Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2024i1.1245
*Biol. Clin. Sci. Res. J., Volume, **2024**: 1245*
Original Research Article

COMPARISON OF ALVARADO, RIPASA, AND AIR SCORING SYSTEM IN DIAGNOSIS OF ACUTE APPENDICITIS

KHAN BS[1*], ZULFIKAR I[2], MAQBOOL N[3], SHEIKH K[1], RIMSHA S[4], SHAKEEL B[4]

[1]*Department of General Surgery, DUHS Ruth K.M. Pfau Civil Hospital Karachi, Pakistan*
[2]*Department of Surgical, DUHS, Ruth K.M. Pfau Civil Hospital, Karachi, Pakistan*
[3]*Department of General Surgery Aga Khan University Hospital, Karachi, Pakistan*
[4]*Department of General Surgery Sindh Government Hospital, New Karachi, Pakistan*
**Corresponding author`s email address:* khanbushra71@gmail.com

(Received, 24th June 2024, Revised 25th October 2024, Published 31st October 2024)

Abstract: *Accurate and timely diagnosis of acute appendicitis is critical in preventing complications and guiding surgical intervention. The Alvarado, RIPASA, and AIR scoring systems are commonly used diagnostic tools, each with varying performance metrics in different clinical settings.* ***Objective:*** *This study aimed to compare the diagnostic performance and overall accuracy of the Alvarado, RIPASA, and AIR scoring systems for diagnosing acute appendicitis.* ***Methods:*** *This observational study was conducted at Civil Hospital Karachi from December 2023 to May 2024, following ethical approval from the institutional review board. A total of 200 patients aged over 18 years presenting with clinical symptoms suggestive of acute appendicitis were included in the study through non-probability consecutive sampling. Each patient's data was analyzed using the Alvarado, RIPASA, and AIR scoring systems to evaluate their diagnostic accuracy, sensitivity, specificity, and area under the curve (AUC).* ***Results:*** *The Alvarado score demonstrated a sensitivity of 88.44%, a specificity of 37.04%, and an overall accuracy of 81.50%, with an AUC of 0.667 (p=0.002). The RIPASA score showed a sensitivity of 81.18%, a specificity of 53.33%, and an accuracy of 77.00%, with an AUC of 0.699 (p=0.001). The AIR score displayed a sensitivity of 81.00%, a specificity of 60.00%, and an accuracy of 82.00%, with an AUC of 0.700 (p<0.001).* ***Conclusion:*** *The Alvarado, RIPASA, and AIR scores each demonstrate diagnostic value in identifying acute appendicitis, though their sensitivity and specificity may vary based on the population and clinical setting. Clinicians should consider these variations when selecting a scoring system to optimize diagnostic accuracy for acute appendicitis.*

Keywords: Scoring System, Appendicitis. Histopathology, Diagnosis

Introduction

Acute appendicitis is one of the most commonly presenting cases in surgical emergencies globally, with a wide spectrum of age groups (1). Acute appendicitis-related complications such as perforation, abscess formation and peritonitis significantly lead to increased rates of morbidity and mortality which can be overcome by timely diagnosis and prompt surgical intervention (2). Despite advances in medical technology and diagnostic modalities, the accurate diagnosis of acute appendicitis remains challenging, often relying on a combination of clinical examination, laboratory and imaging investigations(3).

The Alvarado score, proposed by Alvarado et al. in 1986, incorporates clinical symptoms, signs, and laboratory findings to generate a score having a range from 0 to 10, with higher scores indicating a higher possibility of appendicitis (4). Similarly, the RIPASA score, developed by Chong et al. in 2010, includes additional clinical parameters such as migratory pain, anorexia, and duration of symptoms, aiming to improve diagnostic accuracy (5). More recently, the AIR score, introduced by Andersson et al. in 2016, emphasizes the role of inflammatory markers such as C-reactive protein (CRP) and white blood cell count (WBC), reflecting the systemic inflammatory response associated with appendicitis (6). In Zeb et al., study, the RIPASA score was better in diagnosing acute appendicitis as compared to the Alvarado and AIR scores with sensitivity of 94%, 88% and 77% respectively (7). A study by Chong et al. and Walia et al. also reported the same results (8, 9). However study conducted by Chishti et al. showed a higher sensitivity for the AIR score (97.78%) as compared to the RIPASA (87.78%) and Alvarado score (64.44%) (10). the present study aims to compare the diagnostic performance and overall accuracy of the Alvarado, RIPASA, and AIR scoring systems for diagnosing acute appendicitis.

Methodology

After the ethical approval from the institutional review board, this observational study was carried out at Civil Hospital Karachi, from December 2023 to May 2024. Through non-probability consecutive sampling 200 patients aged above 18 years, presenting with the clinical symptoms suggestive of acute appendicitis were included in the study. Patients with severe co-morbid conditions and pregnant patients were excluded from the present study. After the informed consent, patient records were screened to identify individuals who presented with symptoms suggestive of acute appendicitis and subsequently underwent appendectomy as confirmed by surgical findings and histopathology. Patient demographics (age, gender), clinical presentation (abdominal pain, fever, nausea/vomiting, migration of pain), laboratory investigations (total leukocyte count, C-reactive protein level), surgical outcomes and histopathological diagnosis were recorded

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using a pre-designed proforma. Subsequently, each patient was evaluated using the Alvarado, RIPASA, and AIR scoring systems to calculate their respective scores. SPSS version 26 was used for the analysis of data. Descriptive statistics were used to summarize patient characteristics and scoring system results. Receiver operating characteristic (ROC) curve analysis was used to evaluate the discriminatory ability of each scoring system. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were assessed for each scoring system.

Results

The study included 200 participants with a mean age of 43.96 ± 14.9 years. Of these, 54% were male (n=108) and 46% were female (n=92) Table 1). Clinically, all participants (100%) presented with abdominal pain, while 61% (n=122) had a fever, 74% (n=147) experienced vomiting or nausea, and 80% (n=160) reported migration of pain. Laboratory findings revealed a mean total leukocyte count of 15,036.84 ± 2,152.9 and mean CRP levels of 12.55 ± 3.6. Histopathological diagnosis confirmed acute appendicitis in 85% (n=170) of cases. The mean Alvarado, RIPASA, and AIR scores were 7.78 ± 1.19, 12.81 ± 1.7, and 8.285 ± 1.4, respectively (Table 2).

The Alvarado score demonstrated a sensitivity of 88.44%, a specificity of 37.04%, and an overall accuracy of 81.50%, with an AUC of 0.667 (p=0.002) (Table 3, Figure 1). The RIPASA score showed a sensitivity of 81.18%, a specificity of 53.33%, and an accuracy of 77.00%, with an AUC of 0.699 (p=0.001) (Table 4, Figure 2). The AIR score exhibited a sensitivity of 81.00%, a specificity of 60.00%, and an accuracy of 82.00%, with an AUC of 0.700 (p<0.001) (Table 5, Figure 3). In terms of predictive values, the Alvarado, RIPASA, and AIR scores had positive predictive values of 90.00%, 90.79%, and 88.51%, respectively. Negative predictive values were lower, with 33.33% for both Alvarado and RIPASA and 38.46% for AIR.

Table 1: Demographic parameters of the study participants

Parameters	Mean and Frequency (n=200)
Age	43.96±14.9
Gender	
Male	108 (54%)
Female	92 (46%)

Table 2: Clinical Parameters of the Study Participants

Symptoms	Mean and Frequency (n=200)
Abdominal Pain	200 (100%)
Fever	122 (61%)
Vomiting/Nausea	147 (74%)
Migration of pain	160 (80%)
Total Leucocyte Count	15036.84±2152.9
CRP	12.55±3.6
Histopathological Diagnosis	170 (85%)
Alvarado Score	7.78±1.19
RIPASA Score	12.81±1.7
AIR Score	8.285±1.4

Table 3: Alvarado score diagnostic accuracy for acute appendicitis

Alvarado score	Histopathology Diagnosis		Total	P value
	Yes	No		
Yes	153	17	170	0.002
No	20	10	30	
Total	173	27	200	
Sensitivity				88.44%
Specificity				37.04%
Positive Likelihood Ratio				1.4
Negative Likelihood Ratio				0.31
Positive Predictive Value				90.00%
Negative Predictive Value				33.33%
Accuracy				81.50%
AUC				0.667

Table 4: RISAPA diagnostic accuracy for acute appendicitis

RISAPA Score	Histopathology		Total	P value
	Yes	No		
Yes	138	14	152	0.001
No	32	16	48	
Total	170	30	200	
Sensitivity				81.18%
Specificity				53.33%
Positive Likelihood Ratio				1.74
Negative Likelihood Ratio				0.35
Positive Predictive Value				90.79%
Negative Predictive Value				33.33%
Accuracy				77.00%
AUC				0.699

Table 5: AIR score diagnostic accuracy for acute appendicitis

AIR Score	Histopathology		Total	P value
	Yes	No		
Yes	154	20	174	<0.001
No	16	10	26	
Total	170	30	200	
Sensitivity				81.00%
Specificity				60.00%
Positive Likelihood Ratio				1.36
Negative Likelihood Ratio				0.28
Disease prevalence				85.00%
Positive Predictive Value				88.51%

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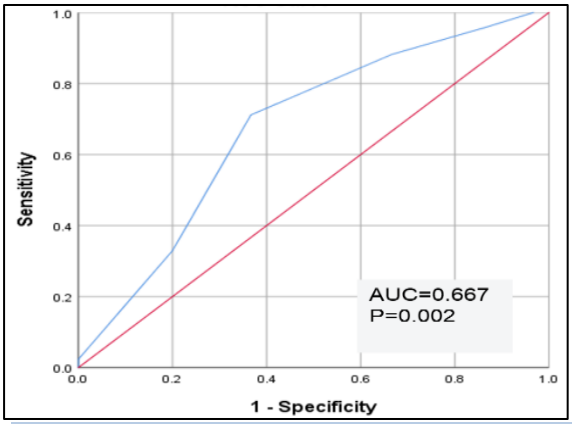
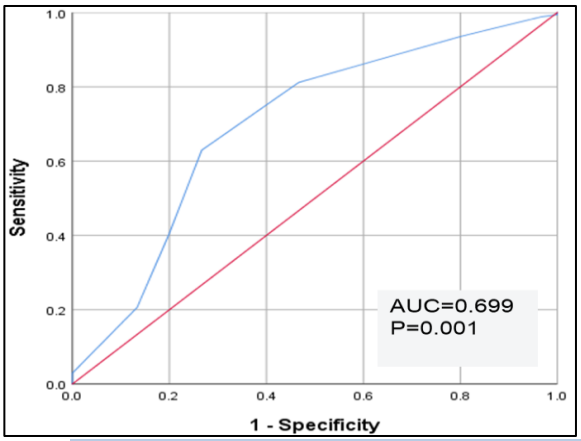


Negative Predictive Value	38.46%
Accuracy	82.00%

Figure 1: ROC curve analysis of Alvarado score



AUC	0.700

Figure 1: ROC curve analysis of RISAPA score

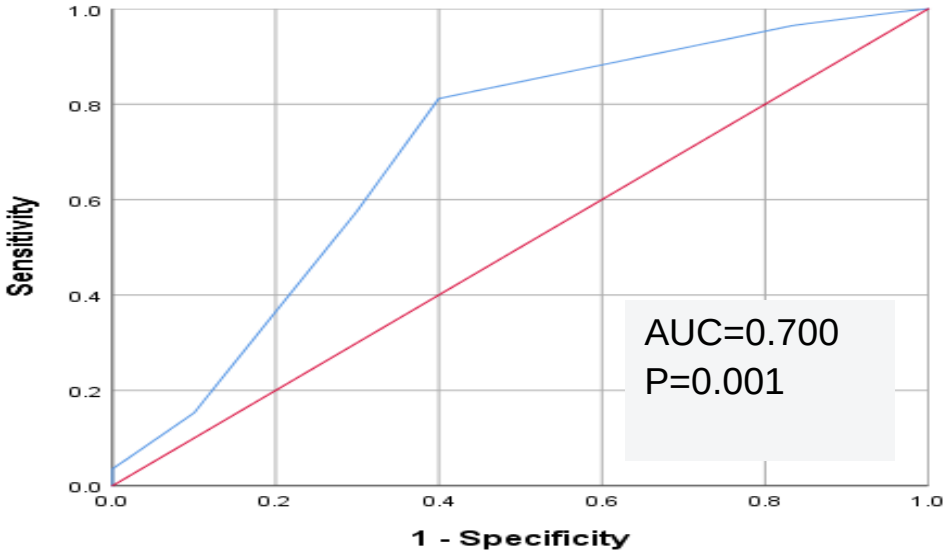


Figure 2: ROC curve analysis of AIR score

Discussion

The outcome of this study presents a comparison of the diagnostic performance of the Alvarado, RIPASA, and AIR scoring systems in diagnosing acute appendicitis and is in consonant with the findings in other studies but presents additional value. The Alvarado score demonstrated a sensitivity of 88.44%, a specificity of 37.04%, and an overall accuracy of 81.50%. These findings are in concordance with previous studies endorsing the usefulness of the Alvarado score as an efficacious tool towards identifying acute appendicitis, especially in areas of operational restraint. Ohle et al. (2011) on the same note state that the sensitivity of the Alvarado score usually falls between 72-90% rendering it appropriate for primary screening (11). Nonetheless, the lower specificity recorded in this study mirrors that of the score when attempting to differentiate acute appendicitis from other causes of abdominal pain hence a high clearance rate of false positives. This case may result in surgeries not required by the patient evidenced by the positive likelihood ratio of 1. 4 and it thus appears that the Alvarado score might be more useful in indicating when appendicitis is likely to be present rather than when it is unlikely (12).

The RISAPA score demonstrated a sensitivity of 81.18%, specificity of 53.33%, and overall accuracy of 77.00%. This is in accord with the results by Chong et al., 2010 which showed 98% sensitivity and 81% specificity in the Asian / Middle Eastern population that was more compatible with the RIPASA score (8). This study found a lower percentage of specificity, (53. 33%) compared with earlier studies but this could be explained by the different populations that the studies used or the type of healthcare setting used in a particular country which may influence the performance of scoring systems. This, however, seems not to be true since the overall positive predictive value of 90.79%. The score's higher negative likelihood ratio (0.35) compared to the Alvarado score suggests that it may still allow a considerable number of false negatives, underscoring the importance of considering additional diagnostic methods when using RIPASA (13). As regards the inflammatory markers such as the C-reactive protein (CRP), the AIR score had a sensitivity of 81.00% and specificity of 60. 00% and the overall accuracy that was obtained was 82. 00%. Such

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findings are in agreement with Andersson and Andersson (2008) the authors found that the AIR score enhances the diagnostic accuracy since it factors in the concentration of CRP and WBC counts distinguishing uncomplicated and complicated appendicitis (14). The AIR score had a little higher accuracy in this study at 82.00% compared to the Alvarado score which was 81.50% suggesting that it may be useful in the reduction of avoidable surgeries. In this regard, this study agrees with other studies like Kollar et al. (2015) that the negative appendectomies were significantly lower in AIR as compared to the Alvarado score in situations where overdiagnosis is a major concern (15).

Therefore, when comparing all these three scoring systems, it is imperative to use the one that best suits the clinical environment and patient demography. Although the Alvarado score is less sensitive, it is beneficial in terms of quick and initial diagnostic stages, especially in resource-limited settings where the availability of more sophisticated diagnostic tools is compromised (16). However, it has its limitations and disadvantages in specific organs because it results in increased unnecessary surgeries as presented in this study. In contrast, the use of the RIPASA score is especially valuable for Asian patients, as it yielded significantly higher diagnostic effectiveness in the study. However, its variations in specificity, as investigated in this paper, indicate that its performance may be contingent on the local population characteristics and protocols in clinics (17). Since the AIR score gives more importance to the inflammatory markers, it had better specificity and reasonable sensitivity compared to other scores making it a useful tool in the distinction between simple and complicated appendicitis thus decreasing the rate of negative appendectomies.

Conclusion

Therefore, all three scores; Alvarado, RIPASA and AIR, aid in the diagnosis of acute appendicitis although their sensitivity depends on the population and practice setting. Alvarado score is considered valuable in the initial triage and diagnosis, particularly in the resource-constraint environment. The RIPASA score has better accuracy in given demographics; in Asian and Middle-Eastern people, mainly. On the other hand, the AIR score offers a higher specificity and could decrease inappropriate operations, which makes it useful whenever inflammatory markers could be employed for diagnostic purposes. More efforts should be devoted to fine-tuning these scoring systems and it might be beneficial to combine some aspects of all three for a more global applicability of the diagnostic resources.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-PDHK-232/23)

Consent for publication
Approved

Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

BUSHRA SAEED KHAN (Post Graduate Trainee)
Coordination of collaborative efforts.
Study Design, Review of Literature.
IMRANA ZULFIKAR (Professor)
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
Conception of Study, Final approval of manuscript.
NARGIS MAQBOOL (Fellow General Surgery)
Manuscript revisions, critical input.
Coordination of collaborative efforts.
KAINAT SHEIKH (Resident General Surgery)
Data acquisition, and analysis.
Manuscript drafting.
SHEHZADI RIMSHA (Consultant General Surgeon)
Data entry and Data analysis, drafting article.
BUSHRA SHAKEEL (Consultant General Surgeon)
Data acquisition, and analysis.
Coordination of collaborative efforts.

References

1. Guaitoli E, Gallo G, Cardone E, Conti L, Famularo S, Formisano G, et al. Consensus statement of the Italian polispecialistic society of young surgeons (SPIGC): diagnosis and treatment of acute appendicitis. Journal of Investigative Surgery. 2021;34(10):1089-103.
2. Almström M, Wester T. Appendicitis. Pediatric Surgery: Diagnosis and Management: Springer; 2023. p. 985-92.
3. Coccolini F, Licitra G, De'Angelis N, Martinez Perez A, Cremonini C, Musetti S, et al. Complication analysis in acute appendicitis results from an international multicenter study. European Journal of Trauma and Emergency Surgery. 2024;50(1):305-14.
4. Jose T, Rajesh P. Appendicitis inflammatory response score in comparison to Alvarado score in acute appendicitis. The Surgery Journal. 2021;7(03):e127-e31.
5. Chong CF, Thien A, Mackie AJA, Tin AS, Tripathi S, Ahmad M, et al. Evaluation of the RIPASA Score: a new scoring system for the diagnosis of acute appendicitis. Brunei Int Med J. 2010;6(1):17-26.
6. Di Saverio S, Birindelli A, Kelly MD, Catena F, Weber DG, Sartelli M, et al. WSES Jerusalem guidelines for diagnosis and treatment of acute appendicitis. World Journal of Emergency Surgery. 2016;11:1-25.
7. Zeb M, Khattak SK, Samad M, Shah SS, Shah SQA, Haseeb A. Comparison of Alvarado score, appendicitis inflammatory response score (AIR) and Raja Isteri Pengiran Anak Saleha appendicitis (RIPASA) score in predicting acute appendicitis. Heliyon. 2023;9(1).
8. Chong C, Adi M, Thien A, Suyoi A, Mackie A, Tin A, et al. Development of the RIPASA score: a new

appendicitis scoring system for the diagnosis of acute appendicitis. Singapore Medical Journal. 2010;51(3):220.
9. Walia D, Shankar N, Singla A, Najmi H, Kaur M. A comparative study of Alvarado, Ripasa and Airs scoring systems in the diagnosis of acute appendicitis. Eur J Mol Clin Med. 2022;9(3):369-79.
10. Chisthi MM, Surendran A, Narayanan JT. RIPASA and air scoring systems are superior to Alvarado scoring in acute appendicitis: Diagnostic accuracy study. Annals of medicine and surgery. 2020;59:138-42.
11. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. BMC medicine. 2011;9:1-13.
12. Deiters A, Drozd A, Parikh P, Markert R, Shim JK. Use of the Alvarado score in elderly patients with complicated and uncomplicated appendicitis. The American Surgeon. 2019;85(4):397-402.
13. Collard M, Lakkis Z, Loriau J, Mege D, Sabbagh C, Lefevre J, et al. Antibiotics alone as an alternative to appendectomy for uncomplicated acute appendicitis in adults: Changes in treatment modalities related to the COVID-19 health crisis. Journal of visceral surgery. 2020;157(3):S33-S42.
14. Andersson M, Andersson RE. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World journal of surgery. 2008;32(8):1843-9.
15. Kollár D, McCartan D, Bourke M, Cross K, Dowdall J. Predicting acute appendicitis? A comparison of the Alvarado score, the Appendicitis Inflammatory Response Score and clinical assessment. World journal of surgery. 2015;39(1):104-9.
16. Poillucci G, Podda M, Oricchio D, Medina KL, Manetti G, De Angelis R. Comparison between AIR, Alvarado and RIPASA scores in the diagnosis of acute appendicitis in a Western population. A retrospective cohort study. Annali Italiani di Chirurgia. 2022;93(4):427-34.
17. Shakya AK. A comparative study of predictive accuracy of RIPASA versus Alvarado and AIR Scores in the diagnosis of Acute Appendicitis. 2023.

[Citation Khan, B.S., Zulfikar, I., Maqbool, N., Sheikh, K., Rimsha, S., Shakeel, B. (2024). Comparison of alvarado, ripasa, and air scoring system in diagnosis of acute appendicitis. *Biol. Clin. Sci. Res. J.*, **2024***: 1081*. doi: https://doi.org/10.54112/bcsrj.v2024i1.1245]