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COMPARISON OF ALVARADO AND RIPASA SCORE IN DIAGNOSING ACUTE APPENDICITIS TAKING HISTOPATHOLOGY AS THE GOLD STANDARD

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Abstract

Background: *Acute appendicitis (AA) is a common presentation to the Emergency Department (ED). The diagnosis of AA has traditionally been clinical. As clinical assessment is subjective, there is a wide variation in admission rate, the extent of investigations, negative appendectomies, and delayed diagnosis with subsequent complications. To objectify this clinical diagnosis of AA, several clinical scoring systems have been introduced, of which RIPASA and ALVARADO have been most used in recent years. This study aims to compare the diagnostic accuracy of these two scoring systems in patients presenting to the ED with clinical features suggestive of AA who underwent appendectomy.*

Objective: *To compare the diagnostic accuracy of the ALVARADO and RIPASA scoring systems in identifying acute appendicitis, using histopathology as the gold standard.*

Materials & Methods: *A comparative prospective study was conducted from April to October 2023 in the ED of Combined Military Hospital, Rawalpindi. We applied the ALVARADO and RIPASA scores to 78 patients, aged over 15 years, who presented to the ED with atraumatic right iliac fossa pain, clinical suspicion of AA, and underwent appendectomy. The researcher scoring the patients, the surgeon deciding to operate, and the histopathologist were all blinded to each other's assessments. A RIPASA score ≥7.5 while an ALVARADO score of ≥7 considered positive for acute appendicitis. Histological diagnosis of AA was used as the reference standard and was correlated with the two scoring systems. Sensitivity, specificity and diagnostic accuracy were calculated using standard formula.*

RESULTS: *Of the 78 patients in the study, 59% (n=46) were male and 41% (n=32) were female. Histopathology showed that 65 patients (83.3%) had an inflamed appendix. In contrast, 69 patients (88.5%) had a high RIPASA score, and 67 patients (85.9%) had a high ALVARADO score. The sensitivity of the ALVARADO score was 98.5% with a specificity of 61.5%. On the other hand, diagnostic metrics for the ALVARADO score showed a sensitivity of 95.4% and specificity of 61.5%. Overall diagnostic accuracies for RIPASA and ALVARADO scores were found as 92.3% and 89.74% respectively.*

CONCLUSION: *The findings of our study suggest that both scoring systems are effective diagnostic tools, with the RIPASA score showing a marginally higher diagnostic accuracy. These findings are consistent with current evidence.*

INTRODUCTION

An acute inflammation of the vermiform appendix, known as acute appendicitis (AA), is most caused by blockage of the appendix's lumen (by fecalith, regular stools, infectious agents, or lymphoid hyperplasia)[1]. AA can result in serious side effects such as sepsis or perforation, and can even be fatal, if left untreated [2]. A study found that common complications of AA included perforation of the appendix (35%), appendicular abscess (25%) and gangrenous appendix (7%)[3].

AA usually manifests as mild-to-severe vague abdominal discomfort that eventually localizes to the lower right quadrant (RLQ) or right iliac fossa (RIF) [4,5]. Fever, anorexia, nausea, vomiting, and an elevated neutrophil count are often associated with AA [4,5]. The diagnosis of AA has traditionally been clinical. However, due to its varied clinical presentation, AA can be challenging for clinicians to diagnose timely, especially in the Emergency Department (ED). As clinical assessment is subjective, there is a wide variation in admission rates, extent of investigations, negative appendectomies and delayed diagnosis with subsequent complications [6]. To objectify this clinical diagnosis of AA, several clinical scoring systems have been introduced to aid prompt diagnosis of AA, avoiding unnecessary admissions and investigations[6,7]. These scoring systems perform better than subjective clinical judgment alone because they offer a methodical and objective way to identify AA [6,7]. Of the several scoring systems, RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) and ALVARADO (Dr. Alfredo Alvarado) have been most used in recent years [8,9]. Points are awarded by these scoring systems according to specific clinical traits and test outcomes[10]. The total sum of these points suggests the likelihood of a clinical diagnosis of AA. In general, a high score corresponds to an increased likelihood of AA. While the various scoring systems suggest a clinical diagnosis, histology remains the gold standard for confirming diagnosis of AA[11].

ALVARADO Score:

A popular scoring system since 1986, the ALVARADO Score is a clinical scoring system used to assess the likelihood of acute appendicitis in patients presenting with abdominal pain[12]. It helps guide decisions on further diagnostic imaging or surgical intervention. The score is based on clinical signs, symptoms, and laboratory findings. Each component is awarded specific points (Table 1) with a maximum total score of 10[12]. The higher the score, the greater the probability of AA (Table 1) [12].

- **Score 1-4**: Low probability of appendicitis; consider alternative diagnoses or observe [12].
- **Score 5-6**: Intermediate probability; consider further imaging (e.g., ultrasound, CT scan) [12].
- **Score 7-10**: High probability; surgical consultation is recommended, as appendicitis is likely[12].

RIPASA Score:

RIPASA is another clinical scoring system developed to diagnose AA, particularly in populations where the ALVARADO Score may not perform well[13]. It incorporates a broader range of clinical signs, symptoms, and demographic data [13], that are assigned points, with a maximum total score of 17.5 (Table 1) [13]. The scores are interpreted as follows:

- **Score <7.0**: Low likelihood of appendicitis; conservative management advised[13].
- **Score 7.5–11.5**: Intermediate likelihood; further evaluation or imaging may be needed[13].
- **Score ≥12.0**: High likelihood of appendicitis; surgical intervention is recommended [13].

Scoring systems like the RIPASA and ALVARADO, provide a standardized approach to identifying low-risk cases, helping to avoid over-investigation and reduce the negative appendectomy rates [14,15]. The RIPASA score is more comprehensive than the ALVARADO score, as it considers additional factors like age, gender, and the length of symptoms before presentation[15]. It has been demonstrated that these additional factors contribute to higher specificity and sensitivity of the RIPASA score over the ALVARADO score [16].

This study aims to compare the diagnostic accuracy of the ALVARADO and RIPASA scores by applying both scoring systems to all patients presenting to the ED with clinically suspected AA who underwent appendectomy. This approach seeks to identify a more accurate scoring method for clinically predicting AA and reducing the rate of negative appendectomies. We evaluated specificity, sensitivity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy to achieve this objective.

Table 1: Table comparing the ALVARADO and RIPASA scoring systems

Assessment / Clinical Parameter		Alvarado[12] Score	RIPASA[13] Score
Demographic Features	Gender	NA	Male: 1
			Female: 0.5
	Age (in Years)	NA	< 39.9: 1
			>40: 0.5
	Ethnicity	NA	Western: 1
Symptoms	Pain in RIF	NA	0.5
	Migratory Pain to RIF	1	0.5
	Anorexia	1	1
	Nausea / Vomiting	1	1
	Duration	NA	< 48 hrs: 1
			>48 hrs: 0.5
Signs	RLQ / RIF tenderness	2	1
	Abdominal Guarding	NA	2
	Rebound tenderness (Blumberg's Sign)	1	1
	Rovsing's Sign	NA	2
	Temperature > 37.3^{0}C	1	1
Diagnostic Investigations	Leukocytosis > 10,000 / mm^3	2	1
	Neutrophil Count > 75%	1	NA
	Negative urinalysis	NA	1
Max Total Score		**10**	**17.5**
Interpretation of Results[14]	AA is not possible (Excludes AA)	NA	< 5
	Low probability of AA	1 – 4	5 - 7
	Intermediate probability of AA (requiring further investigation)	5 - 6	NA
	High probability of AA	7 - 10	7.5 – 11.5
	Absolutely AA	NA	>12

KEY: NA (not applicable); RIF (Right iliac fossa); RLQ (Right lower quadrant of the abdomen); Rovsing's Sign (Right lower abdominal pain elicited by palpation of the left lower abdomen); AA (Acute appendicitis)

MATERIALS AND METHODS

A prospective comparative study was conducted from April to October 2023 in the ED of Combined Military Hospital (CMH), Rawalpindi. This is a large, 1100-bed tertiary care teaching hospital with an annual ED attendance of over 200,000 patients. CMH is primarily a surgical hospital where multiple surgeries are performed daily across various specialties. A significant proportion of these procedures involve appendectomies. Ethical approval was secured from the institution before the start of the study and informed written consent was obtained from all the patients included in the study. All patients presenting to the ED for the duration of the study with atraumatic abdominal pain were screened for suitability. Only patients aged 15 years or more, with clinical suspicion of AA who underwent appendectomy, were enrolled in the study. For this study, clinical suspicion for AA was defined as acute abdominal pain within 72 hours, localized to the RIF. Both male and female non-Western patients were included. The following groups were excluded from the study: pregnant females, patients with a history of previous appendectomy, those with pre-arrival radiological confirmation of AA or an alternate diagnosis, patients who did not provide consent, septic patients with acute abdomen of unknown etiology, and complex patients involving multiple previous surgeries or chronic abdominal diagnoses such as Crohn's disease, irritable bowel and abdominal malignancies or abdominal metastases. A sample size of 78 patients was determined for the study using the sensitivity, specificity sample size calculator with a confidence interval of 95%, margin of error of 5 % and a prevalence of 93.8%, sensitivity and specificity of RIPASA score as 98.3% and 100% respectively as determined by Khan HAQ et al.[17] non-probability convenience sampling was used, and all patients meeting the inclusion criteria during the study period were included. Both AVARADO and RIPASA scores were calculated for each participant in the study. A RIPASA score ≥7.5 while an ALVARADO score of ≥7 considered positive for acute appendicitis. Data on demographic characteristics, clinical presentation, laboratory findings, and all variables required for the two scoring systems, as detailed in Table 1, were collected by the ED physicians in real-time using a specially designed proforma, upon patient presentation to the ED (Annexure 1). The researchers were unaware of the decision to operate during this data collection. Similarly, the operating surgeons and histopathologists were independent and unaware of the scoring results. Data were collected using questionnaires by resident emergency medicine (REM) in the ED as the patient presented. Scores obtained from both the ALVARADO and RIPASA systems were also recorded. The data was entered and analyzed using Statistical Package for Social Sciences (SPSS) version 20. Frequencies and percentages were calculated for age, gender and scores. We evaluated sensitivity (true positive rate), specificity (true negative rate), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy to achieve this objective.

RESULTS

A total of 78 patients, aged 15 to 45 years, were enrolled in the study with a mean age of 28.3 years. The majority (60.2%) were in the 20 to 40-year age range (Figure 1). Specifically, 25.6% (n=20) were aged10–20 years, 34.6% (n=27) were aged 20–30 years, and 25.6% (n=20) were aged 30–40 years. The smallest proportion, 14.1% (n=11), comprised patients aged 40–50 years. The gender distribution in our population was 59% male (n=46) and 41% female (n=32).

Of the 78 patients, 75 (96.1%) reported experiencing RIF pain with 64.1% (n=50) also reporting migratory pain. Anorexia was present in 74.3% of the patients, and 78.2% exhibited nausea or vomiting. In 57.6% of the patients, the duration of symptoms was less than 48 hours. The majority (94.8%) showed RIF tenderness and 56.4% had associated guarding. Rebound tenderness was present in 75.6% of patients, and 50% tested positive for Rovsing's sign. Fever was recorded in 61.5% of the cases. Raised white blood cell counts (WBCs) were noted in 87% of the patients, while 83% had negative urinalysis, suggesting that urinary tract infections (UTI) were

not a significant contributor to the clinical presentation (Figure 2).

Diagnostic findings of histopathology showed that 65 patients (83.3%) had an inflamed appendix. In contrast, 69 patients (88.5%) had a high RIPASA score, and 67 patients (85.9%) had a high ALVARADO score (Table 2). Sensitivity and specificity of RIPASA score was 98.5% and 61.5% respectively; while these values were 95.4% and 61.5% for ALVARADO score. The overall diagnostic metrics for the two scoring systems are further detailed in Table 3. These results indicate that sensitivity and overall diagnostic accuracy are lower for ALVARADO score compared to the RIPASA score. However, findings suggest that both scoring systems are reasonably effective diagnostic tools, with the RIPASA score showing a marginally higher accuracy. Gender based stratification of RIPASA and ALVARADO scores are presented in Figure 3.

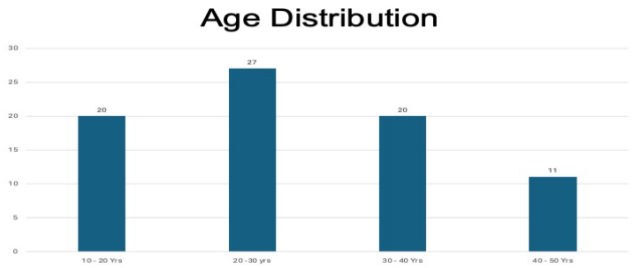

Figure 1: Age distribution of study population

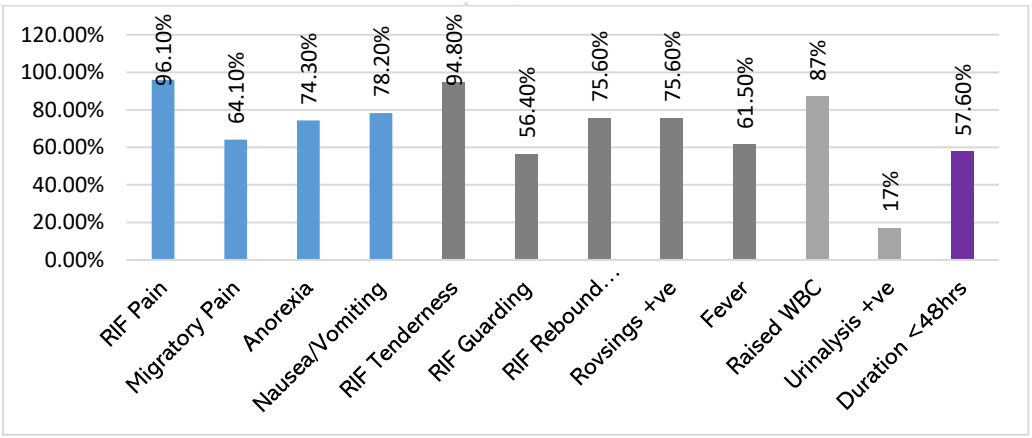

Figure 2: Clinical features of patients included in the study

Table 2: Overall results of RIPASA, ALVARADO and histopathology in diagnosis of acute appendicitis

Acute Appendicitis	RIPASA	ALVARADO	Histopathology
Positive	69 (88.5%)	67 (85.9%)	65 (83.3%)
Negative	09 (11.5%)	11 (14.1%)	13 (16.7%)
Total	78 (100%)	78 (100%)	78 (100%)

Table 3: Diagnostic Yield for RIPASA and ALVARADO Scores for diagnosis of acute appendicitis, with respect to histopathology report

Acute Appendicitis on RIPASA Score	Acute Appendicitis on Histopathology		
	POSITIVE	NEGATIVE	TOTAL
POSITIVE	64 (True Positives)	05 (False Positives)	69

NEGATIVE	01 (False Negatives)	08 (True Negatives)	09	
Total	65	13	78	
Sensitivity	Specificity	Accuracy	PPV	NPV
98.5%	61.5%	92.3%	92.8%	88.9%
Acute Appendicitis on ALVARADO Score	Acute Appendicitis on Histopathology			
	POSITIVE	NEGATIVE	TOTAL	
POSITIVE	62 (True Positives)	05 (False Positives)	67	
NEGATIVE	03 (False Negatives)	08 (True Negatives)	11	
Total	65	13	78	
Sensitivity	Specificity	Accuracy	PPV	NPV
95.4%	61.5%	89.74%	92.50%	72.70%

KEY: PPV (positive predictive value), NPV (negative predictive value)

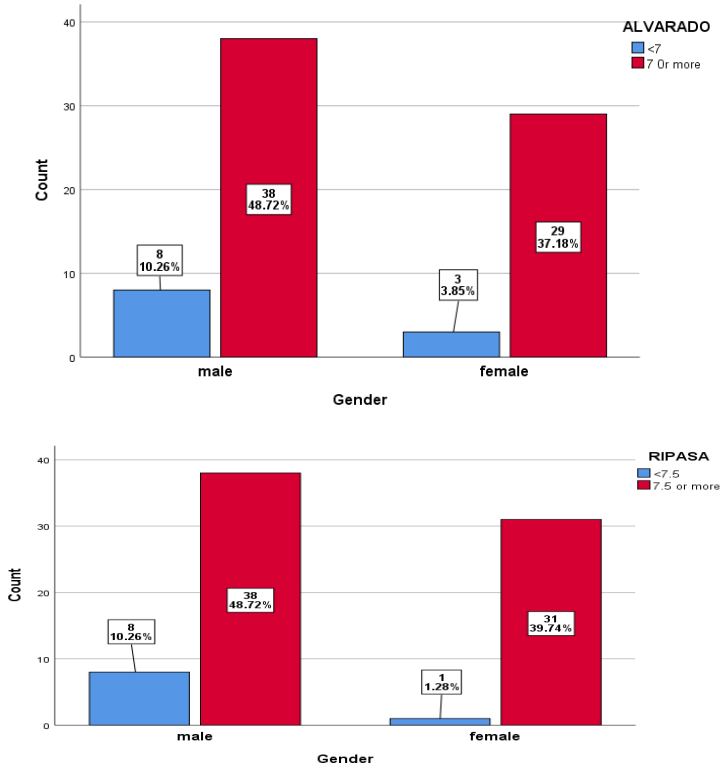

Figure 3: Gender-based comparison of ALVARADO & RIPASA Score

DISCUSSION

The diagnosis of AA remains a significant clinical challenge, with the need for prompt and accurate diagnosis to prevent complications [5]. The diagnostic process has benefited from the application of clinical scoring systems such as the RIPASA and ALVARADO scores. Using histology as the gold standard, this study sought to assess the diagnostic accuracy of the RIPASA and ALVARADO ratings. Our findings indicate that in comparison to the ALVARADO score, the RIPASA score exhibits better diagnostic performance. Specifically, the

RIPASA score showed a higher sensitivity, highlighting its greater ability to correctly identify patients with AA. This is consistent with earlier research that reported RIPASA score to be more sensitive[16]. For instance, a study by Poillucci et al. found RIPASA sensitivity at 90.9%, specificity at 63.3%, and diagnostic accuracy at 87.3%[18]. Additionally, the AUC for RIPASA was higher (0.851) than Alvarado (0.766), in the same study which is consistent with the findings of our findings [17]. The findings of our study also echo those of a study conducted on Pakistani patients, which reported a RIPASA sensitivity of 95.8% and an accuracy of 95.12%, compared to the ALVARADO score, which had a sensitivity of 71.1% and an accuracy of 71.46% [10].

The applicability of the RIPASA score to a wide range of populations is one of its main advantages. The ALVARADO score was created using data from Western populations, whereas the RIPASA score was intended to be more broadly applicable by accounting for differences in clinical presentation and demographic traits[8]. In support of this, our analysis demonstrates that in our cohort, which comprised a sizable percentage of non-Western patients, the RIPASA score retains its diagnostic accuracy.

The RIPASA score is more difficult to utilize and takes longer than the ALVARADO score, despite its benefits. Because of its simplicity and usability, the ALVARADO score is a useful tool when making quick decisions in emergency situations. But it is important to weigh the trade-off between ease of use and diagnostic precision, particularly in situations when a mistaken diagnosis could have serious consequences [19].

The gold standard for definitive diagnosis, histopathology, is only available after surgery. Clinical grading systems are therefore still essential for preoperative evaluation. Our study emphasizes the importance of using a reliable and accurate clinical scoring method in the management of AA.

Strengths and Limitations:

A key strength of our study is that the emergency clinicians scoring the patients, the surgeons performing the surgeries, and the histopathologists were all blinded to each other's findings, ensuring a high-quality, blinded study and minimizing the risk of bias. However, a limitation is that this is a single-center study with a relatively small sample size, which may not fully represent the broader population.

CONCLUSION

The RIPASA score outperforms the ALVARADO score in terms of diagnostic performance, demonstrating higher sensitivity and specificity for diagnosing AA in the ED. When selecting a scoring system, factors such as patient demographics, the clinical setting, and the resources at hand should all be taken into consideration. To further enhance diagnostic precision and improve outcome, future could explore the potential of integrating these scoring systems with imaging modalities.

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