

## A comparative study of RIPASA score and Modified Alvarado score in the diagnosis of acute appendicitis- A valuable tool for decision making

Sachin Kempegowda<sup>1</sup>, Sachin Murukanahalli Basavaraju<sup>2</sup>, Yamuna V S<sup>3\*</sup>

<sup>1</sup>Assistant Professor, Department of General Surgery, AIMS, B G Nagara, Nagamangala Taluk, Karnataka, India

<sup>2</sup>Assistant Professor, Department of General Surgery, AIMS, B G Nagara, Nagamangala Taluk, Karnataka, India

<sup>3</sup>Assistant Professor, Department of General Surgery, AIMS, B G Nagara, Nagamangala Taluk, Karnataka, India

Received: 28-11-2021 / Revised: 25-12-2021 / Accepted: 02-01-2022

### Abstract

**Background-** Acute appendicitis is the most common cause of an acute abdomen requiring emergency surgery. The routine diagnosis of appendicitis is based purely on clinical history and examination combined with laboratory investigations. Our study is an attempt to compare both scoring systems (MODIFIED ALVARADO and RIPASA) in diagnosis of acute appendicitis and correlating both the scoring systems with the intraoperative and histopathological findings. **Objectives-** To correlate the diagnostic scoring systems (Modified Alvarado and RIPASA) with intraoperative and histopathological findings in cases of acute appendicitis. To compare RIPASA and Modified Alvarado scoring systems. **Methods-** A Hospital based Prospective study was conducted at Department of General Surgery, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya from August 2020 to May 2021. Patients presenting to the General surgery department and emergency in our hospital with RIF pain was included in this study. Total Sample size of 138 was studied. Data was collected from the patient's records. For all patients RIPASA and Modified Alvarado scoring was done. Modified Alvarado score contains 7 parameters where as RIPASA score contains 16 parameters and Operative and histopathological findings were compared. **Results-** Out of the 138 patients, 113 patients were <39.9 years of age and 25 patients were ≥40 years. Percentage of 81.9% and 18.1% respectively. 92 were male and 46 were females. Right iliac fossa pain was present in all the 138 patients in the study group. Fischer's exact test has been applied and Modified Alvarado scoring system diagnosis correlates well with the histopathological diagnosis (p-value is <0.0398). Sensitivity of the scoring system in the study is 72.31% and specificity comes out to be 75%. The mean score for normal appendix, healed appendix, healing appendicitis and acute appendicitis is 5.00, 6.777, 7.125 and 8.414 respectively. There has been increase in mean modified Alvarado score with increase in histopathological severity. **Conclusion-** By comparing both scoring systems, RIPASA scoring system found out to be an easy and reliable diagnostic tool for the diagnosis of acute appendicitis and RIPASA scoring system is better than Modified Alvarado scoring system for the diagnosis of acute appendicitis in our study population.

**Keywords-** Acute appendicitis, Modified ALVARADO, RIPASA, sensitivity, specificity, appendicectomy, histopathology

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### Introduction

The appendix (or vermiform appendix or caecal appendix or vermiform process) is a blind-ended tube connected to the caecum, from which it develops embryologically. The literal meaning of appendix is an appendage anything that is attached to a large or a major part as a tail or a limb [1,2]. Acute appendicitis is one of the most common surgical emergencies encountered especially by junior doctors during on call duties with emergency appendectomy making up to 10% of all emergency abdominal surgeries [3,4]. Acute appendicitis is the most common cause of an acute abdomen requiring emergency surgery. The routine diagnosis of appendicitis is based purely on clinical history and examination combined with laboratory investigations.

Kalen et al modified the Alvarado score. In modified Alvarado scoring system shift of WBC to the left has been omitted, the maximum score is 9 and its interpretation being similar with the modified Alvarado scoring [5].

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) is a new scoring system which was developed to aid in the diagnosis of acute appendicitis in the Asian countries.

\*Correspondence

**Dr. Yamuna V S**

Assistant Professor, Department of General Surgery, AIMS, B G Nagara, Nagamangala Taluk, Karnataka, India

E-mail: [dryamunavs@bgsaims.edu.in](mailto:dryamunavs@bgsaims.edu.in)

It was developed in department of surgery at Raja Isteri Pengiran Anak Saleha Hospital, Brunei Darussalam, in 2008 [5]. It includes 15 parameters, containing patient's demographics, symptoms, signs and investigation findings. Our study is an attempt to compare both scoring systems in diagnosis of acute appendicitis and correlating both the scoring systems with the intraoperative and histopathological findings. The need for this study is to establish a valid scoring system for diagnosing cases of suspected acute appendicitis in emergency consultation.

### Materials and Methods

A Hospital based Prospective study was conducted at Department of General Surgery, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya from August 2020 to May 2021. Patients presenting to the General surgery department and emergency in our hospital with RIF pain was included in this study. Patients presenting with RIF pain to our hospital who have undergone appendicectomy. Based on the study done by CF Chong et al [6], the diagnostic accuracy of RIPASA scoring system was 91.83% (95% CI, 87.63% - 96.04%). Taking expected proportion as 90%, assumed precision 5% and with 95% confidence interval, the minimum required sample size is 138. However, all consecutive cases from August 2020 to May 2021, of patients having a diagnosis of acute appendicitis and who underwent appendicectomy was taken for this study.

For the sample size calculation we used here the software nMaster 2.0.

The following formula has been used to estimate the sample size,  
 $n = [Z^2_{1-\alpha/2} p(1-p)] / d^2$

Where, p: Expected proportion

d: Absolute Precision and  $Z^2_{1-\alpha/2}$ : Desired confidence interval.

**Inclusion Criteria**

All age group patients who presented with right iliac fossa (RIF) pain with suspicion of acute appendicitis and who had undergone emergency appendectomy as a primary procedure.

**Exclusion Criteria**

Patients presenting with any form of non RIF pain, such as lower abdominal or upper quadrant pain. Patients who had undergone other emergency laparotomy where appendectomy was also performed as a part of the procedure. Patients with previous history of urolithiasis and pelvic inflammatory diseases. Elective appendectomy.

**Methodology**

Data was collected from the patient's records. A detailed history taking, clinical examination and required laboratory investigations

(white cell count and urinalysis) was done. Ultrasound abdomen was done in most of the cases especially in female patients to rule out the other causes for right iliac fossa pain. If ultrasound findings are inconclusive CT abdomen was done. For all patients RIPASA and Modified Alvarado scoring was done. Modified Alvarado score contains 7 parameters where as RIPASA score contains 16 parameters. A score of 7 is taken as high probability of acute appendicitis for Modified Alvarado scoring system and a score of 7.5 for RIPASA scoring system. Operative findings and histopathology reports was reviewed and correlated with the both scoring systems. RIPASA and Modified Alvarado scoring systems was compared.

**Statistical Methods**

Statistical analysis was done using the software Statistical Package for Social Sciences (SPSS) 22.0 version. Continuous variables was presented by mean  $\pm$ SD and categorical variables by frequency or percentages. To find the association between categorical variables we have used chi-square or Fisher's exact test. Independent t-test was used to find the significant difference in means of the variables. P value <0.05 as statistically significant was considered.

**Results**

**Table 1- Age, Sex and Symptoms wise distribution of Study Participants**

Symptoms	Frequency	Percentage
Right iliac fossa pain	138	100
Anorexia	86	62.3
Nausea and vomiting	100	72.5
Migration of pain to rif	99	71.7
Fever	58	42
Duration of symptoms <48hrs	80	58
Duration of symptoms >48hrs	58	42

As per table 1 Out of the 138 patients, 113 patients were <39.9 years of age and 25 patients were  $\geq$ 40 years. Percentage of 81.9% and 18.1% respectively. 92 were male and 46 were females. Percentage of 66.7% male and 33.3% female which suggest the study was male preponderance. Right iliac fossa pain was present in all the 138 patients in the study group. Anorexia was present in 86 patients. Nausea and vomiting was present in 100 patients. Pain migration to RIF was present in 99 patients. Patients presenting with duration of symptoms less than 48 hours were 80 and more than 48 hours is 58 and Fever was present in 58 patients.

**Table 2- Qualitative Analysis of Both the Scoring Systems**

Modified alvarado score	RIPASA score		Total
	$\geq 7.5$	< 7.5	
$\geq 7$	96	0	96
< 7	26	16	42
TOTAL	122	16	138

As per table 2 on analyzing the cross table by fisher's exact test, there is definitive agreement that both the scoring systems are positively correlating with each other with respect to diagnosis of the disease with p-value < 0.0001, which is statistically significant.

**Table 3- Comparison of Modified Alvarado & Ripasa Scoring System with Intraoperative Findings**

Operative findings	No of patients	MEAN $\pm$ SD of Modified alvarado score	MEAN $\pm$ SD of RIPASA score
Inflamed appendix	113	6 . 6 2 8 $\pm$ 1 . 4 4 6 6	9 . 0 6 $\pm$ 1 . 7 8 8
Inflamed appendix with meckle's diverticulum	4	7 . 0 0 $\pm$ 0 . 8 1 6 5	9 . 1 2 5 $\pm$ 1 . 4 3 6 1
Inflamed and gangrenous appendix	9	7 . 3 3 3 $\pm$ 1 . 8 0 2 8	11 . 0 0 $\pm$ 2 . 6 4 5 8
Severely inflamed and perforated appendix	11	7 . 2 7 3 $\pm$ 1 . 1 0 3 7	10 . 4 5 5 $\pm$ 1 . 4 5 7 0
Mucocele of appendix	1	7	9

As per table 3 on the basis of intra operative findings all study group has been further divided into 5 groups namely inflamed appendix, inflamed appendix with Meckel's diverticulum, Inflamed with gangrenous appendix, severely inflamed with perforated appendix and mucocele of appendix.

**Table 4- Comparison of Modified Alvarado Score Diagnosis with Histopathological Diagnosis**

Modified alvarado score	Histopathological diagnosis		Total
	Appendicitis	No appendicitis	
$\geq 7$	94	2	96
< 7	36	6	42
TOTAL	130	8	138

Fischer's exact test has been applied and Modified Alvarado scoring system diagnosis correlates well with the histopathological diagnosis (p-value is <0.0398). Sensitivity of the scoring system in the study is 72.31% and specificity comes out to be 75%. The positive and negative predictive values are 97.92% and 14.29% respectively. Diagnostic Accuracy of the scoring system is 72.46%. The mean score for normal

appendix, healed appendix, healing appendicitis and acute appendicitis is 5.00, 6.777, 7.125 and 8.414 respectively. There has been increase in mean modified Alvarado score with increase in histopathological severity.

**Table 5-Comparison of Ripasa Scoring Diagnosis with Histopathological Diagnosis**

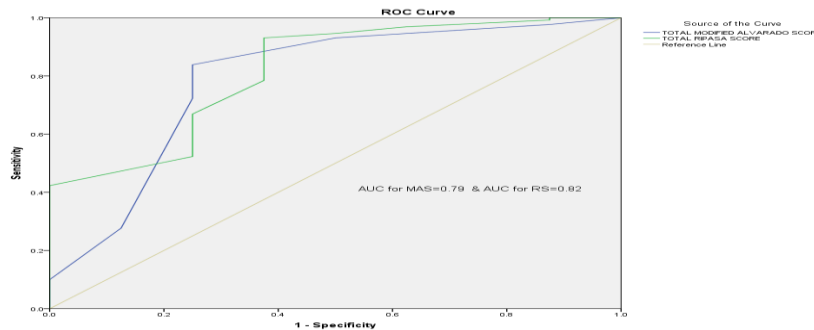
RIPASA score	Histopathological diagnosis		Total
	Appendicitis	No appendicitis	
≥ 7.5	119	3	122
< 7.5	11	5	16
	130	8	138

Fischer’s exact test has been applied and RIPASA scoring system diagnosis correlates well with the histopathological diagnosis (p-value is <0.0387). Sensitivity of the scoring system in the study is 91.5% and specificity comes out to be 62.5%. The positive and negative predictive values are 97.5% and 31.25% respectively. Diagnostic Accuracy of the scoring system is 89.85%. The mean score for normal appendix, healed appendix, healing appendicitis and acute appendicitis is 6.813, 9.422, 9.500 and 9.682 respectively. There has been increase in mean RIPASA score with increase in histopathological severity.

**Table 6-Comparison of Modified Alvarado with Ripasa Scoring in the Diagnosis of Acute Appendicitis**

Statistical analysis	Modified alvarado score	RIPASA score
Sensitivity	72.31%	91.53%
Specificity	75%	62.5%
Positive predictive value	97.92%	97.5%
Negative predictive value	14.29%	31.25%
Diagnostic accuracy	72.46%	89.85%
Negative appendicectomy rates	2.08%	2.45%

As per table 6 Sensitivity, NPV, Diagnostic accuracy of RIPASA was higher than MODIFIED ALVARADO.



**Figure 1- ROC Curve Depicting Both Scoring System of Diagnostic Tool for Identification of Appendicitis**

Sample size = 138  
 MODIFIED ALVARDO SCORERIPASA SCORE  
 AUC = 0.789 AUC = 0.824  
 P value is 0.0001 P value is 0.0001  
 Cut Off score for MAS is > 7 Cut off score for RS is > 7.5  
 1. Sensitivity of 72.31% 1. Sensitivity of 91.53%  
 2. Specificity of 75% 2. Specificity of 62.5%

**Discussion**

Acute appendicitis is one of the most common surgical emergencies encountered by junior surgeons on call with emergency appendicectomy making up one in ten of all emergency abdominal surgeries. Particularly in age group less than 30 years[7]. Present study included 138 cases of acute appendicitis, with 81.9% patients in ≤39.9 years age group and 18.1% patients in >40 years. There were 92 males and 46 females in the study. All the patients clinically suspected to have acute appendicitis were scored according to both the scoring systems and were taken up for surgery based on surgeon’s clinical judgement. In a study by Korner H et al nausea and vomiting, and pain migration to the RIF were the two symptoms that were statistically significant[8]. Present study partially agreed with the study by Korner H et al as it did not find pain migration to RIF as statistically significant. Signs such as RIF tenderness were present in all the 138 cases of acute appendicitis. Rebound tenderness was present in 106 cases (76.8%) (p-value 0.046), guarding in 15 patients (10.9%) (p-value 0.31) and rovsing’s sign in 41 patients (29.7%) (p-value 0.27). Out of all the clinical signs, rebound tenderness was found statistically significant (p-value < 0.05) this finding has been found consistent with the study done by Wagner JM[9]. CF Chonget

al[55] a prospective study reported the sensitivity and specificity of modified Alvarado score to be 68.3% and 87.9% respectively, positive and negative predictive values of Modified Alvarado score were 86.3% and 71.4%. Negative appendectomy rate in that study was 13.8% and diagnostic accuracy was 86.5%. Fischer’s exact test has been applied for Modified Alvarado scoring system (p-value is <0.0398) and for RIPASA scoring system (p-value is <0.0387), diagnosis correlates well with the histopathological diagnosis. There is paucity of studies that correlate both scoring systems with the intraoperative and histopathological findings. In studies by Lewis FR and Althoubaity FK, it was observed that all the gangrenous appendicitis were associated with Modified Alvarado score more than 8[10,11]. The present study has found the mean of scores of gangrenous appendicitis to be 7.33, which is not consistent with previous observational studies. Study by Regar MK et al[12] showed intraoperative finding such as increase in length of appendix is consistent with increase in Modified Alvarado score and RIPASA score at >7 and >7.5 respectively and was statistically significant. Receptor operative curve analysis was done in the present study to look for the cut off score for both the scoring systems, with good sensitivity and specificity. Modified Alvarado score with cut off of >7 showed sensitivity of 72.31% and specificity of 75% with AUC = 0.789 and p-value of 0.0001. RIPASA score with cut off of >7.5 showed sensitivity of 91.53% and specificity of 62.5% with AUC = 0.824 and p-value of 0.0001.

**Conclusion**

On analyzing the cross table by fisher’s exact test, there is definitive agreement that both Modified Alvarado and RIPASA scoring systems

are positively correlating with each other with respect to diagnosis of the disease with p-value < 0.0001, which is statistically significant. By comparing both scoring systems, RIPASA scoring system found out to be an easy and reliable diagnostic tool for the diagnosis of acute appendicitis and RIPASA scoring system is better than Modified Alvarado scoring system for the diagnosis of acute appendicitis in our study population. Intraoperative findings does not correlate with both the RIPASA and Modified Alvarado scoring systems.

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