

## Combined Diagnostic Value of Modified Alvarado Score (MAS) and Ultrasound for the Diagnosis of Acute Appendicitis

Rita Singh<sup>1</sup>, B. Shailendra<sup>2</sup>

<sup>1</sup>Associate Professor, Department of General Surgery, MNR Medical College and Hospital, Sangareddy, Telangana

<sup>2</sup>Assistant Professor, Department of General Surgery, MNR Medical College and Hospital, Sangareddy, Telangana

Received: 15-06-2022 / Revised: 20-07-2022 / Accepted: 20-08-2022

Corresponding author: Dr B. Shailendra

Conflict of interest: Nil

### Abstract

**Introduction:** Acute appendicitis is one of the most happened surgical emergencies, needs early diagnosis and immediate surgical management to prevent adverse events. In an attempt to increase the diagnostic accuracy, several imaging techniques and clinical scoring systems have been established. This study was designed to assess the sensitivity of modified Alvarado score and ultrasound in the diagnosis of acute appendicitis and correlating with operative and histopathology findings.

**Material and Methods:** Eighty clinically diagnosed cases with acute appendicitis and getting admitted for the surgery belonged to age group >18 years were included. Preoperatively, Modified Alvarado score (MAS) and ultrasound abdomen findings were applied in the initial diagnosis. The outcome values of Modified Alvarado score and USG were correlated with operative and HPE findings

**Results:** Migration of pain from umbilicus to right iliac fossa was common presenting symptom, followed by anorexia and tenderness and nausea and vomiting. 37 cases had MAS score >7 and remaining had score <7. The overall sensitivity for cases with MAS score > 7 was 98.4%. The correlation of modified Alvarado score and ultrasonography together with operative and histopathological findings showed statistically significant value ( $p < 0.0025$ ) with sensitivity of 38.75%

**Discussion and Conclusion:** The Modified Alvarado score and ultrasonography together has better sensitivity and increases the diagnostic accuracy for acute appendicitis and reduces negative appendectomy rates. However, compared to the operative and histopathological findings the sensitivity was found to be low with notable specificity.

**Keywords:** Modified Alvarado Score, Ultrasonography, Acute Appendicitis, Histopathological Findings

This is an Open Access article that uses a fund-ing model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### Introduction

Acute appendicitis is one among commonly encountered surgical emergencies stimulate

other intra-abdominal pathologies that needs early diagnosis and management [1]. Many

conditions like acute pancreatitis, bowel obstruction, ovarian cyst, acute cystitis have similar clinical manifestations to appendicitis. The decision to operate is depends on the complete clinical history, physical examination, imaging and laboratory results. Misdiagnosis or delay in diagnosis may leads to adverse outcomes or negative appendectomy [2].

Negative appendectomies are connected with severe postoperative pain, delay in healing, economic burden and prolonged hospital stay [3-5]. Whereas delayed diagnosis leads to severe complication like peritonitis and perforation [6]. It is necessary to appendicitis in the differential diagnosis for cases with complaint of acute abdominal pain.

Several diagnostic approaches have been reported as adjuncts to the clinical findings to establish diagnostic accuracy and minimize the rate of negative appendectomy such as laparoscopy, clinical scoring system, ultrasonography, CT scans and MRI [7,8]. Imaging studies are helpful particularly in the low Alvarado score and other studies have opined that the imaging is valuable diagnostic tool irrespective of Alvarado score. Modified Alvarado score alone have reported a variable negative appendectomy rate up to 20%, but with imaging it is comparatively more reliable [9,10]. Various studies suggested that Ultrasonography is the most affordable and effective method with a sensitivity of the range from 78% to 83% in the diagnosis of appendicitis [11]. However, findings of

## Results

USG should not supersede clinical judgment in cases with high chances of appendicitis [12]. With this reference, the present study was designed to assess the sensitivity of modified Alvarado score and ultrasound in the diagnosis of acute appendicitis and correlating with operative and histopathology findings.

## Materials and Methods

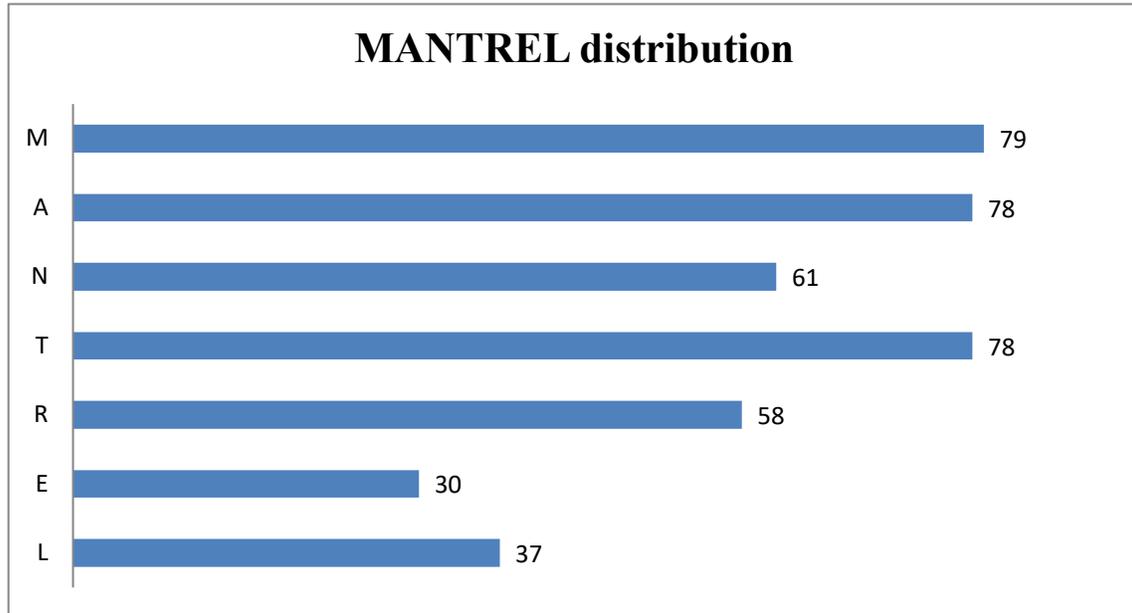
This prospective study was conducted in the Department of General Surgery at MNR Medical College and Hospital, Sangareddy. A total of 80 cases clinically diagnosed with acute appendicitis and getting admitted for the surgery at General surgery department with >14 years were included. Informed consent was obtained from all the study participants and study protocol was approved by the institutional ethics committee. Cases below 18 years of age, women with pregnancy and in lactation, cases undergoing conservative treatment for acute appendicitis were excluded.

Preoperatively, Modified Alvarado score (MAS) and ultrasound abdomen findings were applied in the initial diagnosis. Depending on the Modified Alvarado score and USG findings surgery was performed. Diagnosis of cases that underwent appendectomy was confirmed by both operative finding and histopathological examination. The statistical analysis was performed by using SPSS version 23.0. Chi-square test was used to compare the outcome values of Modified Alvarado score and USG with operative and HPE findings.

**Table 1: Demographic details of study participants**

Demographic parameter	Total cases	
	Frequency	Percentage
<b>Age</b>		
18-30	39	48.75%
31-40	18	22.5%

41-50	13	16.25%
>50	10	12.5%
<b>Gender</b>		
Male	42	52.5%
Female	38	47.5%



**Figure 1: MANTREL distribution of study participants (n=80)**

\*M-Migration of pain from umbilicus to right iliac fossa, A-Anorexia, N-Nausea and vomiting, T-Tenderness, R-Rebound tenderness, E-Elevated temperature, L-Leucocytosis

**Table 2: Modified Alvarado score versus HPE examination.**

Modified Alvarado score		Outcome		Sensitivity
		Positive	Negative	
Group III	Score 3	02	-	89.4%
	Score 4	09	02	
Group II	Score 5	11	02	94.6%
	Score 6	17	-	
Group I	Score 7	23	01	98.4%
	Score 8	11	-	
	Score 9	02	-	
Total		75	05	95.2%

**Table 3: Overall sensitivity of Modified Alvarado Score**

Sensitivity of MAS	Outcome		Total
	Positive	Negative	
Positive	36 (97.29%)	01 (2.70%)	37 (46.25%)
Negative	39 (90.69%)	04 (9.30%)	43 (53.75%)
Total	75 (93.75%)	05 (6.25%)	80 (100%)

**Table 4: Comparison of ultrasonography findings with histopathological findings**

Ultrasonography	Outcome		Total
	Positive	Negative	
Positive	48 (60%)	01 (1.25%)	49 (61.25%)
Negative	27 (33.75%)	04 (9.30%)	31 (38.75%)
Total	75 (93.75%)	05 (6.25%)	80 (100%)

**Table 5: Correlation of MAS, USG with operative and HPE of the appendix**

	Positive	Negative
Modified Alvarado score	37	43
Ultrasonography	49	31
Operative and HPE	75	05
p-value	0.0025	

**Table 6: Sensitivity of Modified Alvarado Score and Ultrasonography findings**

MAS + Ultrasonography	Outcome		Total
	Positive	Negative	
Positive	31 (38.75%)	01 (1.25%)	32 (40%)
Negative	44 (55%)	04 (9.30%)	48 (60%)
Total	75 (93.75%)	05 (6.25%)	80 (100%)

## Discussion

Acute appendicitis is a common surgical abdominal emergency, globally. The diagnosis of acute appendicitis remains challenge for surgeon due to its variable presentation and the lack of reliable diagnostic method. Several methods available in the diagnosis, but ultrasonography and CT remain accurate for the diagnosis. In current study, majority cases were belonged to 18-30 years (48.75%) age group followed by 31-40 years (22.5%) with majority male admissions (52.5%) (Table 1). A study by Samraj A *et al.*, reported that the commonest affected age group was 21-30 years [13].

In current study, MANTREL score parameters such as migration of pain from umbilicus to right iliac fossa, anorexia, nausea and vomiting, tenderness, rebound tenderness, elevated temperature, leucocytosis were statistically significant ( $p < 0.05$ ) (Graph 1). Migration of pain from umbilicus to right iliac fossa was common

presenting symptom, followed by anorexia and tenderness and nausea and vomiting. A study by Samraj A *et al.*, noticed that migration of pain from umbilicus to right iliac fossa is the common presenting symptom followed by nausea/vomiting [13].

A study by Samraj A *et al.*, reported that the modified Alvarado score has a high diagnostic value (82.5%) in the diagnosis of acute appendicitis [13]. Mukhopadhyay A *et al.*, found that a sensitivity of 95.74%, specificity of 100% and accuracy of 89.4% for combined use of USG with Alvarado score in the diagnosis of acute appendicitis [14]. Hemat N *et al.*, stated that combined use of MAS ad high frequency USG are effective in the diagnosis of acute appendicitis ad reduces negative appendectomy rate, morbidity ad postoperative complications [15]. Nasiri S *et al.*, reported that a cut-off point of 6 for the MAS score had better sensitivity for acute appendicitis [16]. Dheeraj T *et al.*, reported

a sensitivity of 92.31% for USG that is more than the sensitivity of MAS i.e. 82.42% and both methods has specificity of 100%.

They also opined that MAS and USG may act as adjunct to clinical evaluation and the surgeons experience [17]. Aabhas Mishra *et al.*, stated that MAS is an effective diagnostic tool for uncomplicated acute appendicitis with a score of  $>7$  (sensitivity-81.61%). It requires ultrasonography as an adjuvant in early diagnosis and prompt surgical management [18].

Hamid K *et al.*, stated that an Alvarado score that is positive for appendicitis would consist of a score greater than 7, which suggests that the patient has a 93% chance of having appendicitis. A negative Alvarado score is 7 or lower, suggesting a 26% probability of having appendicitis [19]. Sridhar L *et al.*, stated that ultrasonography has higher sensitivity and diagnostic accuracy than MAS, but has similar specificity in the diagnosis of acute appendicitis [20]. Nadeem AS *et al.*, stated that USG and MAS is an effective tool in the early diagnosis and rapid surgical treatment of acute appendicitis [21].

The current study findings are similar to the above findings where combined use of MAS and USG are effective. In this study, around 37 cases had MAS score  $>7$ , 30 cases had score 5-6, and 13 cases had MAS score 3-4. The overall sensitivity for cases with MAS score  $> 7$  was 98.4%, for score 5-6 was 94.6% and for score 3-4 was 89.4% (Table 2).

The correlation of modified Alvarado score and ultrasonography together with operative and histopathological findings showed statistically significant value ( $p<0.0025$ ) with sensitivity of 38.75% (Table 5 & 6).

### Conclusion

The study concludes that both Modified Alvarado score and ultrasonography has better sensitivity, increases the diagnostic

accuracy for acute appendicitis and reduces negative appendectomy rates. However, compared to the operative and histopathological findings the sensitivity was found to be low with notable better specificity.

### References

1. Madenci AL, Peranteau WH, Smink DS. Appendix & small bowel diverticula. Maingot's Abdominal Operations. 13th edn. McGraw-Hill Publication 2019: 1813-79.
2. Brunnicardi F. Schwartz's principles of surgery. 9th ed., Andersen D, *et al.* McGraw-Hill; 2009.
3. Ramashankar MM, Pandey R, Saini VC, *et al.* Safeguarding surgeons: Utility of USG & CT in reducing diagnostic errors in acute appendicitis. J Clin & Diag Res 2019;13 (9): PC07-PC09.
4. Mishra A, Kumar SS, Sinha A. Diagnosis of acute appendicitis using modified Alvarado score and abdominal ultrasound. J Clin & Diag Res 2018;12 (4): PC08-PC11.
5. Kansakar N, Agarwal PN, Singh R, *et al.* Evaluation of combined use of modified Alvarado score and ultrasound in predicting acute appendicitis: a prospective study. Int Surg Journal 2018;5(11):3594-7.
6. Dahdaleh FS, Heidt D, Turaga KK. The Appendix. Schwartz's Principles of Surgery. 11th edn. McGraw-Hill Publication 2019: p. 1331-44.
7. Olsen JB, Myren CJ, Haahr PE: Randomized study of the value of laparoscopy before appendectomy. Br J Surg 1993, 80:822-923.
8. Kalan M, Rich AJ, Talbot D, Cunliffe WJ: Evaluation of the modified Alvarado score in the diagnosis of acute appendicitis: a prospective study. Ann R Coll Surg Engl 1994, 76:418-419.
9. Vaghela K. Shah B. Diagnosis of acute appendicitis using clinical Alvarado

- scoring system and computed tomography criteria in patients attending Gujarat Adani Institute of Medical Sciences. A retrospective study. *Pol J Radiol* 2017; 82:726-30.
10. Memon AZ, Irfan S, Fatima K, *et al.* Acute appendicitis: Diagnostic accuracy of Alvarado scoring system. *Asian J Surg* 2013;36 (4):144-9.
  11. Bernard M, Jaffe, Berger DH. The Appendix. In Schwartz's Principles of Surgery. Brunicaudi FC, Anderson DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE, 8th ED. USA: The McGraw-Hill, 2005, 1119-1137.
  12. Ramsden WH, Mannion RA, Simpkins KC, deDombal FT. Is the appendix where you think it is and if not does it matter? *Clin Radiol* 1993; 47:100-3.
  13. Samraj A, Kumar SD. Assessment of the accuracy of using the combination of modified Alvarado score and abdominal ultrasound in acute appendicitis. *Int Surg J* 2017; 4:2997-3001.
  14. Mukhopadhyay A, Majhi RC, Bhattachariya U, *et al.* A study to evaluate the combined use of Alvarado score and imaging for diagnosis of acute appendicitis. *J. Evolution Med. Dent. Sci.* 2020;9(11):851-855.
  15. Hemat N, Ahmad S, Keshwai NK, Awasthi DN. Combined use of modified Alvarado score and USG in decreasing negative appendectomy rate. *Indian J Surg.* 2010; 2:42-48.
  16. Nasiri *et al.* Diagnostic values of ultrasound and the Modified Alvarado Scoring System in acute appendicitis. *International Journal of Emergency Medicine* 2012 5:26.
  17. Dheeraj T, Sumath G, Devi Harsha V, Sai Harish M, Thatha Rao V. Combination of Modified Alvarado Score and Ultrasonography to Improve the Diagnostic Accuracy in Acute Appendicitis. *JMSCR.* 2020;8(2): 90-96.
  18. Aabhas Mishra, Sukumar Santosh Kumar, Anamika Sinha. Diagnosis of acute appendicitis using modified Alvarado score and abdominal ultrasound. *Journal of Clinical and Diagnostic Research.* 2018;12(4): PC08-PC11.
  19. Hamid K, Majid S, Anita S, Rosita K, Derakhshanfar H, Hamidreza H. Evaluation of the Alvarado score in acute abdominal pain. *Ulus Travma Acil Cerr Der.* 2014;20(2):86-90.
  20. Sridhar L, Chennaiah M. Comparative study between modified Alvarado score and abdominal ultrasound in the diagnosis of acute appendicitis *International Journal of Surgery Science* 2019; 3(4): 163-168.
  21. Nadeem AS, Islam M, Sabir IA, Mehreen T, Mumtaz K. Diagnostic accuracy of clinical examination versus combination of abdominal ultrasound and alvarado score in patients with acute appendicitis. *JPMI.* 2008;22(01):41-46.