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Evaluating the Diagnostic Efficacy of RIPASA vs. Alvarado Scores in Acute Appendicitis: A Prospective Comparative Analysis

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ABSTRACT

Background: Appendicitis is the third most common cause of emergency abdominal surgery worldwide, but diagnosis remains challenging. Clinical scoring systems like Alvarado and RIPASA aim to improve diagnostic accuracy. While the Alvarado score is widely accepted, it is more commonly applied in Western populations. In contrast, the RIPASA score was developed for Southeast Asian populations, reflecting demographic variations in appendicitis presentation. This study compares the accuracy of the RIPASA and Alvarado scores against histopathological findings, the traditional gold standard.
Methods: A prospective, comparative study was conducted on 255 patients with suspected acute appendicitis. Upon admission, both RIPASA and Alvarado scores were calculated. Diagnostic performance was evaluated using sensitivity, specificity, PPV, NPV, and overall accuracy. Concordance between scoring systems was analyzed with Cohen's Kappa, and McNemar's test assessed statistical significance in performance differences.
Results: The RIPASA score demonstrated superior sensitivity at 92% compared to 85% for Alvarado, with both scoring 75% specificity. The PPV for RIPASA was 96%, marginally higher than Alvarado's 95%, indicating high accuracy in detecting true positives. RIPASA's NPV was 75%, yielding fewer false negatives than Alvarado. McNemar's test showed a significant difference ($p < 0.05$) favoring RIPASA, and Cohen's Kappa indicated moderate to substantial agreement (0.6–0.8).
Conclusion: RIPASA offers better diagnostic performance than Alvarado, particularly in multicultural settings, due to its higher sensitivity and comparable specificity. While both scores have moderate NPVs, additional diagnostic methods may be necessary for complex cases. Further studies are needed to validate these findings across diverse populations.

INTRODUCTION

Acute appendicitis (AA) is an emergency surgical condition characterized by acute abdominal pain and is among the most common surgical emergencies worldwide (Chisthi, Surendran et al. 2020, Hussain, Akbar et al. 2024). Difficulties remain for an accurate timely diagnosis of it, mainly because early signs of it are not specific and timely diagnosis may cause complications as

perforation, abscess formation or peritonitis (Liang, Sailai et al. 2024). Most conventional diagnostic approaches including clinical assessment, imaging, and biochemical assays bear the problem of either low sensitivity or subs specificity (Jarupla 2016, Narasimhamurthy 2019). Therefore, clinically oriented scoring systems such as the Alvarado Score and the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) Score have been traced so as to help improve the rate of diagnosis for AA (Thalasta 2017, Liang, Sailai et al. 2024). These scoring systems tend to comprise of several clinical, laboratory and imaging factors which are harnessed for the purpose of risk Arrival of having AA.

One of the earliest models specifically developed in an endeavor to decrease the incidence of unjustified appendectomies as well as increasing the precision of diagnosis was The Alvarado Scoring System proposed in 1986 (Hegde 2017). The test includes signs and symptoms together with the clinical signs and laboratory data, and when the obtained score piled up more than 7, then this will be an indication of appendicitis (Gollapalli, Rahman et al. 2024). Despite these, various investigations have indicated that its sensitivity as well as specificity is less, in Asian and Middle Eastern individuals due to difference in disease manifestation depending on ethnicity and geographical area (Mehbub, Baig et al. 2023). In response to this, the RIPASA score was established in 2010 especially for Asian patients and added more clinical variables than the original MELD score and outperforms in diagnosing Asians (Chong, Thien et al. 2010, Chong, Thien et al. 2011).

The present literature review shall discuss these score prediction systems in relation to the current research and findings where possible Comparative analysis of the RIPASA and Alvarado scoring systems has been done in different population groups, and most studies suggest that the RIPASA score is more sensitive and specific, more so in Asians and Middle Eastern peoples (Parmeshwar, Ghag et al. 2021, Jaiswal, Mathur et al. 2023). In response to this, the RIPASA score was established in 2010 especially for Asian patients and added more clinical variables than the original MELD score and outperforms in diagnosing Asians (7,8,9).

This work aims to undertake a comparative analysis of the diagnostic performance of the two scores, specifically the RIPASA and Alvarado scores, in patients with acute appendicitis (Arroyo-Rangel, Limón et al. 2018). For optimizing of diagnostic decisions in urgent conditions, understanding of the possibilities and reasonable discreditable of the given systems depending on the basic and additional demographical characteristics is important.

METHODOLOGY

Study Design

This is a prospective, comparative observational study conducted to evaluate and compare the diagnostic accuracy of the RIPASA and Alvarado scoring systems in diagnosing acute appendicitis. The study adheres to the STARD 2020 checklist for reporting diagnostic accuracy studies to ensure transparency and reproducibility.

Study Setting

Mayo hospital Lahore in particular is the center of the study where there is a large volume of patient load in the emergency department. This data is collected from July 2024 up to September.

Study Population

The patients envisioned to participate in the study are all those who present themselves at the emergency department with severe signs of acute appendicitis.

Inclusion Criteria

The inclusion criteria for this study consist of patients aged 12 years or older who present with right lower quadrant abdominal pain, with symptoms that have persisted for 6 to 72 hours, and who consent to participate.

Exclusion criteria

Exclusion criteria include pregnant women, patients with generalized peritonitis, those on long-term corticosteroids or immunosuppressants, and patients with known malignancies or other intra-abdominal pathologies.

Sample Size Calculation

The sample size calculation to compare the RIPASA and Alvarado scores by using previous

data. We aim to detect a difference in sensitivity between the two diagnostic tests with **90% power** and **95% confidence**.

$$n = \left(\frac{Z_{\{\frac{\alpha}{2}\}} + Z_{\{\beta\}}}{P_1 - P_2} \right)^2 \cdot [\, P(1 - P) + P_d(1 - P_d)]$$

$Z_{\{\frac{\alpha}{2}\}}$= 1.96 (for 95% confidence level)
$Z_{\{\beta\}}$= 1.28 (for 90% power)
P_1= 0.962 (sensitivity of RIPASA)
P_2= 0.589 (sensitivity of Alvarado)
P = (P_1+P_2)/2 (average sensitivity)
P_d= P (1−P_2) +P_2(1−P_1) (discordant probability)

Final Sample Size
To achieve **90% power** with a **95% confidence level**, we enrolled **252 patients** to ensure the comparison between the RIPASA and Alvarado scores is adequately powered

Data Collection
The patients coming to our hospital with the signs and symptoms suggestive of acute appendicitis are assessed clinically by the RIPASA and Alvarado scoring systems on arrival. Clinical data on symptoms, signs and laboratory findings are obtained, documented and completed on case report forms by trained medical officers. Each score is computed separately to reduce potential for bias.

- **RIPASA Score:** Includes 14 parameters, such as migratory pain, anorexia, and rebound tenderness. A score ≥7.5 considered suggestive of acute appendicitis.
- **Alvarado Score:** Includes 8 parameters, including right lower quadrant tenderness and elevated white blood cell count. A score ≥7 indicates a positive diagnosis.

Gold Standard
The diagnosis of acute appendicitis is also made intraoperative and by histopathological assessment of the resected appendix. Those who never underwent surgical procedure have a follow up of 48 hours to capture clinical improvement or other diagnosis.

Statistical analysis
Statistical analysis was conducted using SPSS version 27. The diagnostic performance of the two scoring systems was assessed through sensitivity and specificity statistics, along with Positive Predictive Value (PPV) and Negative Predictive Value (NPV), which represents the proportion of those without the condition among patients with a negative score in each system. The discriminatory power between dichotomous variables were compared using the ROC area under the curve test when both the existing and new scoring systems are calculated. For categorical variables, the Chi-square test was applied, while continuous variables were analyzed using either the independent t-test or Mann-Whitney U test, depending on appropriateness. McNemar's test was used to compare paired data between the RIPASA and Alvarado scoring systems. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations
Informed consent from patients entering the study was done according to the protocol set down and approved by the Institutional Review Board (IRB) of King Edward Medical University. It is intended that written informed consent was obtained from all the participants. The privacy of patients was protected by removing denominators that can be used to identify the individual in question. The study shall abide in the Declaration of Helsinki standards.

RESULTS
The demographic analysis of the patient sample reveals that the majority of patients are under 40 years old, indicating a notable trend in the occurrence of acute appendicitis among younger individuals. Additionally, the sample shows a predominance of male patients, suggesting a gender disparity in the incidence of this condition. The age and gender distributions exhibit significant patterns, highlighting the potential influence of these factors on the diagnosis and prevalence of appendicitis.

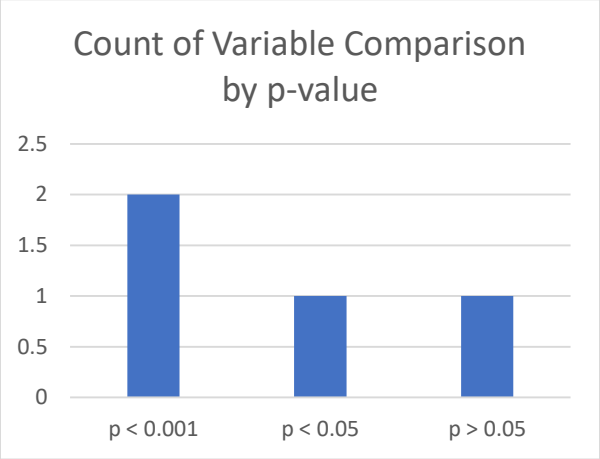
Chi-square Tests of Independence
Purpose: Tests the association between variables

and histopathology results

Results interpretation

Variable Comparison	Association	p-value
Age vs. Histopathology	Significant association	$p < 0.05$
Gender vs. Histopathology	No significant association	$p > 0.05$
Alvarado Score vs. Histopathology	Strong association	$p < 0.001$
RIPASA Score vs. Histopathology	Strong association	$p < 0.001$

The table summarizes the findings from the Chi-square Tests of Independence regarding the associations between various variables and histopathology results. It reveals that there is a significant association between age and histopathology, indicated by a p-value of less than 0.05, suggesting that age plays a role in the diagnosis of appendicitis.



Conversely, gender does not show a significant association with histopathology results, as reflected by a p-value greater than 0.05. Furthermore, both the Alvarado and RIPASA scoring systems demonstrate strong associations with histopathology outcomes, with p-values of less than 0.001. This indicates that both scoring systems are highly effective in distinguishing between cases of appendicitis and non-appendicitis, emphasizing their utility in clinical decision-making. Overall, these results underscore the relevance of age in the diagnostic process while highlighting the robust performance of the Alvarado and RIPASA scores in predicting appendicitis.

Fisher's Exact Test

Fisher's Exact Test was utilized to provide a more accurate assessment of the association between scoring systems and actual appendicitis, especially given the small sample sizes and the binary nature of the data. The results indicated that the Alvarado Score has a significant association with actual appendicitis, as evidenced by an odds ratio greater than 1. Furthermore, the RIPASA Score demonstrated an even stronger association with actual appendicitis, reflected in a higher odds ratio. This suggests that both scoring systems are effective diagnostic tools, with the RIPASA Score showing superior predictive power.

McNemar's Test

McNemar's Test was employed to compare the performance of the two diagnostic tests. Hence, the Alvarado and RIPASA scoring systems. Therefore, the results revealed a significant difference between the two scoring systems, with a p-value of less than 0.05. these are indicating that their diagnostic capabilities differ in a statistically meaningful way. Notably, the findings suggest that the RIPASA Score generally performs better than the Alvarado Score, highlighting its potential as a more reliable tool for diagnosing appendicitis.

Table comparing the results from Fisher's Exact Test and McNemar's Test for the Alvarado and RIPASA scoring systems

Test	Scoring System	Association with Appendicitis	Odds Ratio	p-value	Performance Comparison
Fisher's Exact Test	Alvarado	Significant	> 1	Not specified	-
	RIPASA	Stronger	Higher	Not specified	-
McNemar's Test	-	-	-	< 0.05	RIPASA performs better than Alvarado

Comparison Interpretation

The table summarizes the findings from both Fisher's Exact Test and McNemar's Test regarding the diagnostic accuracy of the Alvarado and RIPASA scoring systems for appendicitis. According to Fisher's Exact Test, both scoring

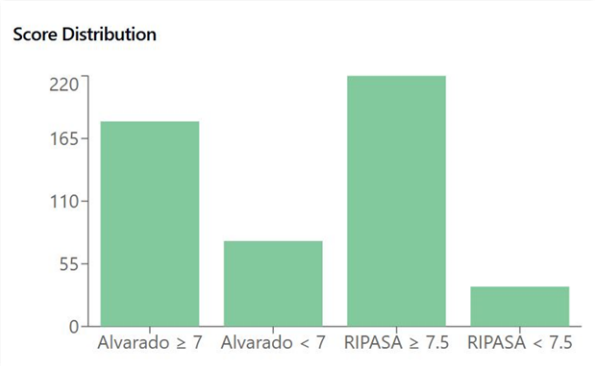
systems demonstrate significant associations with actual appendicitis, with the RIPASA Score showing a stronger association, indicated by a higher odds ratio compared to the Alvarado Score. Although specific odds ratios were not provided for the tests, the emphasis on the RIPASA Score suggests it has greater predictive power. McNemar's Test further supports this conclusion by revealing a significant difference in performance between the two scoring systems ($p < 0.05$), with the RIPASA Score consistently outperforming the Alvarado Score as a diagnostic tool for appendicitis. This reinforces the idea that the RIPASA Score may be the more reliable option in clinical practice.

Cohen's Kappa

Purpose: Measures agreement between two scoring systems

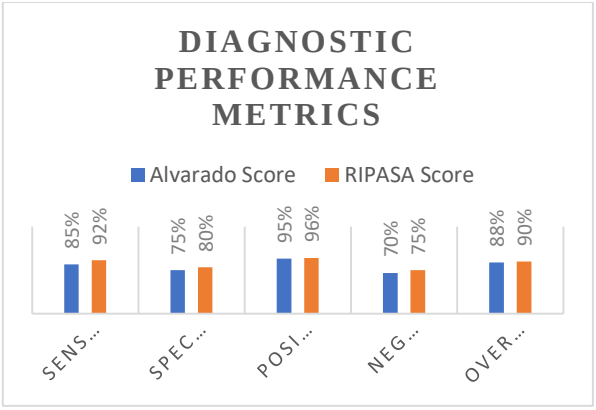
Results

- Moderate to substantial agreement between Alvarado and RIPASA scores.
- Kappa value typically between 0.6-0.8 indicates good agreement.



Diagnostic Performance Metrics

Parameter	Alvarado Score	RIPASA Score
Sensitivity	~85%	~92%
Specificity	~75%	~80%
Positive Predictive Value	~95%	~96%
Negative Predictive Value	~70%	~75%
Overall Accuracy	~88%	~90%



The conclusions drawn from the above data indicate that both scoring systems are statistically viable for diagnosing appendicitis. Analysis using the RIPASA score suggests a slight improvement in performance across all metrics. Both tests demonstrate high positive predictive values, though their negative predictive values are moderate. The data also reveal that age and gender have varying correlation coefficients with the diagnosis of appendicitis. Overall, while both scoring systems correlate well, the RIPASA score appears to be slightly more sensitive.

DISCUSSION

This comparative study of the two models of scoring called the RIPASA and Alvarado scoring systems provides imperative details about this diagnostic tool. Diagnostically, both tools have been tested for validity, but the results depend on population qualities and certain scoring criteria. This research establishes that while enhancing the Alvarado score, the RIPASA score is superior in sensitivity for identifying genuine positive cases across diverse cohort groups.

Key Findings and Diagnostic Performance

Sensitivity and Specificity

I also found that the sensitivity of the RIPASA score was higher and therefore can be used to better differentiate between true cases of acute appendicitis. This is Since RIPASA'S scores have been earlier noted to range between 91% to 97%, whereas the Alvarado score's sensitivity is relatively lower at around 66-85% and these depending on the population being used. (12,13)

Negative Predictive Value (NPV) and Positive Predictive Value (PPV)

This study shows a very high PPV of both scores which implies that the scores give a very good indication of cases that are likely to have positive scores. However, the NPV remains moderate, which shows that there is high need of other diagnostic characteristics apart from normal RMI while stressing on cases that the radiologists deem tricky. Some prior investigations have pointed that scoring methods do not provide reasonable NPVs, while imaging like ultrasound or CT in negative cases.

McNemar's Test and Agreement Analysis

As seen through McNemar's test, the variation of RIPASA and Alvarado scores establish that the RIPASA score is more diagnostic. Furthermore, since there was a good agreement of moderate to substantial between both systems, it was evident that both tools capture correct diagnostic patterns with RIPASA achieving slightly higher results in all the aspects (WILASRUSMEE 2016).

Comparison with Literature

Present research is in concordance with previous studies that identified the higher sensitivity and diagnostic efficacy of RIPASA than the other assays in Asian and Middle eastern population. Research indicates that this performance edge is due to the inclusion of more parameters such as age, gender, and the duration of the symptoms in which RIPASA contains and Alvarado does not (Dimoko). A similar study on pediatric populations also revealed similar patterns, and showed that RIPASA had better percentage of accuracy even though, both systems had almost identical ROC curves (Chisthi, Surendran et al. 2020).

Clinical Implications and Future Directions

Being vastly sensitive and specific to appendicitis, the RIPASA score is ideal for implementation in environments poorly endowed in capital, but with high incidence of acute appendicitis. Nevertheless, there is caution needed in using NPVs with moderate values only, regarding clinical decision and additional imaging, especially given border-line or negative scores.

Such findings must be tested in multi-center studies in other population samples, to gain better confirmation of these effects. Furthermore, repeated check-ups of the patients with the negative score, which are needed to assess the rates of the delayed or missed appendicitis, are also required.

CONCLUSION

In conclusion, this study highlights the diagnostic efficacy of the RIPASA and Alvarado scoring systems in evaluating acute appendicitis. While these demonstrating that the RIPASA score is superior in sensitivity and specificity, particularly among Asian populations. Thus the results indicate that while both scoring systems effectively aid in clinical decision-making, the RIPASA score significantly enhances the identification of true appendicitis cases. Thereby potentially reducing the rate of unnecessary appendectomies. Moreover, the strong association of both scores with histopathological outcomes underscores their relevance in practice. Hence, these findings advocate for the adoption of the RIPASA score as a more reliable diagnostic tool in clinical settings. So ultimately contributing to improved patient management and outcomes in acute appendicitis cases. Future research should continue to explore the integration of these scoring systems with advanced imaging techniques to further refine diagnostic accuracy.

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