acute appendicitis, largely because the localizing symptoms and signs vary with the anatomical relations of the inflamed appendix1.

PATIENTS & METHODS

The study was conducted in the surgical wards of Fallujah Teaching Hospital. Patients aged 10 years or above who were admitted and operated upon with a provisional clinical diagnosis of acute appendicitis were included in this study. Patients below 10 years were referred to paediatric surgery hospital according to MOH instructions.

Diabetic patients and immune compromised patients were excluded from the study.

A total number of 200 patients were included in this study using a Randomized prospective method for the period from September 2025 to April 2026.

For the purpose of statistical analysis, the patients were divided in two groups. Group I include patients having Modified Alvarado Score of 7 or more while Group II include patients having Modified Alvarado Score of 6 and less.

Patients were initially evaluated by history, physical examination, Total Leucocyte Count, and Modified Alvarado Score of each patient was calculated.

In our Modified Alvarado Score (MAS) the left shift of neutrophil has been neglected and yielding a total score of 9 which is more practical, reliable and easily done.

The decision to operate was made independently by the surgeon on call team. All excised appendices were sent for histopathological examination in the histopathological laboratory of Fallujah Teaching Hospital.

Statistical significance of results of group-I and group-II was done. P-value less than or equal to 0.05 considered significant according to Chi-square test.

Sensitivity and specificity of Modified Alvarado Score of both patients' groups were calculated. Overall Sensitivity rate (Accuracy) was calculated.

RESULTS

Gender Distribution of Patients

We had 126 male patients (63%), and 74 female patients (37%). Male to female ratio (M:F) was 1.7:1. Table (Guan, L. *et al*., 2023).

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Table 3: Gender distribution of patients

Gender	Number of patients	Percentage
Male	126	63 %
Female	74	37 %
Total	200	100 %

We had 120 male patients (73.17%) and 44 female patients (26.83 %), total 164 patients with biopsy proven acute appendicitis. Table (Ahmad, M. *et al*., 2002)

In non-appendicitis group only 6 male patients (16.67 %) and 30 patients (83.33 %) were female, total 36 patients. Table (Ahmad, M. *et al*., 2002)

Chi-Square test = 1.145 which also shows no statistical difference between males & females for both appendicitis and non-appendicitis patients' groups. Table (Ahmad, M. *et al*., 2002).

Table 4: Gender distribution of appendicitis and non-appendicitis patients (n=200) according to histopathological results.

Gender	Total Patients	Appendicitis patients (n=164)	Per.%	Non Appendicitis patients (n=36)	Per.%
Male	126	120	73.17 %	6	16.67 %
Female	74	44	26.83 %	30	83.33 %
Total	200	164	100 %	36	100 %
Chi-Square = 1.145 which is > 0.05 (between males & females)					

AGE DISTRIBUTION OF PATIENTS

The following finding was for patients with appendicitis: Table (Fenyö, G. *et al*., 1997)

- The highest incidence was in the third decade with 78 patients (47.56%).
- 27 patients (16.46 %) were in second decade.
- 35 patients (21.34 %) were in forth decade.
- 14 patients (8.54 %) were in fifth decade.
- 10 patients (6.1 %) were above 50 years old.
- Chi-Square test = 1.9078 which also shows no statistical difference between different age groups for both males and females.

Table 5: Age distribution of patients with appendicitis (n=164).

Sex	11-20	21-30	31-40	41-50	51-60	61-70	Total
Male	20	56	26	10	5	3	120
Female	7	22	9	4	1	1	44
Total	27	78	35	14	6	4	164
Percentage	16.46 %	47.56 %	21.34 %	8.54 %	3.66 %	2.44 %	100%
Chi-Square = 1.9078 which is > 0.05 (between different age groups)							

The Age range was between 10 - 70 years old with mean age was 26.6 years relative to operative findings. Table (Dahabreh, I. J. *et al*., 2016)

Chi-Square Test was done to compare between different means of age for certain operative finding in acute appendicitis.

The result is = 3.63 which means that P-value > 0.05). Therefore, there is no statistical difference between different types of operative findings in acute appendicitis. Table (Dahabreh, I. J. *et al*., 2016).

Table 6: Operative finding in relative to age distribution in acute appendicitis with mean age for each type (n=164)

Operative Finding	Number	Age (years)	Mean Age (years)
Catarrhal	102	10 - 70	26.0
Obstructed	20	20 - 60	38.2
Gangrenous	14	20 – 60	32.7
Perforated	21	10 - 40	17.3
Appendicular Abscess	7	10 - 50	22.6

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Total	164	10 - 70	26.6
Chi-Square Test = 3.63 which is > 0.05 (between different mean of age for each type of operative findings)			

Each patient's group was statistically analysed using Chi-Square test which shows no statistical difference between males & females as P-value for each patient age group is more that >0.05.

So, there is no enough evidence to conclude that males and females are different in each target patients Age groups.

Table 7: Age distribution of patients with non-appendicitis according to histopathological results (n=36)

Sex	**11-20**	**21-30**	**31-40**	**41-50**	**51-60**	**61-70**	**Total**
Male	0	2	2	1	1	0	6
Female	1	16	8	4	1	0	30
Total	1	18	10	5	2	0	36
Percentage	2.8 %	50 %	27.8 %	13.9 %	5.5 %	-	100%
Chi-Square Test	0.655	0.527	0.777	0.841	0.206	-	0.677

Duration of the Presentation

Early presentation less than 24 hours found in 122 patients (74.39 %) of patients, while 24 patients (14.63%) had a presentation time between 24-48 hours. Only 18 patients (10.98 %) presented late more than 48 hours. Table (Elniel, M. *et al*., 2018).

Table 8: Duration of sign & symptoms at time of Presentation for patients with appendicitis (n=164)

Duration (hrs.)	**Number of Patients**	**Percentage**
< 24	122	74.39 %
24 – 48	24	14.63 %
> 48	18	10.98 %
Total	164	100 %

Only 6 patients (16.67 %) presented early < 24 hours, while 18 patients (50%) had a presentation time between 24-48 hours. Table (Bukhari, S. A. H., & SH, R. 2002).

12 patients (33.33%) had late presentation > 48 hours in non-appendicitis cases. Table (Bukhari, S. A. H., & SH, R. 2002).

Table 9: Duration of sign & symptoms at time of Presentation for patients with non-appendicitis (n=36)

Duration (hrs.)	**Number of Patients**	**Percentage**
< 24	6	16.67 %
24 – 48	18	50 %
> 48	12	33.33 %
Total	36	100

The Scoring System

There are 110 male patients (87.30 %) scored ≥ 7 points; only 106 of them (96.36 %) proved to have appendicitis by Histopathological study. In females, there are 57 patients (77.03 %) scored ≥ 7 points, only 50 patients (87.72 %) had appendicitis on Histopathology, as seen in table 10.

Chi-Square test shows a statistical difference for those patients with Modified Alvarado Score ≥ 7 (P-value <0.05).

Table 10: Results of MAS for Group-I (Patients scored ≥ 7)

Sex	**No. of patients operated upon**	**Group-I Score ≥ 7**	**Percentage**	**Appendicitis confirmed histologically**	**Sensitivity**
Male	126	110	87.30 %	106	96.36 %
Female	74	57	77.03 %	50	87.72 %
Total	200	167	83.5 %	156	93.41 %
Chi-Square = 0.000931809 , P-value < 0.05 (Statistically Significant)					

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There are 16 male patients (12.70 %) scored ≤ 6 points, only 5 of them (29.41 %) had appendicitis by histological confirmation.

In female 17 patients (22.97 %) scored ≤ 6 points, only 3 of them (17.65 %) had appendicitis on histopathological basis. Table (Kalan, M. *et al*., 1994).

Chi-Square test shows no statistical difference for those patients with Modified Alvarado Score ≤ 6 (P-value >0.05).

Table 11: Results of MAS for Group-II (Patients scored ≤ 6)

Sex	**No. of patients operated upon**	**Group-II Score ≤ 6**	**Percentage**	**Appendicitis confirmed histologically**	**Sensitivity**
Male	126	16	12.70 %	5	29.41 %
Female	74	17	22.97 %	3	17.65 %
Total	200	33	16.5 %	8	24.24 %
Chi-Square = 5.523 , P-value > 0.05 (Statistically not Significant)					

Sensitivity of Modified Alvarado Score relates its ability to identify cases of acute appendicitis especially for those patients scored ≥ 7 which shows high Sensitivity rate of (93.41%).

Specificity of Modified Alvarado Score relates its ability to exclude cases of non-acute appendicitis especially for those patients scored ≤ 6 which shows high Specificity rate of (75.76 %).

The results of both patients' groups were statistically analysed using Chi-square test which shows that it is statistically significant for Group-I (P-value <0.05) and the chances of having acute appendicitis are more with MAS of 7 or above. While Chi-square test shows that the result is statistically not significant (P-value > 0.05) for Group-II. Table (Horžić, M. *et al*., 2005)

Chi-Square test = 0.010909498 which shows statistical difference between patient Group-I & Group-II. Table 12.

Table 12: Two Patients Groups compares Results of MAS

	Group I Patients Score ≥ 7	**Group II Patients Score ≤ 6**
Total Number of Patient with Clinical diagnosis of Appendicitis	167	33
Histologically confirmed Appendicitis	156	8
Sensitivity of MAS	93.41%	24.24 %
Specificity of MAS	6.59 %	75.76 %
Chi-Square Test for each Group	0.000931809	5.523
Chi-Square Test Significance between Group-I & Group-II	P-value < 0.05 (= 0.010909498)	

Overall, 164 patients confirmed having acute appendicitis according to biopsy reports. Table 13
Overall, 36 patients confirmed having non-acute appendicitis according to biopsy reports. Table 13

Overall Sensitivity (Accuracy rate) of MAS was 82 % and overall Specificity (Negative rate) of MAS was 18 %. Table 13.

Table 13: Overall Sensitivity (Accuracy) & Specificity of Modified Alvarado Scoring System

	Overall Patients
Total Number of Patient with Clinical diagnosis of Appendicitis	200
Histologically confirmed Appendicitis	164
Histologically confirmed Non-appendicitis	36
Overall Sensitivity (Accuracy) of MAS	82 %
Overall Specificity of MAS	18 %

Table 14: Significance of Modified Alvarado Score Predictors in diagnosis of acute appendicitis

Predictor	**Significance Level**	**Appendicitis (n=164)**	**Non – Appendicitis (n=36)**

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Migratory RIF pain			
Positive	0.00157	75.61 %	19.44 %
Negative		24.39 %	80.56 %
Anorexia			
Positive	0.00573	95.73 %	44.44 %
Negative		4.27 %	55.56 %
Nausea and vomiting			
Positive	0.00962	86.59 %	61.11 %
Negative		13.41 %	38.89 %
Tenderness (RIF)			
Positive	0.00417	97.56 %	16.67 %
Negative		2.44 %	83.33 %
Rebound tenderness			
Positive	0.00405	92.68 %	11.11 %
Negative		7.32 %	88.89 %
Elevated temperature			
Positive	0.00821	71.95 %	41.67 %
Negative		28.05 %	58.33 %
Leucocytosis			
Positive	0.00191	78.05 %	47.22 %
Negative		21.95 %	52.78 %

Gross Pathology

The Negative Appendicectomy rate for all operated upon patients in both groups of study was 36 patients (18 %). Table (15)

The unnecessary surgical intervention was done for only 8 patients (4%); 3 male patients (1.5 %) and 5 female patients (2.5 %). Table 15

The unnecessary surgical intervention include patient with operative finding of (Mesenteric Adenitis, Pelvic Inflammatory disease and those with No Gross Pathology detected). Table 15.

Table 15: Diagnosis of (Negative) non-appendicitis patients according to operative finding (n=36)

Pathology	**Male**	**Female**	**Total**
Meckel's Diverticulitis	2	-	2 (5.56 %)
Right Ovarian Cyst (Ruptured, Twisted)	-	26	26 (72.22 %)
Mesenteric Adenitis	2	1	3 (8.33 %)
Pelvic Inflammatory disease	-	2	2 (5.56 %)
No Gross Pathology detected	1	2	3 (8.33 %)
Total	5	31	36 (100 %)

DISCUSSION

Diagnostic accuracy in case of acute appendicitis should be high because negative appendicectomy carries significant morbidity and complication rate32. There is greater risk for abdominal adhesions after appendicectomy for normal appendix as compared with that of acute appendicitis 41. History, clinical examination, total leucocyte count and abdominal ultrasonography are helpful to achieve a more accurate diagnosis (Syed Waris Ali, S. *et al*., 2010).

In countries with advanced diagnostic facilities like ultrasonography, CT scan and diagnostic laparoscopy are routinely available and are helpful in making a treatment plan, but in our setup such investigations are not available in most hospitals 24 hourly and are also costly. Moreover, one cannot rely on any single investigation, but a combination of thorough physical examination along with investigations is essential for accurate diagnosis of acute appendicitis (Shinji HIMENO, Seiei YASUDA. 2003; Syed Waris Ali, S. *et al*., 2010).

Several patient-related factors are involved, patient education, delayed presentation to the medical care system, unreliability of history and presentation,

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high progression rate of the inflammatory process, immunologic factors and finally the primary care doctor (Körner, H. *et al*., 1997; Lewis, F. R. *et al*., 1975).

It has been observed that use of a scoring system helps in reaching a decision and making a treatment plan11. As junior doctors are the first doctors to encounter patients with acute appendicitis in emergency departments, therefore, a scoring system used for the diagnosis of acute appendicitis should be simple enough to be used in an emergency department setting11.

Modified Alvarado Score is just a simple mathematical tabulation of the common clinical signs and symptoms found in patients with acute appendicitis. Other scoring systems like Ohmann, Eskelinen and SIRS score are also under trial at different centres (Sitter, H. *et al*., 2004; Nozoe, T. *et al*., 2002).

In this study there were 164 males and 74 females with male: female ratio = 1.7: 1. This gender ratio is higher than TD Owen (1992) University Hospital Wales (7, 18) and D Talbot (1994) Royal Victoria Infirmary Newcastle (Saud, A. H. 1999); (19) studies which done in England. But our study gender ratio is almost similar to SYED WARIS ratio (1.8:1) Combined Military Hospital, in Pakistan 2010 (Syed Waris Ali, S. *et al*., 2010).

In our study the most common age group of incidences with acute appendicitis was in the third decade (21–30 years) with 78 patients (47.56%). This is similar to SYED WARIS (44% in third decade) Combined Military Hospital, in Pakistan 2010; (Syed Waris Ali, S. *et al*., 2010).

The most common operative finding in our study was Catarrhal appendicitis with 102 patients of mean age (26.0) years, which is little bit more than Saud Aziz (62 patients, mean 24.0 years) Baghdad Teaching Hospital, Iraq (1999) (Saud, A. H. 1999).

The most common time of presentation was during the first 24 hours of developing symptoms with 122 patients (74.39 %), while the least time of presentation was after 48 hours with only 18 patients (10.98 %). Our result is similar to Saud Aziz (71 patients, 66.98% <24 hours) and (16 patients, 15.1% > 48 hours) Baghdad Teaching Hospital, Iraq (1999) (Saud, A. H. 1999).

The most common operative finding for those operated upon patients with non-appendicitis was Ovarian Cyst (whether ruptured or twisted) with 26 patients (72.22 %), which is higher than Saud Aziz study (7 patients, 30.43%) in Baghdad Teaching Hospital, Iraq (1999) (Saud, A. H. 1999).

This percentage could be decreased by increasing the experience of ultrasonographers and this will affect the accuracy of Modified Alvarado Score. In spite of these, differentiating appendicitis from other gynaecological conditions in women of childbearing age remains difficult (Alvarado, M. A. 1986; Lewis, F. R. *et al*., 1975).

When the results of group-I are compared with group-II, it is seen that accuracy rate of Modified Alvarado score increase with the rise in score; while negative appendicectomy rate decreases with the rise in score, which supports the hypothesis of this study.

So, our accuracy rate was 93.41% for Group-I and 24.24 % for Group-II; while in Saud Aziz it was (80.62% for Group-I and 11.11 % for Group-II) Baghdad Teaching Hospital, Iraq (1999) (Saud, A. H. 1999).

And our negative appendicectomy rate was 6.59% for Group-I and 75.76% for Group-II; while in Saud Aziz it was (6.3 % for Group-I and 88.89 % for Group-II) Baghdad Teaching Hospital, Iraq (1999) (Saud, A. H. 1999).

In this study 8 patients (28.6%) out of group-II had acute appendicitis confirmed by histopathology which is a significant number and this could be missed if totally relied upon the scoring system (Syed Waris Ali, S. *et al*., 2010).

We analysed statistically both patients' groups using Chi-square test and it was statistically significant for Group-I (P-value <0.05), while for Group-II it was statistically not significant (P-value > 0.05). Similar analysis was done by SYED WARIS for his result at Combined Military Hospital, in Pakistan 2010 41, which is statistically significant.

Therefore, the chances of having acute appendicitis are more with MAS of 7 or above 41. Moreover, it should be kept in mind that no scoring system is 100% effective but modifications may increase the accuracy in future.

The overall accuracy rate of our study was (82 %) which is equal or higher than other local previous studies of M. Shanshal, Yarmouk Teaching Hospital (1991), F.N. Tikriti, Baghdad Teaching Hospital (1992) and Saud Aziz, Baghdad Teaching Hospital (1999) Iraq 7.

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The negative appendicectomy rate in our study was 18% which is less than the similar studies carried out by M. Shanshal (1991) and F.N. Tikriti (1992), but it is equal to Saud Aziz study during 1999. See Table (Bhattacharjee, P. K. *et al*., 2002).

Table 16: The diagnostic Accuracy of patients presented with appendicitis using Modified Alvarado Score. Comparison between local previous studies & our study.

Author	**Country**	**Year**	**Accuracy (Sensitivity)**	**Negative Appendicectomy**
M. Shanshal – Yarmouk Teaching Hospital	Iraq	1991	122/158 (77.2 %)	33/158 (20.89 %)
F.N. Tikriti – Baghdad Teaching Hospital	Iraq	1992	159/205 (77.56 %)	41/205 (20 %)
Saud Aziz – Baghdad Teaching Hospital	Iraq	1999	106/129 (82.17 %)	23/129 (17.8 %)
Our Study Fallujah Teaching Hospital	Iraq	2025	164/200 (82 %)	36/200 (18 %)

The sensitivity rate of our study regarding patients scored ≥ 7 is (96.36%) for male & (87.72%) for female which is higher than Syed Waris study which was done at Combined Military Hospital in Pakistan during 2010. See Table (Ramirez, J. M., & Deus, J. 1994).

Table 17: Sensitivity rate of Modified Alvarado Score. Comparison between Regional previous studies & our study.

Author	**Country**	**Year**	**Sex**	**No. of Patients**	**Score ≥ 7**	**Appendicitis (Histopathology)**
SYED WARIS - Combined Military Hospital, Rawalpindi	Pakistan	2010	Male	65	46	44, (68.75%)
			Female	35	26	20, (31.25%)
Our Study Fallujah Teaching Hospital	Iraq	2025	Male	126	110	106, (96.36%)
			Female	74	57	50, (87.72%)

When we compare the sensitivity rate of our study for those patients **scored ≥ 7**, we will find that it is less than other developed countries studies like that of TD Owen University Hospital in Wales 18 and D Talbot Royal Victoria Infirmary in Newcastle 19 during 1992 and 1994 respectively. See Table (18).

Table 18: Sensitivity rate of MAS for patients scored ≥ 7 only. Comparison between International previous studies & our study

Author	**Country**	**Year**	**Sex**	**No. of Patients**	**Score ≥ 7**	**Appendicitis (Histopathology)**
TD Owen University Hospital Wales	England	1992	Male	75	50	47, (94 %)
			Female	70	40	31, (78 %)
D Talbot Royal Victoria Infirmary Newcastle	England	1994	Male	21	15	14, (93 %)
			Female	17	15	10, (67 %)
Our Study Fallujah Teaching Hospital	Iraq	2025	Male	126	110	106, (84.13 %)
			Female	74	57	50, (67.57 %)

In this study the **Overall Sensitivity** was 82%. Internationally, lower results have been found by TD Owen University Hospital study in Wales in 1992 18. Similar results have been found by D Talbot Royal Victoria Infirmary study in Newcastle in 1994 19.

Regionally higher results have been found by SYED WARIS - Combined Military Hospital, Rawalpindi in Pakistan in 2010 41.

As a highly sensitive test is required for the diagnosis of a condition where the consequences of a false positive test are serious, therefore, this sensitivity of 82% suggests MAS can be an effective tool in the diagnosis of acute appendicitis in adults. See Table 19.

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Table 19: Overall Accuracy Rates of MAS. Comparison between all (Regional, International) previous studies & our study

Author	Country	Year	No. of Patients	Score ≥ 7	Score ≤ 6	Overall Accuracy
TD Owen University Hospital Wales	England	1992	215	135	80	57.67 %
D Talbot Royal Victoria Infirmary Newcastle	England	1994	49	41	8	81.63 %
SYED WARIS - Combined Military Hospital, Rawalpindi	Pakistan	2010	100	72	28	88.9%
Our Study Fallujah Teaching Hospital	Iraq	2025	200	167	33	82 %

CONCLUSION

MAS is a simple and useful aid to support the clinical diagnosis of acute appendicitis and patients with MAS of 7 or above will have more chances of having biopsy proven acute appendicitis than patients having MAS of 6 or less.

It is recommended that MAS should be introduced and practiced in emergency departments as this simple scoring system will be of great help to junior doctors. It is simple and a non-computer aided scoring system.

Modifications in Alvarado Score are also recommended, e.g. assigning more points to pain and tenderness in right lower abdominal quadrant, extra sign(s) like cough test and/or Rovsing's sign and/or rectal tenderness for which further studies should be carried out.

RECOMMENDATIONS

1. A score indicating observational management is disregarded when there is clinical evidence of peritonitis of undetermined aetiology.
2. Progression of signs and symptoms regardless the score is an indication for surgery.
3. Cases under observation should be closely followed with hourly charting of symptoms, vital signs, abdominal examination with further investigations.
4. Observation period should not exceed 24 hours regardless of the score.
5. The intent of scoring system is not to replace the surgical judgment, but to discriminate between the two groups when there is uncertainty as to indication for surgery or observation.
6. The use of advanced diagnostic facilities like ultrasonography, CT scan and diagnostic laparoscopy will aid in setting the provisional diagnosis especially for equivocal cases.

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