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Alvarado or RIPASA? Which one do you use to diagnose acute appendicitis?: A cross-sectional study

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Abstract

Background and Aims: Acute appendicitis is one of the most common causes of lower abdominal pain, which is considered a general surgical emergency worldwide. The present study aimed to compare the diagnostic value of Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Alvarado score systems in diagnosing acute appendicitis.

Methods: A prospective cross-sectional study was conducted at Shahid Sadoughi and Shahid Rahnemoon Hospitals in Yazd between September 2020 and February 2020. The statistical population consisted of all of the patients referred to the Accident and Emergency department with right iliac fossa (RIF) pain. All patients were scored using Alvarado and RIPASA scoring system. sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were computed by using SPSS statistical software. An receiver operating characteristic curve were plotted.

Results: In present study, one hundred suspected patients with appendicitis who underwent appendectomy were evaluated. The mean age of our study population was 25.2 ± 12.1 years, and the gender distribution was 57% males and 43% females. The sensitivity, specificity, PPV and NPV of RIPASA were 86.6%, 66.7%, 92.2%, and 52.2%, respectively. The sensitivity, specificity, PPV and NPV of Alvarado score were 67.1%, 72.2%, 91.7%, 32.5%, respectively. The diagnostic accuracy was 68% for Alvarado score and 83% for RIPASA. The area under the curve for RIPASA (0.87) was more than that for Alvarado score (0.77).

Conclusion: The RIPASA score system had higher sensitivity, PPV, NPV, and accuracy than the Alvarado one. It is recommended for the physician and surgeon to evaluate patients with RIF pain using the RIPASA score.

KEYWORDS
Alvarado, Appendicitis, RIPASA, sensitivity, specificity

1 | INTRODUCTION

Acute appendicitis is one of the most common causes of lower abdominal pain, which is considered a general surgical emergency worldwide [1,2] and affects 7%–12% of the general population. The most common age range is 25–35 years of age.[3,4] Despite the advances in the treatment and diagnosis of appendicitis, it is still difficult to diagnose acute appendicitis in young people, the elderly, and women of reproductive age. Various gastrointestinal, reproductive, or gynecological inflammatory conditions have signs and symptoms similar to acute appendicitis.[5] Diagnosis of appendicitis is challenging and based on a set of clinical signs and physical examination, combined with laboratory findings.[6] Although the use of tools such as computed tomography (CT) scans and ultrasonography help to confirm the appendicitis diagnosis and increase diagnostic accuracy, due to their high costs and availability problems, cost-effective alternative methods are preferred to reduce negative appendectomy and appendicitis complications.[7,8] One of the cost-effect diagnostics assisting tools is clinical scoring systems. Different scoring systems assign numerical values to signs, symptoms, and laboratory results. The Alvarado scoring system is the first and the most popular systems for surgeons to diagnose appendicitis.[9] Another scoring system is the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) system, a new scoring system for diagnosing acute appendicitis. Its high sensitivity, specificity, and diagnostic accuracy have been identified, especially in the Asian population.[3] Studies that compared the diagnostic accuracy of the Alvarado and RIPASA are still sparse. The present study aimed to compare the diagnostic value of RIPASA and Alvarado score systems in diagnosing acute appendicitis.

2 | MATERIALS AND METHODS

A prospective cross-sectional double-center study was conducted at Shahid Sadoughi and Shahid Rahnemoon Hospitals, a university-afliated tertiary medical center in Yazd, between September 2020 and February 2020. Ethical committee of Shahid Sadoughi University of medical sciences approved the study (IR.SSU.MEDICINE.R-EC.1398.144); all the study procedures were conducted following the Declaration of Helsinki, and Informed consent was obtained from all of the patients before the study. The statistical population consisted of all of the patients referred to the Accident and Emergency (A&E) department with right iliac fossa (RIF) pain. Each patient was examined by a surgeon. Patients suspected of having acute appendicitis based on clinical examinations, ultrasound, and laboratory findings who underwent laparoscopic appendectomy were included in the study. Children under 14 years old, pregnant women, people with skin pigmentation, nail polish, venous pulse, severe anemia (Hb <5), appendicular mass and features of peritonitis were excluded from the study. The Histopathological findings of each patient's appendix sampling were recorded to identify positive as well as negative appendectomies. The data was completed through a preprepared form that contains demographic information (age, gender, and nationality), history, examinations and laboratory findings of the patients. Alvarado and RIPASA scoring were done for all patients. This system includes 10 points and evaluates 8 parameters based on the patient's symptoms and signs and laboratory findings, as well as the RIPASA system includes 18 parameters. The Alvarado score had eight parameters, whereas the RIPASA score included 18. RIPASA's parameter scores varied from 0.5 to 2 and 1 to 2 for Alvarado were shown in Table 1.[9,10]

All the data was analyzed by SPSS version 20 for Windows (SPSS Inc.). Qualitative variables were reported by cross-tabulation and quantitative variables were reported by mean and standard deviation. Chi-square test were used for analyses. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy and negative appendectomy rate for both Alvarado and RIPASA scoring system were calculated. An receiver operating characteristic (ROC) curve at the optimal cut-off threshold scores for the Alvarado and RIPASA scores were plotted using the SPSS software. The level of significant p-value was set at 0.05.

TABLE 1 Alvarado & RIPASA scoring system

Characteristics	RIPASA score	Alvarado score
male	1	–
Female	0.5	–
Age <39.9 years	1	–
Age >40 years	0.5	–
Foreign national	1	–
Symptoms		
Right Iliac Fossa (RIF) pain	0.5	–
Pain migrating to the RIF	0.5	1
Anorexia	1	1
Nausea/vomiting	1	1
Symptoms duration <48 h	1	–
Symptoms duration >48 h	0.5	–
Sign		
Tenderness in the right lower quadrant	1	2
Abdominal guarding	2	–
Blumberg sign	1	1
Rovsing sign	2	–
Elevated temp/fever	1	1
Laboratory		
Leukocytes >10,000/mm^3	1	2
Neutrophilia >70%	–	1
Negative urinalysis	1	–
Total	17.5	10

Abbreviation: RIPASA, Raja Isteri Pengiran Anak Saleha Appendicitis.

3 | RESULTS

In present study, 100 suspected patients with appendicitis who underwent appendectomy in Shahid Sadoughi and Shahid Rahnemoon hospitals were evaluated. The mean age of our study population was 25.2 ± 12.1 years (range: 7–59) and the gender distribution was 57 (57%) males and 43 (43%) females. The participants were also assessed using the Alvarado system, and those with scores of 7 or above were classified in the high possibility group, while those with scores of 7 or lower were classified in the low probability group. The probability of acute appendicitis was high in 55 of 82 individuals with a diagnosis of acute appendicitis based on histopathological examination (HPE), and HPE has a significant relationship with Alvarado ($p = 0.001$). The participants were assessed using the RIPASA system, and those who achieved a score of 7.5 or more were classified in the high probability group. According to RIPASA 86.6% of individuals diagnosed with acute appendicitis confirmed by HPE had a high probability of appendicitis based on preoperative assessment. A significant association was seen between the RIPASA score and the HPE ($p < 0.001$) (Table 2).

The sensitivity, specificity, PPV and NPV of RIPASA were 86.6%, 66.7%, 92.2% and 52.2%, respectively. The sensitivity, specificity, PPV and NPV of Alvarado score were 67.1%, 72.2%, 91.7%, 32.5%, respectively. The diagnostic accuracy was 68% for Alvarado score and 83% for RIPASA (Table 3). Subsequently, the area under the curve (AUC) of these two scoring systems was calculated and the results were compared with each other. The AUC was 0.87 for RIPASA which was more than that for Alvarado score, which was 0.77 for Alvarado (Figure 1).

TABLE 2 Alvarado & RIPASA scoring systems in relation to histopathological reports

| Alvarado score | Histopathological report | | Total (%) | p-value[a] |
	Positive (%)	Negative (%)		
≤7.0	55 (67.1)	5 (27.8)	60 (60)	0.001
<7.0	27 (32.9)	13 (72.2)	40 (40)	
RIPASA score				
≤7.5	71 (86.6)	6 (33.3)	77 (77)	<0.001
<7.5	11 (13.4)	12 (66.7)	23 (23)	

Abbreviation: RIPASA, Raja Isteri Pengiran Anak Saleha Appendicitis.
[a]Chi-square test were used for analyses. The level of significant p-value was set at 0.05.

TABLE 3 Sensitivity, specificity, and positive and negative predictive values of RIPASA and RIPASA scoring systems

	Alvarado Score (CI 95%)	RIPASA Score (CI 95%)
Sensitivity	67.1% (58.04–76.16)	86.6% (80–93.2)
Specificity	72.2% (63.5–80.9)	66.7% (57.5–75.9)
Positive predictive value	91.7% (86.3–97.1)	92.2% (87–97.4)
Negative predictive value	32.5% (23.3–41.7)	52.2% (42.4–62)
Accuracy	68% (58.9–77.1)	83% (75.7–90.3)

Abbreviations: CI, confidence interval; RIPASA, Raja Isteri Pengiran Anak Saleha Appendicitis.

4 | DISCUSSION

Acute appendicitis is one of the most common surgical emergencies that diagnosis delay can lead to perforation, bowel obstruction, rupture, sepsis and peritonitis. So quick and correct diagnosis of acute appendicitis is very important and associated with decreased
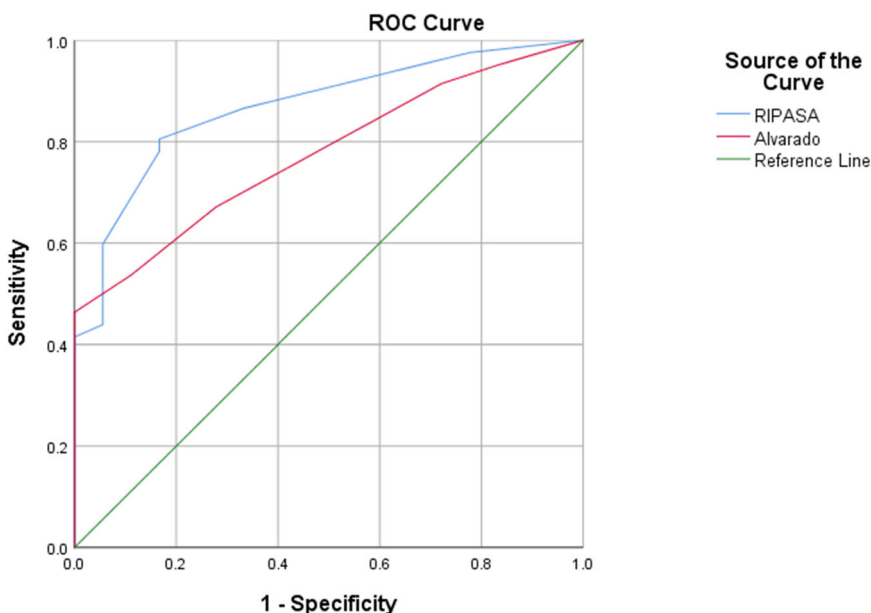

FIGURE 1 Receiver operating characteristic for Alvarado and RIPASA scoring system. RIPASA, Raja Isteri Pengiran Anak Saleha Appendicitis

of morbidity and mortality.[2,11,12] The definitive diagnosis of appendicitis can be significantly assisted by radiological modalities such CT scan, which has extremely high sensitivity and specificity. However, it is preferred that we utilize alternative methods to assess the probability of acute appendicitis due to the high cost of these procedures, the requirement for an expert radiologist, and their unavailability in all hospitals and clinic.[13] Blood parameters such as white blood cell count and C-reactive protein can assist in the diagnosis, however both are nonspecific and can be increased in a variety of inflammatory and infection diseases, and have several differential diagnoses. Physical exams are useful in detecting appendicitis and increasing diagnostic accuracy; several scoring systems have been developed to screen patients for appendicitis. Acute appendicitis is diagnosed using the Alvarado scoring system, which was developed in 1986. Although this approach showed a high level of sensitivity and specificity in western population, it was less effective in diagnosing acute appendicitis in Asian population. To estimate the risk of appendicitis, the RIPAS scoring system was modified with additional characteristics. Despite of the numerous studies evaluating scoring systems, the studies have not yet reached the same conclusion, and the findings have varied among nations.[3] In the present study, we compared two scoring systems, RIPASA and Alvarado, to detect acute appendicitis in patients referred to the Middle East's Accident and Emergency (A&E) Department with acute RIF pain. The results of this study for Alvarado and RIPASA scores showed sensitivity of 67.1% versus 86.6%, specificity of 72.2% versus 66.7%, PPV of 91.7% versus 92.2% NPV of 32.5% versus 52.2%. In the present study, the ROC curve was constructed to determine the optimal cutoff score for both scoring systems based on their sensitivity and specificity. For Alvarado, a cut-off score of higher than seven was determined, but for RIPASA, the optimal cut-off value was higher than 7.5. The AUC was 0.87 for RIPASA which was more than that for Alvarado score. The diagnostic accuracy of Alvarado and RIPASA criteria in this study was 68% and 83%, respectively. Both systems can assist surgeons in diagnosing acute appendicitis; however, the RIPASA system was more sensitive and offered better estimation methods than the Alvarado score. In a similar study, Praveena Suresh et al. reported that the sensitivity of RIPASA score was more highly than Alvarado (100% vs. 60.8%, respectively).[14] consistent with our findings, Parmeshwar et al.[15] reported sensitivity of 94.73% for RIPASA scoring system and 67.36% for Alvarado that was closed to our findings (67.1% vs. 67.36%). Next, we evaluated the specificity of scoring systems. In the study by Rodrigues et al.,[16] it was reported that the Alvarado score had a better specificity than the RIPASA score, although it had a higher sensitivity. In this regard, Damani et al.[17] found that the RIPAS score has a sensitivity, specificity, PPV, and NPV of 91%, 60%, 95%, and 42%, respectively, While the Alvarado criterion had a sensitivity, specificity, PPV and NPV of 67%, 95%, 95%, and 10%. In this study, the specificity of the Alvarado score (72.2%) was greater than that of the RIPASA (66.6%). In addition, in the study of Chong et al.[3] was stated that the Alvarado scoring system has a sensitivity of 59% and a specificity of 23% in an Asian society.[18–20] In contrast, specificity of Alvarado was greater in the present research (67.1% sensitivity and 72.2% specificity). In the Middle East, Alvarado score estimates may be more reliable than in East Asia. In the study conducted by Malik et al. in western countries, the sensitivity (85.9%) and specificity (69.8%) of the RIPASA score in a population with a relatively equal gender distribution were lower than in earlier studies.[21] It was possible that the larger proportion of male patients in previous trials affected the outcomes.[22] Nevertheless, in our study, even though 57% of the patients were male, the evaluation with the RIPASA score was similar to Malik et al.'s[22] study (sensitivity 86.6% and specificity 66.7%); this shows gender distribution in the study cannot be effective in diagnostic accuracy. In the study of Regar et al.[23] Sensitivity, specificity, PPV, and NPV of RIPASA score were calculated as 94.74%, 60%, 97.83%, and 37.5%, respectively. Khadda et al.[24] observed similar findings, Sensitivity, specificity, PPV, and NPV were calculated as 97.73%, 77.42%, 86%, and 96%. Similar results were reported by other research.[25–27] Nonetheless, in the current investigation, the sensitivity of RIPASA was slightly lower than in other studies, which may have dependent on the examiner. Overall, the RIPASA scoring system was more reliable than Alvarado's; therefore, it can be used to evaluate patients with RIF pain in the A&E setting and, if necessary, the on-call surgeon can be informed so that they can determine the next procedure to take after performing the necessary investigations. It is also recommended that physicians in rural areas without CT scan units evaluate patients using the RIPASA score. In addition to the great importance of correctly diagnosing patients with a high probability of appendicitis, it is also important to correctly diagnose patients with a low probability of appendicitis. Overdiagnosis of appendicitis increases the number of negative or unnecessary appendectomy cases, such that in the study by Kalan et al.,[28] negative appendectomy rate were estimated to be between 20% and 40%.[28–30] In previous studies, Shuaib et al.[31] and Rathod et al.[32] reported 18.4% and 20.69%, respectively. Several surgeons believe that raising the incidence of negative appendectomy to reduce the frequency of delay in the diagnosis of appendicitis and its related complications is admissible.[33] In the present study, patients were evaluated using the standard hospital method to assess the necessity for appendectomy, and 18% of patients had a negative appendectomy. Incredibly, according to RIPASA score, out of 77 patients in the group with a high probability of acute appendicitis, HPE ruled out acute appendicitis in just 7.8% of patients, and it could have led to a reduced rate of negative appendectomy.

5 | CONCLUSION

The RIPASA score system had higher sensitivity, PPV, NPV, and accuracy than the Alvarado one. It is recommended for the physician and surgeon to evaluate patients with RIF pain using the RIPASA score.

AUTHOR CONTRIBUTIONS

Naeimeh Heiranizadeh: conceptualization; data curation; methodology; project administration; supervision; writing – review & editing. **Seyyed Mohammad Hossein Mousavi Beyuki**: data curation; investigation; methodology; project administration; validation; writing – original draft; writing – review & editing. **Saeed kargar**: conceptualization; data curation; methodology; supervision; visualization; writing – review & editing. **Aryana Abadiyan**: data curation; validation; writing – original draft; writing – review & editing. **Hamid Reza Mohammadi**: formal analysis; methodology; software; writing – original draft; writing – review & editing.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The datasets and/or analysed data will be open access and available from the corresponding author on reasonable request.

ETHICS STATEMENT

Approval was obtained from the ethics committee of Shahid Sadoughi University of Medical Sciences. The procedures used in this study adhere to the tenets of the Declaration of Helsinki. All participants have signed an informed consent which includes the consent for publication.

TRANSPARENCY STATEMENT

The lead author Hamid Reza Mohammadi affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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