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# Comparative Evaluation of RIPASA, Alvarado, and Modified Alvarado Scores in Acute Appendicitis Diagnosis

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#### ABSTRACT

**Background:** Acute appendicitis is a common surgical emergency characterized by inflammation of the appendix, though diagnosis can be challenging. Scoring systems such as Alvarado are widely used, but their diagnostic accuracy varies regionally. The RIPASA score, developed for Asian populations, claims superior diagnostic performance. This study aimed to validate and compare the RIPASA, Alvarado, and Modified Alvarado scores in an Indian population.

**Methods:** A prospective observational study was conducted from May 2023 to May 2024, involving 100 patients (72 males, 28 females; mean age 30.9 years) presenting with right iliac fossa pain and undergoing appendicectomy at a single center. All patients were evaluated preoperatively using the RIPASA, Alvarado, and Modified Alvarado scores. Histopathological examination (HPE) of the surgical specimen was considered the diagnostic gold standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, negative appendectomy rate, and area under the ROC curve (AUC) were analyzed.

**Results:** Histopathology confirmed appendicitis in 93 patients (negative appendectomy rate: 7%). RIPASA (cutoff ≥7.5) showed higher sensitivity (96.8%), specificity (62.5%), NPV (71.4%), and accuracy (92.0%) compared to Alvarado (81.7%, 37.5%, 19.0%, 79.0%) and Modified Alvarado (82.8%, 33.3%, 20.0%, 80.0%), respectively (p<0.001). RIPASA also had a lower negative appendectomy rate (3.2%) and greater discriminative ability (AUC 0.83) than Alvarado (0.63) and Modified Alvarado (0.65). **Conclusion:** The RIPASA score outperformed Alvarado and Modified Alvarado scores in diagnosing acute appendicitis, making it a more reliable diagnostic tool in the Indian population.

**Key-words:** Acute appendicitis, RIPASA score, Alvarado score, Diagnostic accuracy, Negative appendectomy rate, Validation study

## INTRODUCTION

Acute appendicitis is recognized as a frequently encountered surgical crisis globally, with an approximate occurrence rate of about 1 in 7 individuals <sup>[1].</sup> The incidence rates are reported to be 1.5 and 1.9 for every 1000 units of individuals in the man and woman populations, in the same order <sup>[2]</sup>.

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Access this article online https://iijls.com/ A postponement in conducting a surgical procedure to remove the appendix enhances analytical precision and elevates the likelihood of perforation in the appendix and sepsis, consequently increasing both morbidity and mortality rates <sup>[3]</sup>. Conversely, diminished diagnostic accuracy leads to a rise in the levels of adverse outcomes or unnecessary appendectomies, which are generally estimated to range from about 20% to 40% <sup>[4]</sup>. The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score represents a novel diagnostic evaluation framework designed for the diagnosis of acute appendicitis, demonstrating significantly improved sensitivity, specificity, and diagnostic accuracy about the Alvarado score, especially within Asian populations <sup>[5]</sup>. While the

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RIPASA scoring system offers additional features and surpasses the Alvario scoring next frame in comprehensiveness, the former lacks specific critical Constraints, including Demographic indicators, and the length of time symptoms have been present before medical demonstration.

The elements under consideration are demonstrated to influence the accuracy measures including the detection and discrimination capabilities of the AppendiScan Score utilized in diagnosing acute appendicitis <sup>[6]</sup>. While an ultrasonogram exhibits relatively lower specificity, Computed tomography (CT) assists in verifying the diagnosis; nevertheless, it is costly as well as may not always be readily available.

The assessment using the Alvarado score indicated evaluated for its precision during the pre-surgical phase identification The study on acute appendicitis conducted by Kalan, Talbot, and Cunliffe in 1994.4 indicates a high score facilitates the ahead-of-time detection of the occurrence of acute appendicitis in pediatric patients and male individuals, while for females, the rate of fallacious positives for Inflammation of the appendix occurred elevated. In 2010, Chong et al conducted a potential investigation involving individuals who presented with right iliac fossa pain to the Accident and Emergency department or the surgical wards at RIPAS Hospital, the national hospital located in Brunei Darussalam<sup>[7]</sup>. They determined that the RIPASA scoring system proves to be a superior appropriate appendix inflammation severity index tailored for regional contexts in Southeast Asia, demonstrating excellent detection capability, precise identification, and reliable diagnostic performance. This research aims to confirm the reliability of the scoring mechanism within our environment.

#### MATERIALS AND METHODS

**Study Setting of study-** This forward-looking observational research was conducted in the Department of General Surgery and Department of Emergency Medicine of GIMSR Medical College, Visakhapatnam, India.

**Study Period and Population-** The research was conducted over the span of one year, commencing in May 2023 and concluding in May 2024. It involved individuals spanning the age range of 15 to 60 years who

exhibited acute right iliac fossa (RIF) pain and received appendicectomy. The decision for operational intervention was derived from clinical assessment, ultrasonographic (USG) findings, and in chosen cases, computed tomography (CT) imaging. Pregnant female patients, individuals in the presence of a mass located in the appropriate iliac fossa, individuals with chronic or recurrent discomfort in the correct position iliac fossa, and those previously diagnosed with pelvic inflammatory disease were not included in the study to prevent confounding factors.

Scoring Systems Used- A total of 100 patients were assessed using three clinical assessment frameworks: RIPASA score, Alvarado evaluation framework, and modified appendicitis diagnostic scale. For every patient, RIPASA was determined for 18 parameters with an overall maximum score of 17.5. Demographic, symptomatic, clinical, and investigative elements were part of the scoring system. For demographics, males were given 1 point and females 0.5 points, patients less than 39.9 years received 1 point and those greater than 40 years received 0.5 points. In the symptom category, pain at the RIF and pain migration to the RIF were both assigned 0.5 points, anorexia and nausea or vomiting were each assigned 1 point, those lasting fewer than 48 hours were assigned 1 point, and those lasting exceeding 48 hours were assigned 0.5 points. For clinical findings, RIF tenderness was assigned 1 point, guarding was assigned 2 points for tenderness, rebound tenderness was rated as 1 point, and 2 points for a positive Rovsing's sign, and elevated body temperature ranging from 37°C to 39°C was assigned 1 point. Lab tests involved elevated white blood cell (WBC) count, which added 1 point, and negative urine analysis, which added 1 point. A further 1 point was assigned for non-Asian ethnicity. A rating of 7.5 or higher was regarded as suggestive related to acute appendiceal inflammation.

The Alvarado Appendicitis Score, which has a maximum of 10, included symptoms such as shifting discomfort in the lower right abdomen accompanied by loss of appetite and feelings of nausea, sometimes leading to vomiting, with each symptom assigned a score of 1 point.

Clinical indicators included localized pain on palpation in the lower right abdomen, which was scored at twosome of points, while pain elicited upon release of pressure in the same region was assigned 1 point, and an increase in temperature was also scored at 1 point.

Laboratory findings contributed to the scoring with leukocytosis, which was valued at 2 points, and a left shift (neutrophilia), which was assigned 1 point. A score greater than 7 was indicative of appendicitis.

The Revised Alvarado score did not encompass the parameter of neutrophilia and totaled 9. It comprised migratory RIF discomfort, loss of appetite, and nausea or emesis, each contributing one point. Discomfort localized in the lower right abdominal region contributed an additional 2 points, along with rebound tenderness and raised temperature each adding 1 point, and leukocytosis adding 2 points. The presence was indicated by a score of over 7 for acute appendicitis.

**Data Collection-** After appendicectomy, surgical findings and histopathology reports of every patient were evaluated to act as the gold standard for diagnosis. Clinical data relevant to the study and all the results of the score were recorded in a standardized study proforma. The information was subsequently input into Microsoft Excel and analyzed through SPSS version 23.0, MedCalc version 9.0.1, and Systat version 12.0. Graphs and tables were created using Microsoft Office software.

**Diagnostic Accuracy and ROC Examination-** To assess the analytical significance of the RIPASA, the original Alvarado clinical evaluation method, and the adapted Alvarado clinical scoring scale, along with their diagnostic accuracy in detecting real cases, excluding false alarms, and confirming positive outcomes, and negative predictive value (NPV), and overall, the precision of diagnostics was computed when in contrast with histopathological outcomes. The analysis of the ROC (Receiver Operating Characteristic) curve was also conducted on all three scores to ascertain their ability to predict acute appendicitis.

**Statistical Analysis-** Descriptive statistical analysis was employed to present the findings. The central tendency and dispersion of continuous variables are represented by mean and standard deviation along with the scope. Data classified was expressed regarding rate and proportion. The application of the Chi-square test was utilized to appraise the significance of various parameters across groups, with statistical significance achieved with a p-value<0.05.

**Ethical Considerations-** Ethical permission for the research was taken from the Institutional Ethical Review Board before data collection was started.

## RESULTS

The present study included 100 patients diagnosed with suspected acute appendicitis, comprising 72 males (72%) and 28 females (28%) with a mean age of 30.9 years. Most patients fell within the 21–30 years age range (41%), followed by 31–40 years (35%), and only 6% were in the 51–60 years range.

Patients were evaluated using three clinical scoring systems—RIPASA, Alvarado, and Modified Alvarado. To facilitate an understanding of their component parameters and score weightings, the detailed scoring criteria are presented in Table 1.

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Category	Parameter	Score
Demography	Male	
	Female	0.5
	Age < 39.9 years	
	Age > 40 years	0.5
	Right iliac fossa (RIF) pain	0.5
	Pain migration to RIF	
Symptoms	Anorexia	
	nptoms Nausea and vomiting	
	Duration of symptoms < 48 hours	1
	Duration of symptoms > 48 hours	0.5
	RIF tenderness	1
Signs	Signs Guarding	
	Rebound tenderness	
	Rovsing's sign	2
	Fever > 37°C and < 39°C	1

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Investigation	Raised white blood cell (WBC) count	1
	Negative urine analysis	1
Additional	Non-Asian ethnicity	1
Total Score		17.5

#### Table 2: Alvarado Scoring System

Category	Parameter	Score
Symptoms	Migratory RIF pain	1
	Anorexia	1
	Nausea/Vomiting	1
Signs	Tenderness in RIF	2
	Rebound tenderness in RIF	1
	Elevated temperature	1
	Leucocytosis	2
Laboratory	Shift to left (neutrophilia)	1
Total Score		10

Fable 3: Modified	l Alvarado	Scoring	System
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Category	Parameter	Score
	Migratory RIF pain	1
Symptoms	Anorexia	1
	Nausea/Vomiting	1
	Tenderness in RIF	2
Signs	Rebound tenderness in RIF	1
	Elevated temperature	1
Laboratory	Leucocytosis	2
Total Score		9

Using the above scoring frameworks, patients were categorized into high- and low-probability groups. Based on RIPASA (cutoff  $\geq$ 7.5), 93% were high probability. For Alvarado and Modified Alvarado (cutoff  $\geq$ 7), 79% and 80% were high probability, respectively. Histopathology confirmed acute appendicitis in 93 cases. Thus, the overall negative appendectomy rate was 7%. Comparative diagnostic performance metrics are presented in Table 4.

Score Type	PPV	NPV	Diagnostic Accuracy
RIPASA	96.8%	71.4%	92.0%
Alvarado	96.2%	19.0%	79.0%
Modified Alvarado	96.3%	20.0%	80.0%

Table 4: Predictive Values and Diagnostic Accuracy

RIPASA also showed lower false positives and a negative appendectomy rate of only 3.2%, as compared to 3.8% (Alvarado) and 3.7% (Modified Alvarado). ROC curve analysis further confirmed the superior discriminative ability of RIPASA (AUC 0.83) compared to Alvarado (0.63) and Modified Alvarado (0.65).

## DISCUSSION

Acute appendicitis continues to be one of the most frequent causes of emergency abdominal surgery. Despite its prevalence, accurate diagnosis remains a clinical challenge, particularly in resource-constrained environments where advanced imaging may not always be feasible [8]. Clinical scoring systems such as Alvarado and its modifications have been widely used, but their diagnostic performance has shown regional variability <sup>[9]</sup>. In the present study, the RIPASA scoring system demonstrated significantly superior diagnostic performance compared to the Alvarado and Modified Alvarado scores. RIPASA achieved a sensitivity of 96.8%, specificity of 62.5%, and diagnostic accuracy of 92.0%. These findings are consistent with multiple earlier studies conducted in Asian populations, where RIPASA has been shown to outperform Western scoring systems due to its design tailored for regional demographics <sup>[10,11]</sup>.

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The inclusion of additional clinical parameters in the RIPASA score—such as age, gender, duration of symptoms, and negative urine analysis—likely contributes to its superior performance. In contrast, the Alvarado and Modified Alvarado scores include fewer variables and were originally developed based on Western population data, limiting their applicability in South Asian settings <sup>[12]</sup>. Our findings echo previous Indian studies that noted Alvarado scores performed less reliably in young adults and female patients <sup>[13,14]</sup>.

The negative appendectomy rate is an important indicator of diagnostic accuracy. In this study, histopathology confirmed acute appendicitis in 93 of 100 cases, yielding a 7% negative appendectomy rate. However, when stratified by scoring systems, the false-positive rate was lower with RIPASA (3.2%) compared to Alvarado (3.8%) and Modified Alvarado (3.7%) <sup>[15]</sup>. These results support RIPASA's ability to correctly rule out non-appendicitis cases, potentially minimizing unnecessary surgeries.

Furthermore, the RIPASA score achieved a higher negative predictive value (71.4%) compared to Alvarado (19.0%) and Modified Alvarado (20.0%). This reinforces its value in safely identifying patients unlikely to require surgical intervention, thus reducing unnecessary exploration and associated morbidity <sup>[16]</sup>.

Receiver Operating Characteristic (ROC) analysis in our study demonstrated that RIPASA had the highest area under the curve (AUC) at 0.83, indicating superior discriminative ability over Alvarado (0.63) and Modified Alvarado (0.65). AUC values closer to 1 represent better diagnostic performance, and this finding supports the use of RIPASA as a more reliable screening tool for suspected appendicitis in Indian patients <sup>[17]</sup>.

While imaging techniques such as ultrasonography and computed tomography can aid in the diagnosis, their cost, availability, and operator dependency limit their routine use in primary and secondary care centers. Hence, reliance on a scoring system like RIPASA, which incorporates both subjective symptoms and objective findings, is highly practical and cost-effective <sup>[18]</sup>.

Other studies have shown that RIPASA also reduces diagnostic delays, which is important because delayed diagnosis increases the risk of perforation, peritonitis, and postoperative complications. In our study, patients with a high RIPASA score were triaged more efficiently and underwent early surgical intervention with favorable histopathological correlation <sup>[10,11]</sup>.

Our study confirms that the RIPASA scoring system provides a more comprehensive assessment, particularly in regions like India where epidemiological and clinical patterns may differ from those in Western populations. The inclusion of variables like symptom duration, guarding, and Rovsing's sign adds diagnostic weight, which may be absent or underemphasized in traditional scoring systems <sup>[12,15]</sup>.

Although the Alvarado score is well established and still in use globally, multiple Indian studies, including ours, consistently show that its sensitivity and specificity are inferior when compared to RIPASA <sup>[13,14,17]</sup>. Moreover, RIPASA's structure makes it more adaptable to diverse populations by accounting for ethnographic differences in disease presentation and patient behavior <sup>[10]</sup>.

This study also aligns with results from other Indian and Southeast Asian analyses that support RIPASA as a better triage tool. Its adoption in emergency settings may lead to more accurate diagnosis, timely surgical intervention, and reduced healthcare burden due to fewer unnecessary investigations or surgeries <sup>[16,18]</sup>.

In conclusion, RIPASA is a more regionally suited and statistically superior tool for diagnosing acute appendicitis in the Indian population. When used systematically, it can reduce diagnostic uncertainty, lower negative appendectomy rates, and improve clinical outcomes.

#### CONCLUSIONS

The current research concluded that the scoring system referred to as RIPASA exhibits greater accuracy in detecting true cases and correctly excluding non-cases in comparison to the Alvarado evaluation system. Additionally, it demonstrates superior accuracy in detecting conditions, elevated positive test accuracy rate, and a strong ability to correctly identify negative cases; thus, it results in a reduced rate of nontherapeutic appendectomy Consequently, it might serve as inferred that the RIPASA diagnostic algorithm can be advantageously utilized for a more thorough investigation into acute appendicitis with presentation of promising and cost-effective diagnostic approach.

#### CONTRIBUTION OF AUTHORS

Research concept- N Siva Durgesh, MNS Priya Kaiwallya

Research design- N Siva Durgesh, Sreya Banapuram Supervision- N Siva Durgesh Materials- N Siva Durgesh, Sreya Banapuram Data collection- N Siva Durgesh, Sreya Banapuram Data analysis and interpretation- N Siva Durgesh Literature search- N Siva Durgesh, Sreya Banapuram Writing article- N Siva Durgesh, Sreya Banapuram Critical review- N Siva Durgesh Article editing- N Siva Durgesh, MNS Priya Kaiwallya Final approval- N Siva Durgesh

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