# A Comparative Study of RIPASA Score and Alvarado Score in Diagnosis of Acute Appendicitis

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## ABSTRACT

**Objective:** To compare the diagnostic accuracy of the RIPASA and the Alvarado scoring systems for the detection of acute appendicitis in symptomatic patients, taking histopathological findings as the gold standard.

**Study Design:** A cross-sectional, validation study.

**Place and Duration of the Study:** Department of General Surgery, Azra Naheed Medical College, CMA Hospital, Lahore, Pakistan, from May to November 2024.

**Methodology:** After meeting the selection criteria, a total of 150 patients were enrolled. Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Alvarado scores were calculated for each patient. Patients were labelled as positive or negative according to their respective scores. Meanwhile, patients underwent the appendicectomy procedure. The appendix was sent for histopathology for confirmation of diagnosis as acute appendicitis. Diagnostic accuracy of RIPASA and Alvarado scores was calculated by using a 2 × 2 contingency table, taking histopathology as the gold standard.

**Results:** In this study, the mean age of the participants was 25.16 ± 9.21 years. Among all participants, 73 (48.7%) were males, and 77 (51.3%) were females. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for the RIPASA scoring system were 102/108 (94.44%), 29/42 (69.05%), 102/115 (88.7%), 29/35 (82.86%), and 131/150 (87.33%), respectively. Similarly, the sensitivity, specificity, PPV, NPV, and diagnostic accuracy for the Alvarado scoring system were 81.48%, 66.67%, 86.27%, 58.33%, and 77.33%, respectively.

**Conclusion:** In conclusion, the RIPASA scoring system is more reliable and effective for diagnosing acute appendicitis, offering higher diagnostic accuracy compared to the Alvarado scoring system.

**Key Words:** RIPASA score, Alvarado score, Acute appendicitis, Appendectomy, Histopathology.

## INTRODUCTION

With a lifetime occurrence rate of around one in seven, acute appendicitis is one of the most frequent surgical emergencies.[1,2] In general surgery, it represents the leading cause of acute abdomen and the most frequent cause of community-acquired intra-abdominal infections.[3,4] In an effort to reduce the number of negative appendectomy cases, various clinical scoring systems have been developed to assist in ambiguous scenarios.[1,5]

In both industrialised and developing nations, acute appendicitis is the abdominal emergency with the highest mortality rate.[6]

In other words, 6% of the population will have an attack sometime in their lives if the lifetime chance is 1 in 7. Emergency care is necessary for cases of acute appendicitis. Perforation, peritonitis, and abscess development are all possible repercussions, and there are also risks linked with surgical operations if the condition is not managed correctly.[6] In Pakistan, a study reported that 10.3% patients had gangrenous appendix, 11.6% had perforated appendix, and 33.6% had acutely inflamed appendix.[7,8]

Reducing morbidity and mortality requires a diagnosis that is both prompt and accurate, and which relies heavily on clinical evaluation and test data. The periumbilical pain, nausea, vomiting, and right lower quadrant pain that characterise acute appendicitis are only present in around half of the cases.[9] A comprehensive clinical judgement that includes a complete history and clinical examination is used to diagnose acute appendicitis. Acute appendicitis is believed to have a complex aetiology, including luminal blockage, nutritional, and family variables.[10] Acute appendicitis may be diagnosed with the help of radiological tests, such as computerised tomography (CT) scan and abdominopelvic ultrasound (US); however, the

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high cost and restricted availability of these tests have prevented them from being widely used, especially in poor countries. The prevalence of unnecessary appendectomies has prompted the development of many grading systems to aid in the identification of acute appendicitis.[11,12]

The RIPASA scoring system, a novel method for identifying acute appendicitis, was suggested specifically for Asian people.[1] When compared to the Alvarado scoring system, prior research showed that the RIPASA score had a high sensitivity and specificity.

This study aimed to compare the RIPASA and Alvarado scores for their capacity to identify acute appendicitis taking histopathology as the gold standard.

## METHODOLOGY

This was a cross-sectional (validation) study that was carried out at the Department of General Surgery, Azra Naheed Medical College, CMA Hospital, Lahore, Pakistan, from May to November 2024. All patients aged 12 to 50 years, of either gender, and presenting with right-lower quadrant pain with nausea and vomiting were included. Patients with American Association of Anesthesilogists (ASA) score III and IV, positive beta-HCG, right iliac fossa mass (confirmed on US), with a previous history of urolithiasis and pelvic inflammatory disease, and having symptoms for >7 days were excluded from the study. The sample size was calculated using a 95% confidence interval and percentage of acute appendicitis, i.e., 33.6%,[7] sensitivity of RIPASA, i.e., 86.6% with a 9.5% margin of error, and specificity of RIPASA, i.e., 66.7% with a 9.5% margin of error.[13] Ethical approval was obtained from the Institutional Ethical Review Board. Informed consent was taken from all enrolled patients. All relevant data including demographic details were recorded. The patients were evaluated for signs and symptoms. Blood and urine samples were taken to fulfil clinical scoring criteria. RIPASA score (Table I) and Alvarado score (Table II) were calculated for each patient. Patients were labeled as positive or negative for both scoring systems. Acute appendicitis diagnosis was made using RIPASA and Alvarado scoring systems. On RIPASA score, if the patients had a score >7.5, it was labelled as positive for acute appendicitis. On the Alvarado score, if the patients obtained a score >7, they were labelled as positive for acute appendicitis. Meanwhile, all patients underwent appendectomy under general anaesthesia by an on-call surgical team with the assistance of the primary researcher. Appendix specimen was sent for histopathology to confirm the diagnosis. On histopathology, it was labelled as positive if microscopic evidence of acute inflammation with lymphoid hyperplasia, and luminal obstruction on pathological examination was obtained.

Statistical Package for the Social Sciences for Windows (SPSS Inc., Chicago, Illinois, USA) version 25 was used to record and analyse the data. Diagnostic performance of RIPASA and Alvarado scores (including sensitivity, specificity, accuracy,

and predictive values) was calculated by using a 2 × 2 contingency table taking histopathology as the gold standard. Mean and standard deviation (SD) and frequencies (%) were calculated for numeric and categorical variables, respectively. Kappa statistics was applied to check the agreement between RIPASA, Alvarado, and gold standard, i.e., histopathology. A p-value of ≤0.05 was taken as significant.

**Table I: RIPASA scoring system.**

| Characteristics | Score |
|---|---|
| Male | 1.0 |
| Female | 0.5 |
| Age <39.9 (years) | 1.0 |
| Age >40 (years) | 0.5 |
| RIF pain | 0.5 |
| Pain migrating to RIF | 0.5 |
| Anorexia | 1.0 |
| Nausea / vomiting | 1.0 |
| Duration of symptoms <48 hours | 1.0 |
| Duration of symptoms >48 hours | 0.5 |
| RIF tenderness | 1.0 |
| RIF guarding | 2.0 |
| Rebound tenderness | 1.0 |
| Rovsing sign | 2.0 |
| Fever | 1.0 |
| Elevated WBC | 1.0 |
| Negative urinalysis | 1.0 |
| Foreign NIC | 1.0 |
| Total score | 17.5 |

| Total RIPASA score | Decision-making guidelines |
|---|---|
| <5.0 | Probability of acute appendicitis is unlikely |
| 5.0-7.0 | Low probability of acute appendicitis |
| 7.5-11.5 | Probability of acute appendicitis is high |

RIF, Right iliac fossa; WBC, White blood cells; NIC, Nursing interventions classification.

**Table II: Alvarado scoring system.**

| | Score |
|---|---|
| Symptoms | |
|     Pain migrating to RIF >24 hours | 01 |
|     Anorexia | 01 |
|     Nausea - vomiting | 01 |
| Sign | |
|     RIF tenderness | 02 |
|     Rebound tenderness | 01 |
|     Fever at presentation | 01 |
| Investigation | |
|     Raised WBC (>10,000 cells/mm$^3$) | 02 |
|     Shift of WBC to left | 01 |
|     Total score | 10 |

RIF, Right iliac fossa; WBC, White blood cells; NIC, Nursing interventions classification.

**Table III: Demographics and clinical parameters of recruited patients.**

| Parameters | Frequency | Percent (%) |
|---|---|---|
| Age (years) | 25.16 ± 9.21 (12.0-50.0) | |
| Gender | | |
|     Male | 73 | 48.7 |
|     Female | 77 | 51.3 |
| Duration of symptoms (hours) | 31.32 ± 11.44 (2.0-48.0) | |
| RIPASA score | 8.84 ± 1.83 (1.40-12.0) | |
| Acute appendicitis on RIPASA score | | |
|     Positive | 115 | 76.7 |
|     Negative | 35 | 23.3 |
| Alvarado score | 7.55 ± 1.52 (4.0-10.0) | |
| Acute appendicitis on Alvarado score | | |
|     Positive | 102 | 68.0 |
|     Negative | 48 | 32.0 |
| Acute appendicitis on histopathology | | |
|     Positive | 108 | 72.0 |
|     Negative | 42 | 28.0 |

**Table IV: Validity of RIPASA and Alvarado scoring systems for the diagnosis of acute appendicitis.**

| Acute appendicitis | Histopathology | | Total | p-value |
|---|---|---|---|---|
| | **Positive** | **Negative** | | |
| RIPASA score | | | | <0.001 |
|    Positive | 102 | 13 | 115 | |
|    Negative | 6 | 29 | 35 | |
| Total | 108 | 42 | 150 | |
| Alvarado score | | | | <0.001 |
|    Positive | 88 | 14 | 102 | |
|    Negative | 20 | 28 | 48 | |
| Total | 108 | 42 | 150 | |
| | **RIPASA Score** | | **Alvarado Score** | |
| Sensitivity | 94.44% | | 81.48% | |
| Specificity | 69.05% | | 66.67% | |
| PPV | 88.7% | | 86.27% | |
| NPV | 82.86% | | 58.33% | |
| Diagnostic accuracy | 87.33% | | 77.33% | |

*The Kappa statistics test was applied.*

**Table V: Evaluation of validity of RIPASA scoring system and Alvarado scoring system for the diagnosis of acute appendicitis when patients were stratified for effect modifiers.**

| Variables | Categories | Sensitivity | Specificity | PPV | NPV | Diagnostic accuracy | p-value |
|---|---|---|---|---|---|---|---|
| **RIPASA** | | | | | | | |
|   Age | ≤30 | 95.24% | 71.43% | 88.89% | 86.21% | 88.24% | <0.001 |
| | >30 | 91.67% | 57.14% | 88% | 66.67% | 83.87% | 0.004 |
|   Gender | Male | 92.73% | 50% | 85% | 69.23% | 82.19% | <0.001 |
| | Female | 96.23% | 83.33% | 92.73% | 90.91% | 95.21% | <0.001 |
|   Duration of symptoms | ≤24 | 95.92% | 46.67% | 85.45% | 77.78% | 84.38% | <0.001 |
| | >24 | 93.22% | 81.48% | 91.67% | 84.62% | 89.53% | <0.001 |
| **Alvarado** | | | | | | | |
|   Age | ≤30 | 80.95% | 65.71% | 85% | 58.97% | 76.47% | <0.001 |
| | >30 | 83.33% | 71.43% | 90.91% | 55.56% | 80.65% | 0.005 |
|   Gender | Male | 85.45% | 44.44% | 82.46% | 50% | 75.34% | 0.008 |
| | Female | 77.36% | 83.33% | 91.11% | 62.5% | 79.22% | <0.001 |
|   Duration of symptoms | ≤24 | 79.59% | 40% | 81.25% | 37.5% | 70.31% | 0.125 |
| | >24 | 83.05% | 81.48% | 90.74% | 68.75% | 82.56% | <0.001 |

*Kappa statistics were applied.*

## RESULTS

In this study, a total of 150 patients were enrolled. The mean age of the participants was 25.16 ± 9.21 years. Among the patients, 73 (48.7%) were males and 77 (51.3%) were females. The mean duration of symptoms was 31.32 ± 11.44 hours. The average RIPASA and Alvarado scores were 8.84 ± 1.83 and 7.55 ± 1.52, respectively. Acute appendicitis was diagnosed in 115 (76.7%) patients using the RIPASA scoring system and in 102 (68%) patients using the Alvarado scoring system. Histopathological analysis confirmed acute appendicitis in 108 (72%) patients (Table III).

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of the RIPASA scoring system for diagnosis of acute appendicitis were 94.44% (102/108), 69.05% (29/42), 88.7% (102/115), 82.86% (29/35), and 87.33% (131/150), respectively, compared to histopathology. Similarly, sensitivity, specificity, PPV, NPV, and diagnostic accuracy of the Alvarado scoring system for diagnosis of acute appendicitis were 81.48% (88/108), 66.67% (28/42), 86.27% (88/102), 58.33% (28/48), and 77.33% (116/150), respectively taking histopathology as the gold standard (Table IV).

In patients aged ≤30 years, the diagnostic accuracy of RIPASA was 88.24%, and in patients aged >30 years, it was 83.87%. In patients aged ≤30 years, the diagnostic accuracy of Alvarado was 76.47%, and in patients aged >30 years, it was 80.65%. In males, the diagnostic accuracy of RIPASA was 82.19%, and in females, it was 95.21%. In males, the diagnostic accuracy of Alvarado was 75.34%, and in females, it was 79.22%. In patients who had symptoms of appendicitis for ≤24 hours, the diagnostic accuracy of RIPASA was 84.38%, and in patients who presented after >24 hours of developing symptoms, the accuracy of RIPASA was 89.53%. In patients who had symptoms of appendicitis for ≤24 hours, the diagnostic accuracy of Alvarado was 70.31%, and in patients who presented after >24 hours of developing symptoms, accuracy was 82.56%, taking histopathology as the gold standard (Table V).

## DISCUSSION

Acute appendicitis is a frequent surgical emergency in surgical practice. The doctor's clinical expertise in the accident and emergency room is crucial to the diagnosis. A thorough clinical examination of the abdomen is the primary diagnostic tool, although laboratory tests and imaging, such as abdominal US, may supplement the clinical evaluation.[14,15]

Similar to this study's findings, Majid *et al.*, found that in detecting acute appendicitis, the RIPASA score was 89% accurate compared to Alvarado score, which was 72%. The diagnostic accuracy, sensitivity, specificity, PPV, and NPV of RIPASA scoring for diagnosis of acute appendicitis were 92.1%, 62.1%, 95.2%, 48.6%, and 88.9%, respectively while for Alvarado scoring were 72.6%, 68.9%, 95.1%, 23.2%, and 72.2%, respectively.[12]

A study conducted in Kohat determined that the RIPASA score, which had a diagnostic accuracy of 95.1%, is a helpful new diagnostic score for acute appendicitis in the local community.[16] RIPASA is a reliable and sensitive diagnostic method for acute appendicitis when compared to the Alvarado score, according to another study in Karachi, Pakistan.[17] Emergency department doctors can detect acute appendicitis with strong sensitivity but a low specificity by using the RIPASA scoring system, according to another study conducted in Peshawar, Pakistan.[18]

According to a study conducted in Rajasthan, India, NPV, PPV, sensitivity, specificity, and diagnostic accuracy of RIPASA and Alvarado scores for identifying acute appendicitis were 94.7%, 60%, 97.8%, 37.5%, and 93%, respectively, and 67.3%, 80%, 98.4%, 11.4%, and 68%, respectively.[19]

According to one study done in India, the RIPASA score showed a 96.2% sensitivity and a 90.5% specificity. To identify acute appendicitis, the Alvarado score has a 58.9% sensitivity and an 85.7% specificity.[1] According to research done in Pakistan, the RIPASA score may detect instances of acute appendicitis with a sensitivity of 96.7% and specificity of 93.0%.[16] Sensitivity of the RIPASA score was 91.1% and specificity was 60% in another Pakistani study by Damani *et al*. The Alvarado score had a sensitivity of 11.67% but a specificity of 95%.[17] However, a global study found that RIPASA was only moderately accurate, with a sensitivity of 86.6% and a specificity of just 66.7%. The Alvarado score had a 72.2% specificity and a 67.1% sensitivity.[13]

The RIPASA and Alvarado ratings had a 93.2% diagnostic accuracy. However, their sensitivity, specificity, PPV, and NPV to identify acute appendicitis were 61.8%, 92.2%, 64.9%, and 91.5% and 73.7%, 68.6%, 92.1%, 34.8%, and 74.3%, respectively, according to another study done in Jordan.[20] One study by Chong *et al.* showed higher diagnostic accuracy of the RIPASA score as compared to this study. According to the Chong *et al.* 98% of patients received appropriate treatment after being correctly diagnosed with acute appendicitis (RIPASA score >7.5).[21]

The RIPASA scoring system demonstrated more reliable results compared to the Alvarado scoring system. Therefore, it is recommended that the RIPASA scoring system be prioritised for diagnosing acute appendicitis in the future.

One of the limitations of this study was the small sample size due to time and financial constraints. Another limitation of the study was that it was a single-centre study. Due to a single-centre setting and a non-probability sampling technique, the results of this study could not be generalised to the whole population.

## CONCLUSION

In conclusion, the RIPASA scoring system is more reliable and effective for diagnosing acute appendicitis, offering higher diagnostic accuracy compared to the Alvarado scoring system.

**ETHICAL APPROVAL:**
Ethical approval was obtained from the Institutional Ethical Review Board.

**PATIENTS' CONSENT:**
Informed consent was taken from all enrolled patients.

**COMPETING INTEREST:**
The authors declared no conflict of interest.

**AUTHORS' CONTRIBUTION:**
AA, YM, MAA: Contributed to the data collection and interpretation.
MS, HA, CMA: Data analysis and review.
All authors approved the final version of the manuscript to be published.

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