

COMPARISON OF DIAGNOSTIC ACCURACY OF ALVARADO SCORE AND RIPASA SCORING SYSTEM IN DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT

BACKGROUND: Acute appendicitis is one of the most common surgical emergencies, frequently presenting with abdominal pain, often located in the right lower quadrant (RLQ). Despite its prevalence, diagnosing acute appendicitis remains challenging due to the variability in clinical presentation and the anatomical heterogeneity of the appendix.

OBJECTIVE: To compare the diagnostic accuracy of ALVARADO and RIPASA scoring systems in the diagnosis of acute appendicitis, keeping histopathology as the standard reference.

METHODOLOGY: This cross-sectional comparative validation study was conducted at CMH Rawalpindi from July 1, 2023, to December 31, 2023, and included 61 patients who met the inclusion criteria. ALVARADO and RIPASA scores were calculated pre-operatively in patients following laparoscopic appendectomy. The removed appendix was then sent for histopathological diagnosis. A 2x2 table was drawn for calculating diagnostic accuracy parameters. Data was analyzed by the Statistical Package for Social Sciences version 20.

RESULTS: In comparison to histopathological assessment, the accuracy, sensitivity, specificity, positive predictive value, and negative predictive value of RIPASA score to diagnose acute appendicitis was 91.80%, 95.65%, 80.00%, 93.62%, and 85.71% while for ALVARADO score these values were 85.25%, 91.30%, 66.67%, 89.36%, and 71.43%, respectively

CONCLUSION: The accuracy of the RIPASA scoring system is higher as compared to the ALVARADO score in diagnosing acute appendicitis.

KEY WORDS: ALVARADO score, Appendicitis, Appendectomy, Diagnostic accuracy, RIPASA score.

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INTRODUCTION:

During the process of surgical removal of the diseased appendix, surgeons frequently discover significant anatomic heterogeneity in the appendix's length and location, even though it is usually situated just below the cecum.¹ Previously, this component of the gastrointestinal system was considered an unnecessary anatomical structure. However, current research has revealed that it contains a significant quantity of bacteria and immune cells, which can significantly influence gastrointestinal function, immunity, and the development and advancement of various medical conditions.^{2,3} Acute appendicitis is a surgical condition that can manifest when the lumen of the appendix gets obstructed, leading to the onset of an acute phase of inflammation that can be triggered by various factors, including infestation of the appendicular lumen by parasites, abnormal enlargement of the lymph nodes, dislodgement of fecoliths and malignancy.^{4,5}

Many patients approach the emergency room complaining of lower abdominal pain, especially located in the right lower quadrant which may or may not have started near the umbilical region of the abdomen and the most common underlying diagnosis in such cases, particularly in younger populations is

acute appendicitis.⁶ The clinical diagnosis of acute appendicitis poses challenges because to the necessity for physicians to gather information from multiple sources, such as medical history, test results, and imaging studies. Numerous basic scores, including as the ALVARADO score, AIS score, RIPASA score, AAS score, and others, have been employed in the endeavor to diagnose acute appendicitis clinically, however, none of these scores have garnered general acceptance as a definitive diagnostic approach.^{7,8} The major reason for not relying completely on the clinical scores lies in the fact that, in many cases where, clinical assessment completely suggests the presence of an inflamed appendix warranting its surgical removal, yet when the patient is surgically explored and the appendix is isolated, surgeon discovers it to be completely normal without any inflammation resulting in negative appendectomy.⁹ In fact, it has been reported in previous literature that on a global scale, the chances of a patient undergoing an operation for surgically removing the appendix when it is not inflamed at all, i.e., a negative appendectomy, can escalate to as high as 46%, making it a major concern.⁹

For this purpose, computed tomography (CT) of the abdomen has been extensively employed in clinical settings to make a definitive diagnosis of "acute appendicitis" due to its notable accuracy rate

of 95.6% in facilitating this diagnosis.¹⁰ Nevertheless, the gold standard for establishing a conclusive diagnosis of acute appendicitis involves doing a histological evaluation of the excised appendicular specimen by a specialist histopathologist that makes the diagnosis of presence of inflammation in the excised appendicular specimen by direct visualization and evaluation of the tissue.¹¹

In Pakistan, however, access to advanced diagnostic modalities (like the CT scan) is limited to either those patients who live in the big cities where tertiary care hospitals are equipped with such radiological machinery or to the individuals who can afford private health care. Owing to this limited access to modern healthcare services such as CT scans, it is crucial to explore different approaches that can enhance the diagnostic capabilities of surgeons who do not have access to advanced investigation services that can help prevent unnecessary surgeries and decrease the occurrence of negative appendectomies. In such situations, surgeons thus have to rely on clinical scores, amongst which ALVARADO and RIPASA scores are commonly used. ALVARADO score is a 10-point score having parameters including left shift (> 75% neutrophils), > 10,000/mm³ white cells, pain migration to right lower quadrant (RLQ), nausea/vomiting, anorexia, rebound tenderness, elevated temperature and RLQ tenderness. RIPASA score is a 15-point score, and its parameters include age, gender, right iliac fossa (RIF) pain, pain migration to RIF, nausea/vomiting, anorexia, duration of symptoms, RIF tenderness, RIF rebound tenderness, RIF guarding, Rovsing's sign, fever, raised white count and negative urinalysis. Therefore, finding the most effective scoring system that can effectively diagnose acute appendicitis clinically is essential. The present study determined which of the aforementioned scores has better diagnostic accuracy in diagnosing acute appendicitis.

METHODOLOGY:

This comparative cross-sectional validation study was conducted at CMH, Rawalpindi, from 1st July 2023 to 31st Dec 2023 after obtaining approval from the institutional ethical review board. Appropriate sample size was calculated using the WHO sample size calculator for single population proportions with specified absolute precision using the following formula:

For the calculations, the following assumptions were made: a confidence level of 95%, an absolute precision of 4.5%, and an anticipated sensitivity of 96.7% for the RIPASA score in diagnosing acute appendicitis.¹² This gave us a sample size of 61.

All patients who were aged 14 years or above, both male and female gender, who presented with classical pain in RUQ with tenderness and rebound tenderness were included in this study. Patients who were unfit to undergo surgery already had an appendectomy, those requiring emergency appendectomy due to appendiceal perforation, and those for which an alternative diagnosis was made for abdominal pain were excluded from the study.

Patients were selected by using a non-probability consecutive sampling technique. Once selected, all the baseline characteristics, including age (in years), gender, and duration of symptoms (in hours), were documented. All the patients were subjected to standard pre-operative assessment protocol through a set of blood tests and basic radiology. After explaining the study's purpose, informed consent was presented to patients (parents in case of minors) to get signatures for assuring their official consent of participation in the study and for surgery. After those two, researchers assessed patients separately for each score. ALVARADO score is a 10-point score having parameters including left shift (> 75% neutrophils), > 10,000/mm³ white cells, pain migration to right lower quadrant (RLQ), nausea/vomiting, anorexia, rebound tenderness, elevated temperature and RLQ tenderness. RIPASA score is a 15-point score, and its parameters include "age, gender, right iliac fossa (RIF) pain, pain migration to RIF, nausea/vomiting, anorexia, duration of symptoms, RIF tenderness, RIF rebound tenderness, RIF guarding, Rovsing's sign, fever, raised white count and negative urinalysis. One researcher assessed the patient and calculated the ALVARADO score, and a score of ≥ 7 was considered diagnostic of acute appendicitis.¹³ Once the first researcher finished their assessment, the second researcher assessed the same patient and calculated the RIPASA score and a score of ≥ 7.5 was considered diagnostic of acute appendicitis.¹⁴ After this, all these patients underwent laparoscopic removal of the appendix by the same surgical team as per the standard 3-port technique led by a consultant surgeon with a minimum of two years of experience. The removed appendix was sent for histopathological assessment to the pathology department, where a consultant pathologist made the histopathological diagnosis of acute appendicitis. Based on these results, a 2x2 contingency table was drawn for each score, which was then used to calculate sensitivity (SN), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), and accuracy of ALVARADO score and RIPASA score in the diagnosis of acute appendicitis with histopathological finding as reference standard.

Data was analyzed by using Statistical Package for Social Sciences (SPSS) 20.00. The normality of data was checked by the Shapiro-Wilk test. Quantitative data (age and duration of symptoms) were presented as mean \pm standard deviation (SD). Quantitative data (gender, presence of ALVARADO score ≥ 7 , presence of RIPASA score ≥ 7.5 , and histopathological diagnosis of acute appendicitis) was represented by using percentage and frequency. Based on standard formulas, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of both scores were calculated.

Ethical approval with reference no.565 was obtained from the Hospital Research and Ethical Committee (IREB) of Combined Military Hospital, Rawalpindi on 1/07/23.

RESULTS

Our study included 61 patients. The mean age was 19.13 ± 3.71 years. There were 41 (67.21%) males and 20 (32.79%) were females. The mean duration of symptoms was 5.70 ± 1.85 hours. A summary of these pre-operative parameters is shown in Table 1.

Table 1: Pre-operative baseline characteristics of patients (n = 61)

Parameter	n (%)
Mean age	19.13 ± 3.71 years
Gender	
Male	41 (67.21%)
Female	20 (32.79%)
Mean duration of symptoms	5.70 ± 1.85 hours

Frequency of patients who were found to have ALVARADO score ≥ 7 was 47 (77.05%) while total number of patients who were found to have “acute appendicitis diagnosis on histopathology” was 46 (75.41%). The number of patients who had both an ALVARADO score ≥ 7 as well as an acute appendicitis diagnosis on histopathology was 42 (68.85%) **[True Positive (TP)]**, while those who had ALVARADO score ≥ 7 but did not have an acute appendicitis diagnosis on histopathology were 5 (8.20%) **[False Positive (FP)]**. Similarly, patients who did not have an ALVARADO score ≥ 7 but had acute appendicitis diagnosis on histopathology were 4 (6.56%) **[False Negative (FN)]**, while those who neither had ALVARADO score ≥ 7 nor diagnosis of acute appendicitis diagnosis on histopathology were 10 (16.39%) **[True Negative (TN)]** as shown in Table 2.

Table 2: 2x2 Contingency Table of ALVARADO score for True Positive, True Negative, False Positive and False Negative (n = 61)

	Acute appendicitis on histopathology	No acute appendicitis on histopathology
ALVARADO score ≥ 7	42 (TP)	5 (FP)
ALVARADO score < 7	4 (FN)	10 (TN)

The frequency of patients who were found to have an RIPASA score ≥ 7.5 was 47 (77.05%), while the total number of patients who were found to have acute appendicitis diagnosis on histopathology was 46 (75.41%). The number of patients who had both RIPASA score ≥ 7.5 as well as acute appendicitis diagnosis on histopathology was 44 (72.13%) **[TP]**, while those who had RIPASA score ≥ 7.5 but did not have acute appendicitis diagnosis on histopathology were 3 (4.92%) **[FP]**. Similarly, patients who did not have RIPASA score ≥ 7.5 but had acute appendicitis diagnosis on histopathology were 2 (3.28%) **[FN]**, while those who neither had “RIPASA score ≥ 7.5 nor diagnosis of acute appendicitis diagnosis on histopathology were 12 (19.67%) **[TN]** as shown in Table 3.

Table 3: 2x2 Contingency Table of RIPASA score for True Positive, True Negative, False Positive, and False negative (n = 61)

	Acute appendicitis on histopathology	No acute appendicitis on histopathology
RIPASA score ≥ 7.5	44 (TP)	3 (FP)
RIPASA score < 7.5	2 (FN)	12 (TN)

Based on the formulas mentioned above, we found that accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of RIPASA score to diagnose acute appendicitis were 91.80%, 95.65%, 80.00%, 93.62%, and 85.71%, while for ALVARADO score these values were 85.25%, 91.30%, 66.67%, 89.36%, and 71.43%, respectively. These findings are shown below in Table 4.

Table 4: Sensitivity, Specificity, PPV, NPV, and accuracy of ALVARADO score and RIPASA score in the diagnosis of acute appendicitis with histopathological finding as the reference standard (n = 61)

	ALVARADO score	RIPASA score
Sensitivity [TP/TP+FN x 100]	91.30%	95.65%
Specificity [TN/FP+TN x 100]	66.67%	80.00%
PPV [TP/TP+FP x 100]	89.36%	93.62%
NPV [TN/FN+TN x 100]	71.43%	85.71%
Accuracy [TP+TN/TP+TN+FP+FN x 100]	85.25%	91.80%

DISCUSSION

Approximately one hundred cases per 100,000 persons have acute appendicitis, making it a common surgical complication seen in emergency rooms around the world.^{15,16} When a patient develops one of the complications of this disease, such as a perforation of the appendix, despite being a highly benign condition itself, it becomes associated with a high risk of both mortality and morbidity.^{17,18} To avoid this, it is crucial to guarantee timely identification and immediate management in order to prevent the possible consequences of a typically harmless condition known as acute appendicitis. When a choice is taken to surgically remove an acutely inflamed appendix based on the clinical signs and symptoms, there is a significant increase in the rates of negative appendectomies which means that the appendix is discovered to be uninflamed following removal, with recorded incidences reaching as high as 39%.^{19,20} This results in the unnecessary exposure of a patient to surgical procedures, which inherently entail a multitude of adverse health outcomes. In order to mitigate this issue, one approach is to subject patients to sophisticated radiological examinations such as CT scans, which are associated with radiation exposure and higher healthcare expenses. In addition, the utilization of clinical scores, such as the ALVARADO score and RIPASA score, can serve as a means to enhance the dependability of clinical diagnosis. Present study focused on comparing the diagnostic ability of these two scores in effectively diagnosing acute appendicitis.

In this study, average age of patients was 19 years with majority of patients being males which corresponds with the fact that acute appendicitis occurs mostly in younger male population.²¹ In present study, RIPASA score had relatively higher values of diagnostic parameters as compared to ALVARADO score in making diagnosis of acute appendicitis. Sensitivity of RIPASA score in present study was 95.65% while of ALVARADO score it was 91.30% showing the difference to be relatively comparable. Compared to this, Akbar et al.²² reported sensitivities of RIPASA score at 98.02% while of ALVARADO score it was 53% showing a high degree of variability between the sensitivity of these two scores. In comparison to present study, Majid et al.²³ did report

RIPASA score to have higher accuracy to diagnose acute appendicitis as compared to ALVARADO score but the reported accuracy of both the scores was much less compared to present study. Contrary to present study, approximately similar values of diagnostic accuracy of RIPASA score and ALVARADO score were reported in a study conducted by Aslam et al.²⁴ who reported these values at 98.08% and 97.88%, respectively.

Based on the results obtained from the present study, it is strongly advocated to utilize the RIPASA score as a highly dependable diagnostic tool for clinically identifying acute appendicitis and determining the appropriate course of action for early surgical intervention in its treatment. This intervention has the potential to not only decrease the incidence of negative appendectomies but also mitigate the avoidable exposure of patients to radiation and the associated financial burden of CT scans. The limitations of this study included its single-center design, small sample size, and short study duration.

CONCLUSION

RIPASA scoring system is a better clinical scoring system with a relatively higher accuracy of 91.80% as compared to the ALVARADO score with an accuracy of 85.25% in diagnosing acute appendicitis when the histopathological assessment of removed appendix is kept as a reference standard. Given its higher accuracy, the RIPASA scoring system should be considered the preferred tool for evaluating patients with suspected acute appendicitis, particularly in settings with limited access to advanced imaging. It is recommended that healthcare professionals be trained in the application of RIPASA to ensure consistent use across clinical settings, and further research with larger, diverse populations is needed to validate its broader applicability. While RIPASA alone offers high diagnostic reliability, its use in combination with imaging techniques may still be beneficial in uncertain cases. Lastly, clinical guidelines should be updated to incorporate RIPASA as a primary diagnostic tool in the management of acute appendicitis.

Conflict of Interest Statement

The authors declare no conflict of interest related to this publication.

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- C. Manuscript writing
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All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved



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