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COMPARATIVE EVALUATION OF RIPASA AND ALVARADO SCORING SYSTEMS IN PREDICTING ACUTE APPENDICITIS: A PROSPECTIVE OBSERVATIONAL CASE SERIES

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ABSTRACT

Background: Acute appendicitis is the most common cause of acute abdomen requiring emergency surgery, with a lifetime risk of 6–7% [1,2]. Although the Alvarado score is widely used for preoperative risk stratification, its diagnostic accuracy has been shown to be limited in Asian populations [3,4]. The RIPASA score, developed in 2010 specifically for Asian demographics, incorporates additional clinical and demographic variables and has demonstrated superior diagnostic performance in several validation studies [5,6].

Objective: To compare the diagnostic accuracy of the RIPASA and Alvarado scoring systems against histopathologically confirmed intraoperative findings in patients undergoing appendectomy for suspected acute appendicitis.

Methods: This prospective observational case series was conducted at the Department of General Surgery, Sree Balaji Medical College and Hospital, Chennai, India, from July 2024 to January 2026. Ninety consecutive patients aged ≥18 years presenting with clinical features suggestive of acute appendicitis and scheduled for appendectomy were enrolled. Both scoring systems were calculated preoperatively and correlated with histopathological findings. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, and receiver operating characteristic (ROC) curve analyses were performed [7].

Results: The mean age of the cohort was 34.2 years, with male predominance (62.2%). Histopathological examination confirmed acute appendicitis in 76 patients (84.4%), yielding a negative appendectomy rate of 15.6%. The RIPASA score (≥7.5) demonstrated sensitivity of 78.9%, specificity of 71.4%, PPV of 93.8%, NPV of 38.5%, and diagnostic accuracy of 77.8% (AUC = 0.80). The Alvarado score (≥7) showed sensitivity of 60.5%, specificity of 57.1%, PPV of 88.5%, NPV of 21.1%, and diagnostic accuracy of 60.0% (AUC = 0.62). All differences were statistically significant ($p < 0.05$) [8].

Conclusion: The RIPASA scoring system demonstrated superior diagnostic accuracy compared to the Alvarado score in this Indian cohort. Integration of the RIPASA score into emergency department protocols may reduce negative appendectomy rates and improve clinical decision-making in resource-limited settings [9,10].

KEYWORDS: acute appendicitis; Alvarado score; RIPASA score; diagnostic accuracy; negative appendectomy; clinical scoring systems; case series

INTRODUCTION

Acute appendicitis remains the most frequent cause of acute abdominal pain necessitating emergency surgical intervention, with a reported lifetime risk of approximately 6–7% in the general population [1]. The condition predominantly affects adolescents and young adults, with a higher incidence observed in males [2,11]. Despite considerable advances in diagnostic imaging and laboratory assessment, the clinical diagnosis of acute appendicitis continues to pose a significant challenge owing to its protean presentation, particularly in females, children, elderly patients, and those with atypical symptomatology [12,13].

Appendectomy has been the definitive treatment for acute appendicitis for over a century. However, reliance solely on clinical judgment has historically resulted in negative appendectomy rates ranging from 15% to 30%, which, although previously considered acceptable to avoid perforation, is associated with avoidable surgical morbidity, prolonged hospitalization, and increased healthcare expenditure [14,15]. The imperative to reduce unnecessary surgical interventions has driven the development of standardized clinical scoring systems that integrate historical, examination, and laboratory parameters into quantitative risk assessment tools [16].

The Alvarado score, introduced in 1986, is the most extensively studied and widely employed clinical scoring system for

appendicitis worldwide [3]. Comprising eight clinical and laboratory variables with a maximum score of 10, a cut-off of ≥7 is generally considered indicative of probable appendicitis. However, multiple studies have demonstrated that the Alvarado score exhibits reduced sensitivity and specificity when applied to Asian and Middle Eastern populations, resulting in a significant proportion of missed diagnoses and suboptimal diagnostic performance [4,17]. This limitation has been attributed, in part, to the absence of demographic parameters such as age and gender, as well as certain clinical signs like Rovsing's sign, from the scoring algorithm [18].

In response to these limitations, Chong et al. developed the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score in 2010, specifically designed for Asian populations [5]. The RIPASA score incorporates 15 parameters, including demographic variables, clinical symptoms and signs, and two routine laboratory investigations, yielding a maximum score of 17.5. A cut-off of ≥7.5 is considered suggestive of acute appendicitis. Subsequent validation studies across multiple Asian countries have consistently demonstrated that the RIPASA score possesses superior sensitivity, specificity, and overall diagnostic accuracy compared to the Alvarado score [6,19,20].

A recent systematic review and meta-analysis incorporating 35 studies found that the RIPASA score had a pooled sensitivity of 0.95 and specificity of 0.71, compared with 0.72 and 0.77 for the Alvarado score, respectively [21]. These findings underscore the population-specific nature of diagnostic scoring tools and highlight the necessity for regional validation before clinical implementation [22].

The present study was designed as a prospective observational case series to compare the diagnostic accuracy of the RIPASA and Alvarado scoring systems against histopathologically confirmed intraoperative findings in patients presenting with suspected acute appendicitis at a tertiary care centre in South India. The aim was to identify the more reliable and population-specific scoring system for early diagnosis, appropriate surgical decision-making, and reduction of negative appendectomy rates [9].

MATERIALS AND METHODS

Study Design and Setting

This prospective observational case series was conducted at the Department of General Surgery, Sree Balaji Medical College and Hospital, Chennai, India, over an 18-month period from July 2024 to January 2026. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrolment [23].

Study Population

Ninety consecutive patients aged ≥18 years who presented to the emergency department with clinical features suggestive of acute appendicitis and were subsequently scheduled for appendectomy were enrolled. Patients with a history of previous appendectomy, definitive alternative diagnosis for right iliac fossa pain, appendicular lump or mass, pregnancy, contraindications to surgery, or significant comorbidities precluding reliable clinical assessment were excluded [24].

Data Collection and Clinical Assessment

A standardized proforma was used to record demographic details (age, gender), clinical symptoms (right iliac fossa pain, migratory pain, anorexia, nausea/vomiting, fever), physical examination findings (right iliac fossa tenderness, rebound tenderness, guarding, Rovsing's sign), and laboratory investigations (complete blood count with total and differential leukocyte count, urine routine examination) [25]. Imaging studies, including ultrasonography and contrast-enhanced computed tomography, were performed selectively as clinically indicated [26].

Scoring System Calculation

Both the Alvarado score (maximum score: 10; cut-off ≥7) and the RIPASA score (maximum score: 17.5; cut-off ≥7.5) were calculated preoperatively for each patient by the evaluating surgeon. The specific components and assigned weights for each scoring system have been previously described in detail [3,5]. Clinical decisions regarding appendectomy were based on the treating surgeon's clinical judgment and were not influenced by the scores, which were calculated independently for study purposes [27].

Surgical Procedure and Reference Standard

All enrolled patients underwent appendectomy under appropriate anaesthesia (general or regional). Intraoperative findings, including the macroscopic appearance of the appendix (congested, suppurative, gangrenous, perforated, or normal), were systematically recorded. All resected appendectomy specimens were submitted for histopathological examination, which served as the definitive reference standard for the diagnosis of acute appendicitis [28,29].

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 26.0 (IBM Corp., Armonk, NY). Categorical variables were expressed as frequencies and percentages, while continuous variables were reported as means with standard deviations. Sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy were calculated for both scoring systems using standard 2×2 contingency tables. ROC curve analysis was performed to compare the discriminative ability of the two scores, with the area under the curve (AUC) used as the primary metric. A p-value of <0.05 was considered statistically significant [30].

RESULTS

Demographic Profile

The study enrolled 90 patients, of whom 56 (62.2%) were male and 34 (37.8%) were female, yielding a male-to-female ratio of 1.65:1. The majority of patients (68.9%) were below 40 years of age. The largest proportion belonged to the 18–30-year age group (37.8%), followed by the 31–40-year group (31.1%), 41–50-year group (20.0%), and patients above 50 years (11.1%). This age distribution is consistent with the known epidemiology of appendicitis, which predominantly affects young adults [2,11].

Table 1. Age and sex distribution of study participants (n = 90)

Age group (years)	Male (n)	Female (n)	Total n (%)
18–30	22	12	34 (37.8%)
31–40	17	11	28 (31.1%)
41–50	12	6	18 (20.0%)
>50	5	5	10 (11.1%)
Total	**56 (62.2%)**	**34 (37.8%)**	**90 (100%)**

Clinical Presentation

Right iliac fossa pain was the universal presenting symptom (100%). Migratory pain was observed in 73.3%, anorexia in 68.9%, nausea or vomiting in 64.4%, and fever in 60.0%. On examination, right iliac fossa tenderness was the most consistent sign (94.4%), followed by rebound tenderness (57.8%), guarding (51.1%), and Rovsing's sign (31.1%). These findings are concordant with the classical symptom complex described in the literature [12,31].

Table 2. Clinical features of study participants (n = 90)

Clinical Feature	n	%
Right iliac fossa pain	90	100.0
Migratory pain	66	73.3
Anorexia	62	68.9
Nausea / vomiting	58	64.4
Fever	54	60.0
RIF tenderness	85	94.4
Rebound tenderness	52	57.8
Guarding	46	51.1
Rovsing's sign	28	31.1

Scoring System Distribution

Using the Alvarado scoring system, 52 patients (57.8%) scored ≥7, while 38 (42.2%) scored <7. With the RIPASA scoring system, 64 patients (71.1%) scored ≥7.5 and 26 (28.9%) scored <7.5. The higher proportion of patients classified as high-probability by the RIPASA score reflects its broader inclusion of clinical and demographic parameters [5,32].

Histopathological Findings

Histopathological examination confirmed acute appendicitis in 76 patients (84.4%), while 14 patients (15.6%) had a histologically normal appendix, yielding a negative appendectomy rate of 15.6%. This rate is consistent with rates reported in recent large-scale studies from Asian centres, which range from 10–20% [14,33].

Correlation of Scoring Systems with Histopathology

Among the 52 patients with Alvarado scores ≥7, 46 (88.5%) had histopathologically confirmed appendicitis and 6 (11.5%) had negative histopathology. Among 38 patients scoring <7, 30 (78.9%) were subsequently found to have confirmed appendicitis, representing false-negative cases. For the RIPASA score, among 64 patients scoring ≥7.5, 60 (93.8%) had confirmed appendicitis and 4 (6.3%) had negative histopathology. Among 26 patients scoring <7.5, 16 (61.5%) had confirmed appendicitis and 10 (38.5%) had negative histopathology [34,35].

Table 3. Diagnostic performance of Alvarado and RIPASA scoring systems (n = 90)

Parameter	Alvarado (≥7)	RIPASA (≥7.5)
Sensitivity (%)	60.5	78.9
Specificity (%)	57.1	71.4
PPV (%)	88.5	93.8
NPV (%)	21.1	38.5

Diagnostic accuracy (%)	60.0	77.8
AUC (95% CI)	0.62 (0.50–0.74)	0.80 (0.70–0.89)
p-value	<0.05	<0.001

ROC Curve Analysis

The area under the ROC curve for the RIPASA score was 0.80 (95% CI: 0.70–0.89), compared with 0.62 (95% CI: 0.50–0.74) for the Alvarado score. Both scoring systems demonstrated statistically significant discriminative ability, but the RIPASA score exhibited clearly superior diagnostic performance with a substantially higher AUC [6,36].

Table 4. Comparison of present study findings with published literature

Study	Score	Sensitivity (%)	Specificity (%)	Accuracy (%)
Chong et al. [6]	RIPASA	98.0	81.3	91.8
Chong et al. [6]	Alvarado	68.3	87.9	86.5
Nanjundaiah et al. [37]	RIPASA	96.2	90.5	96.0
Din et al. [20]	RIPASA	95.8	87.9	95.1
Heiranizadeh et al. [38]	RIPASA	86.6	66.7	83.0
Basile et al. [21]	RIPASA*	95.0	71.0	—
Present study	**RIPASA**	**78.9**	**71.4**	**77.8**
Present study	**Alvarado**	**60.5**	**57.1**	**60.0**

Pooled estimates from meta-analysis of 35 studies.

DISCUSSION

The present prospective case series evaluated 90 patients with suspected acute appendicitis and compared the diagnostic performance of the RIPASA and Alvarado scoring systems against histopathological findings. The demographic composition of the study cohort, characterized by a predominance of young adults and males, is consistent with the established epidemiology of acute appendicitis [2,11]. Addiss et al. reported a peak incidence in the second and third decades of life with a male predilection, findings that have been corroborated across multiple population-based studies [11]. The inclusion of age as an independent variable within the RIPASA scoring system may partly account for its superior diagnostic performance in populations with a high proportion of young adult patients [5].

The clinical presentation observed in our cohort was characteristic, with right iliac fossa pain as the universal symptom and right iliac fossa tenderness as the most consistent sign (94.4%). The prevalence of migratory pain (73.3%) and anorexia (68.9%) is comparable to rates reported by Humes and Simpson in their comprehensive clinical review [12].

Importantly, Rovsing's sign, which is incorporated into the RIPASA score but absent from the Alvarado system, was present in 31.1% of patients. Although less frequently elicited, this sign has been shown to enhance diagnostic specificity when positive, and its inclusion may contribute to the improved performance of the RIPASA score [5,39].

The negative appendectomy rate of 15.6% in our series is within the range reported in contemporary literature. A systematic review by Basile et al. found that negative appendectomy rates varied from 5% to 25% across different populations and healthcare settings [21]. Notably, clinical scoring systems and preoperative imaging have been shown to reduce these rates significantly. Flum and Koepsell demonstrated that liberal use of diagnostic imaging reduced the negative appendectomy rate from 22% to 14% in a large population-based study [14]. In resource-limited settings where advanced imaging may not be universally available, validated clinical scoring systems assume particular importance as decision-support tools [22,40].

The Alvarado score demonstrated moderate sensitivity (60.5%) and specificity (57.1%) in our cohort, with a notably low NPV of 21.1%. These findings are concordant with those of Dezfuli et al., who reported comparable diagnostic accuracy of the Alvarado score in an Asian population [4]. Owen et al. similarly observed variable sensitivity of the Alvarado score, particularly in populations with diverse demographic characteristics [17]. The low NPV observed in our study implies that a substantial proportion of patients with Alvarado scores below the diagnostic threshold nevertheless harboured confirmed appendicitis, rendering the score unreliable as a tool for excluding the diagnosis [41].

In contrast, the RIPASA score demonstrated substantially higher sensitivity (78.9%), specificity (71.4%), PPV (93.8%), NPV (38.5%), and overall diagnostic accuracy (77.8%). These findings are consistent with the original validation study by Chong et al., who reported sensitivity of 98.0% and specificity of 81.3% for the RIPASA score in a Bruneian population [6]. Subsequent studies from the Indian subcontinent have reported similar trends. Nanjundaiah and Mohammed found RIPASA sensitivity of 96.2% and specificity of 90.5% in a series of 206 patients [37]. More recently, Din et al. reported RIPASA diagnostic accuracy of 95.1% in a Pakistani cohort of 389 patients [20].

The somewhat lower sensitivity observed in our study compared with the aforementioned reports may be attributable to differences in disease severity at presentation, patient selection criteria, inter-observer variability in clinical assessment, and sample size.

Additionally, our study included only patients who ultimately underwent surgery, which may have introduced selection bias by excluding conservatively managed cases that might have scored differently on the two systems [42].

ROC curve analysis further confirmed the superior discriminative ability of the RIPASA score (AUC = 0.80) compared with the Alvarado score (AUC = 0.62). This is consistent with the meta-analysis by Basile et al., which reported a pooled AUC for RIPASA that was consistently higher than for Alvarado across 35 included studies [21]. The improved ROC

performance of the RIPASA score can be attributed to its incorporation of additional demographic and clinical parameters—including age, gender, duration of symptoms, and Rovsing's sign—which collectively enhance its sensitivity and overall discriminatory power in Asian populations [5,43].
It is worth noting that neither scoring system demonstrated perfect diagnostic performance, and both should be regarded as adjuncts to, rather than replacements for, clinical judgment. The integration of clinical scoring with selective imaging and serial observation represents the optimal approach to minimizing diagnostic errors in suspected appendicitis [26,44]. Nonetheless, in emergency departments and resource-limited healthcare facilities where advanced imaging may be unavailable or impractical, the RIPASA score offers a demonstrably superior alternative to the Alvarado score for initial risk stratification [40,45].

LIMITATIONS

Several limitations of this study warrant acknowledgement. First, the sample size of 90 patients, although adequate for preliminary analysis, limits the generalizability of the findings and precludes robust subgroup analyses by age, sex, or disease severity. Second, the study included only patients who underwent surgical intervention, and those managed conservatively were excluded, which may have introduced selection bias and influenced the observed diagnostic performance. Third, imaging modalities were selectively applied rather than uniformly performed, which may have affected clinical decision-making in certain cases. Fourth, inter-observer variability in clinical examination findings could not be entirely eliminated. Finally, this was a single-centre study, and multi-centre validation is needed to confirm the applicability of these findings across diverse Indian populations [46].

CONCLUSION

The RIPASA scoring system demonstrated significantly superior diagnostic accuracy compared to the Alvarado score in this prospective case series from a South Indian tertiary care centre. Its higher sensitivity, specificity, predictive values, and overall discriminative ability, as evidenced by ROC analysis, support its adoption as the preferred clinical scoring tool for evaluating suspected acute appendicitis in Asian populations. Integration of the RIPASA score into emergency department protocols, in conjunction with selective imaging and clinical judgment, may facilitate earlier diagnosis, reduce negative appendectomy rates, and optimize patient outcomes, particularly in resource-limited healthcare settings [9,10].

DECLARATIONS

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Conflicts of Interest: The authors declare no conflicts of interest.

Ethical Approval: This study was approved by the Institutional Ethics Committee of Sree Balaji Medical College and Hospital, Chennai.

Informed Consent: Written informed consent was obtained from all participants.

Data Availability: The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

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