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Original Research Article

Evaluation of modified Alvarado scoring system as a diagnostic tool for acute appendicitis and its correlation with Histo-pathological examination: A prospective study

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Abstract

Background: The Alvarado scoring system was first described in 1986 and has been validated in surgical practice since then. The use of an objective scoring system such as the Modified Alvarado system (**Table 1**) can reduce the number of negative appendectomies.

Aims and Objectives: To evaluate the effectiveness of the Modified Alvarado Scoring System (MASS), as a diagnostic tool for acute appendicitis and to correlate its findings with histopathological examination (HPE) in patients presenting with right iliac fossa (RIF) pain at a teaching hospital in Northern India. Other objectives are to evaluate the utility of MASS in reducing negative appendectomy and to analyze the prevalence of various clinical signs and symptoms of acute appendicitis in the study population.

Materials and Methods: A prospective clinical study was carried out at Rama Medical College Hospital, Hapur for a period of 2 years. Patients admitted with right iliac fossa pain presenting in the casualty were included in the study. Sample size of 100 subjects was taken.

Result: Individuals with scores >7 have a 93% sensitivity. Pain was the most prevailing feature, recognized in all subjects (100%). RIF tenderness accounted for majority of signs on clinical examination (93%).

Conclusion: The Modified Alvarado Scoring system's simplicity, application ease, and reliance on patient history, medical examination, and fundamental laboratory investigations make it a highly utilitarian method for diagnosing appendicitis.

Keywords: Modified Alvarado Score, Acute Appendicitis, Right Iliac Fossa Pain, Appendectomy, Negative Appendectomy Rate.

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1. Introduction

Acute appendicitis is one of the most frequent causes of acute abdomen. The progression of acute appendicitis to appendicular perforation has been linked to significantly higher morbidity and mortality rates. Consequently, surgeons are more inclined to perform operations when the diagnosis is probable rather than waiting for certainty.[1] Despite over a century of experience, surgeons still struggle with accurately diagnosing acute appendicitis due to its numerous presentations, making it a common yet challenging diagnostic issue. Accuracy of Clinical examination has been described between 72% and 96%, with significant variation based on the examiner's level of experience.[2] Surgeons have historically agreed to accept a 21% rate of negative results at appendectomy and the excision of a healthy appendix[3], despite the catastrophic sequelae of missing burst appendices. Appendectomy rates are described to be 21% negative.[4] Acute appendicitis affects 7% of people at some point in their lives.[5-6] Consequently, a lot of work has been put into timely diagnosing and managing it.[7] This endeavor has effectively decreased the death rates below 0.1% for cases of acute appendicitis without complications, below 0.7% in gangrenous appendicitis and below 6% in appendicular perforation.[6] Dr. Alfredo Alvarado in 1986 presented the Alvarado scoring system[8] and has been substantiated in surgical practice since then. The percentage of negative appendectomy cases can be decreased to 0-6% by using a quantitative evaluation method like the Alvarado system.[8-10] The scoring method that Alvarado outlined was updated by

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M. Kalan, et. al in order to lower the negative appendectomy incidence without raising fatalities or morbidity.[11] The Alvarado scoring system assists the clinical examination in diagnosing acute appendicitis and it helps to determine whether a specific case needs surgical intervention. The aim is to minimize the occurrence of negative appendectomies. Treating presumed appendicitis, particularly "negative" appendectomy, entails considerable clinical and financial burdens, and it is not an insignificant issue. In the USA patients who underwent negative appendectomy exhibited significantly longer hospital stays, increased complication rates, and higher mortality. The yearly expense of an unsuccessful appendectomy negative appendectomy is estimated at 740 million dollars. In our economically constrained nation, there is a demand for an affordable, safe, and precise diagnostic approach that is trustworthy, reproducible, and applicable in all settings without relying on expensive and complex supportive diagnostic methods. The Alvarado score proves to be a simple, rapid, and non-invasive solution. The study aimed to evaluate the diagnostic efficacy of the Modified Alvarado Scoring System (MASS), evaluating its sensitivity. Due to scarcity of adequate studies done in our country, there is pressing need for research in evaluating the usefulness and sensitivity of Modified Alvarado scoring system in patients diagnosed with acute appendicitis and subsequently minimizing the number of negative appendectomies.

Table 1: Modified alvarado scoring system (MASS)

The modified alvarado scoring system	Score
Migration of Pain	1
Anorexia	1
Nausea & Vomiting	1
Tenderness	2
Rebound Tenderness	1
Raised Temperature	1
Leukocytosis	2
Total	9

Individuals who have a scores ranging 1 to 4 were not diagnosed to have appendicular inflammation those who had scores ranging 5 to 6 were flagged for additional assessment because, while the diagnosis of acute appendicitis was thought to be likely, it was not strong enough to support an immediate surgical intervention. Acute appendicitis was diagnosed in those who scored above 7, and they were scheduled for surgery. Reassessment may result in an elevation or reduction in the Alvarado score.

2. Materials and Methods

A prospective study involving 100 cases of suspected appendicitis, was conducted to evaluate the diagnostic accuracy of the modified Alvarado score by evaluating sensitivity of the score. This study was conducted at Casualty Department and Department of Surgery, Rama Medical College Hospital & Research Center, Hapur in a study period of around 24 months, from May 2022 to April 2024.

2.1. Inclusion criteria

All patients admitted with Right iliac fossa pain at Rama Medical College Hospital & Research Center, Hapur during the mentioned period constituted the sample of the present study. Patients presented to casualty with RIF pain and diagnosed provisionally as acute case of appendicitis and consenting to undergo surgery were included in the study.

2.2. Exclusion criteria

All patients diagnosed as appendicular lump**,** pregnant women**,** patients with pelvic inflammatory disease, history of abdominal TB and lastly patients not willing to undergo surgery were excluded.

2.3. Statistical analysis

Results were recorded and tabulated using Microsoft Excel and data was analyzed statistically by SPSS V22 software. "P value" was taken as significant at <0.05.

3. Results

Table 2: Age and gender based distribution**.**

Age (Years)	Men	Women	Total
≤ 10	1	2	3
11 to 20	8	9	17
21 to 30	26	13	39
31 to 40	14	8	22
41 to 50	12	4	16
>50	1	2	3
Total	62	38	100

The above table indicates that majority of cases of appendicitis occurs in individuals aged between 21 and 40 years.

Table 3: Percentage of presenting clinical features

Clinical Features	%
RIF pain	100
Anorexia	71
Nausea & Vomiting	76
RIF-tenderness	93
Rebound -Tenderness	59
Fever	67
Leukocytosis	64

Table 4: Results of modified ALVARADO score

MASS	Total (n=100)	Male	Female	Children
Below 5	9	3	6	-
5 to 6	19	9	10	-
Above 7	72	50	22	3

Table 5: Correlation of modified alvarado scoring with ultrasonography.

MASS	Total (n=100)	USG Positive	USG Negative
Below 5	9	7	2
5 to 6	19	11	7
Above 7	72	69	4

Sensitivity of 95.83% is found in Modified Alvarado 7-9 compared to 57.89 % in 5-6 score

Table 6: Histopathological diagnosis of the specimen of appendix sent for study

Histopathology (n=100)	%
Lymphoid Hyperplasia	26
AC. Appendicitis	52
AC. Ulcerative	11
AC. Gangrenous	7
AC. Perforative	4

Table 7: Results of modified ALVARADO score on operated patients (n=100)

Mass with gender	Number of individuals	Appendicitis	Lymphoid hyperplasia
Score: Below 5			
Male	3	-	3 (100%)
Female	6	-	6 (100%)
Total	9	-	9
Score: 5 to 6			
Male	9	5(55.55%)	4 (44.44%)
Female	10	7(70.00%)	3(30.00%)
Total	19	10(52.63%)	9 (47.37%)
Score Above 7			
Male	50	48(96.00%)	2 (4.00%)
Female	22	19(86.36%)	3(13.63%)
Total	72	67 (93.06%)	5(6.94%)

False positive results of Modified Alvarado score are more in female sex compared to males.

Table 8: Diagnostic value of modified alvarado scoring

Mass	Appendicitis	Lymphoid hyperplasia
<5		9
n=9		(100%)
5-6	10	9
n=19	(52.63%)	(47.37%)
7-9	67	5
n=72	(93.06%)	(6.94%)

Increased proportion (47.37%) of negative appendectomy is observed for the Modified Alvarado Scoring 5-6 and significantly reduced proportion (6.94%) of negative appendectomy is observed for the Modified Alvarado Scoring 7 to 9. (p value-0.0001)

Table 9: Diagnostic value of modified alvarado score.

	Total no. of patients	Score >7	Appendicitis	Sensitivity
Men	62	50	48	93%
Women	38	22	19	86%
		Score 5-6	Appendicitis	Sensitivity
Men		9	5	55%
Women		10	7	70%

Modified Alvarado Scoring Above 7 has more diagnostic value for diagnosing Appendicitis compared to Modified Alvarado Scoring Below 5.

The study analyzed 100 patients (62 men, 38 women) with suspected acute appendicitis. The highest incidence was observed in the 21–40 age group (**Table 2**), peaking in the second and third decades of life, with males more commonly affected. Pain (100%) was the most frequent symptom (**Table 3**), typically starting at the umbilicus and shifting to the right iliac fossa (RIF). Other commonly reported symptoms included nausea and vomiting (76%), anorexia (71%), and low-grade fever with tachycardia (67%). Most patients sought medical attention within 12–24 hours after symptom onset.

On physical examination, RIF tenderness was the most prominent sign (93%), followed by rebound tenderness (59%) and abdominal stiffness (7%), which was associated with gangrenous or perforated appendicitis. A raised WBC count was noted in 64% of cases. Among the 100 patients, 96 underwent laparoscopic appendectomy, while 4 had open surgery due to financial constraints. The patients were classified based on the MASS, 50 men, 22 women, and all 3 children had a score above 7; 9 men and 10 women had scores between 5 and 6; and 3 men and 6 women had scores below 5 (

Table 4).

Histopathological findings (**Table 5**, **Table 6**) confirmed 48 out of 50 men (96%) with MAS >7 had acute appendicitis, while 2 had a normal appendix. Among the 22 women with MAS >7, 19 had appendicitis, and 3 had a normal appendix. In the 5 to 6 score range, negative appendectomy rates were significantly higher, 5 out of 9 men and 7 out of 10 women had true appendicitis, while the rest had a normal appendix (**Table 7**). The sensitivity of MAS >7 was 96%, effectively diagnosing acute appendicitis and reducing negative appendectomies. Negative appendectomy rates were 6.94% for MAS >7 (**Table 8**) and 47.37% for MAS 5–6 (P value-0.0001). In males, negative appendectomy rates were 4% for MAS >7 and 44.44% for MAS 5–6, whereas in females, it was 13.63% for MAS >7 and 30% for MAS 5 to 6 (**Table 9**). The higher rate in women was attributed to

gynecological conditions such as pelvic inflammatory disease (PID) and ovarian cyst torsion, which can mimic appendicitis. No patient with a score below 5 required appendectomy, confirming the Modified Alvarado Score as an effective tool for ruling out appendicitis and significantly reducing unnecessary surgeries.

4. Discussion

The study highlights the demographic and clinical patterns of acute appendicitis, reaffirming that the condition predominantly affects individuals in the second and third decades of life, with a higher incidence in males. This age and gender distribution aligns with established findings, suggesting a potential influence of anatomical and hormonal factors in the disease's prevalence. The classic symptom of pain migrating from the umbilicus to the right iliac fossa was universally present, confirming its diagnostic significance. Other frequently reported symptoms, such as nausea, vomiting, anorexia, and fever with tachycardia, further emphasize the importance of a comprehensive clinical assessment in identifying suspected cases early.[1-4]

Physical examination findings supported the classical diagnostic approach, with right iliac fossa tenderness being the most common sign, followed by rebound tenderness and abdominal stiffness. Notably, abdominal stiffness was more frequently associated with complicated cases such as gangrenous or perforated appendicitis, underscoring the necessity of prompt diagnosis and intervention to prevent disease progression. A raised WBC count was observed in 64% of cases, reinforcing its role as a supportive diagnostic marker.[6]

The Modified Alvarado Score (MAS) demonstrated high diagnostic accuracy, with a sensitivity of 96% in cases with a score greater than.[7] This high sensitivity contributed to a significant reduction in negative appendectomies, with rates of 6.94% in MAS >7 compared to 47.37% in those with scores of 5 to 6 (Table-8). The variation in negative appendectomy rates between males and females, with higher rates in women, can be attributed to gynecological conditions such as pelvic inflammatory disease and ovarian cyst torsion, which can present with similar symptoms. This finding reinforces the importance of ultrasonography in female patients with suspected appendicitis to minimize misdiagnosis and unnecessary surgeries.[5,12]

Laparoscopic appendectomy was the preferred surgical approach, performed in 96% of cases, highlighting its advantages in terms of reduced postoperative pain, shorter hospital stay, and faster recovery.[13] The 4% of patients who underwent open surgery did so due to financial constraints, emphasizing the need to improve accessibility to laparoscopic procedures in resource-limited settings. Importantly, no patients with MAS <5 required surgery, confirming the effectiveness of the scoring system in ruling out appendicitis and avoiding unnecessary procedures.[6,14]

The study underscores the practicality of the Modified Alvarado Score as a reliable diagnostic tool, particularly in resource-constrained environments where advanced imaging may not be readily available. It suggests that patients with MAS >7 should undergo immediate appendectomy, while those with scores between 5 and 6 should be carefully observed with ultrasonographic evaluation to improve diagnostic precision. Incorporating MAS into routine surgical decision-making can significantly enhance diagnostic accuracy, reduce negative appendectomy rates, and optimize patient management. Further research incorporating newer imaging techniques and biomarkers may refine the diagnostic process, further improving outcomes for patients with suspected acute appendicitis.[15-17]

5. Conclusion

In this study, subjects between the ages of 21 & 40 had highest prevalence of acute appendicitis. With the largest prevalence during second & third decades of life, the incidence was decreased in both younger and older age groups. Through a correlation between the Modified Alvarado Scoring and histological reports attributed to appendicitis, we discovered that individuals with scores >7 have a 93% sensitivity. RIF tenderness accounted for the majority of signs on clinical examination (93%). The Modified Alvarado Scoring system’s simplicity, application ease, and reliance on patient history, medical examination, and fundamental laboratory investigations make it a highly utilitarian method for diagnosing appendicitis. It is an affordable option and resident surgeons in all medical colleges with intrinsic labs can utilize it. During routine medical practice it can serve in the guise of a useful supplement to surgical decision-making while treating suspected cases of acute appendicitis. By using ultrasonography, diagnostic accuracy increased and a negative appendectomy can be avoided.

In individuals whose clinical scores fall between 5 and 6, hospitalization and observation is necessary along with ultrasound surveillance. If a patient's clinical score is greater than 7, we advise an immediate appendectomy for both men and women. Modified Alvarado score dramatically decreases the quantity of negative appendectomies. While the proportion of appendicular perforation is not heightened overall.

6. Source of Funding

None.

7. Conflict of Interest

None.

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