

Comparison of the effectiveness of RIPASA and modified Alvarado scores in identifying perforated appendicitis

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ABSTRACT

BACKGROUND: Acute appendicitis is one of the most common emergency surgical conditions and may progress to perforation, sepsis, and mortality if not treated promptly. This study aimed to evaluate the effectiveness of the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score and the Modified Alvarado Scoring System (MASS) in identifying perforated acute appendicitis.

METHODS: This study included 164 patients admitted to the General Surgery Department between June 2023 and December 2023 with a preliminary diagnosis of acute appendicitis. MASS and RIPASA scores, along with demographic data, were obtained from the Hospital Information Management System (HIMS) at the time of diagnosis.

RESULTS: A total of 153 patients were included in the final analysis. The mean age was 35.2±14.1 years (range: 18–82 years). Perforation was identified in 15.8% of cases evaluated by ultrasonography (USG) and 6.1% of those assessed by computed tomography (CT). A RIPASA score >7 demonstrated a sensitivity of 71.1% and a specificity of 54.7% for detecting perforation. Patients with perforation had significantly higher RIPASA and MASS scores (both p<0.001) and longer hospital stays (p<0.001).

CONCLUSION: Compared with the MASS scoring system, the RIPASA score demonstrates higher sensitivity and specificity and is associated with greater inflammation when elevated. Its incorporation into routine clinical practice may facilitate faster, more efficient, and cost-effective management in emergency and general surgical settings.

Keywords: Acute appendicitis; Modified Alvarado Scoring System; perforation; RIPASA.

INTRODUCTION

Acute appendicitis is one of the most common general surgical emergencies worldwide and often requires urgent surgical intervention. The lifetime risk is estimated at 8.6% in males and 6.7% in females.^[1] If not treated promptly, acute appendicitis may progress to perforation, sepsis, and death, making early diagnosis and timely management essential. Surgical treatment is the standard of care, with both open and laparoscopic approaches widely used.

Clinically, acute appendicitis typically presents with pain migrating from the epigastric region to the right lower quadrant; however, presentations can vary considerably. Ultrasonography (USG) is the most commonly used imaging modality in the diagnosis of acute appendicitis, whereas computed tomography (CT) is considered the gold standard. In addition to imaging, various scoring systems have been developed to aid diagnosis and to differentiate appendicitis from other causes of acute abdomen. Among these, the Alvarado score (AS), introduced in 1986 and subsequently modified, is the most widely used. According to a 2023 meta-analysis, the sensitiv-

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ity of the Modified Alvarado Scoring System (MASS) ranges from 14% to 97%.^[2] Although the Modified Alvarado Scoring System demonstrates good sensitivity and specificity, its development in Western populations may limit its generalizability. To address this limitation, the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score was introduced in 2010 to improve the diagnosis of acute appendicitis in Eastern populations and has demonstrated higher sensitivity and specificity compared with MASS.^[2] Although several studies have reported the superiority of RIPASA over MASS in diagnosing acute appendicitis,^[2-5] no consensus exists regarding their relative effectiveness in the early and accurate identification of perforated acute appendicitis. Therefore, this study aimed to evaluate the effectiveness of RIPASA and MASS in diagnosing perforated acute appendicitis.

MATERIALS AND METHODS

This study included 164 patients admitted to the General Surgery Department of Gulhane Training and Research Hospital between June 2023 and December 2023 with a preliminary diagnosis of acute appendicitis. Eleven patients were excluded based on predefined exclusion criteria. The study was approved by the local ethics committee (decision no. 14/3, dated July 10, 2024) and was conducted in accordance with the ethical principles of the Declaration of Helsinki of the World Medical Association for research involving human subjects. All authors declare that the study complied with the Declaration of Helsinki and was prepared in accordance with the ethical standards of Türkiye. Patient data, including sex, age, MASS and RIPASA scores at admission, preoperative imaging findings, type of surgery performed, length of hospital stay, and postoperative pathology results, were retrospectively obtained from the Hospital Information Management System (HIMS). Patients under 18 years of age and those with pathology results indicating neoplasia were excluded. Cases with intraoperative perforation were identified based on surgical notes.

The RIPASA score includes more parameters than the MASS score. This system comprises a total of 18 parameters, with a maximum possible score of 17.5. One point is assigned for male sex, age under 40 years, anorexia, nausea and vomiting, symptom duration of less than 48 hours, right lower quadrant tenderness, rebound tenderness, elevated body temperature, increased white blood cell count, negative urine analysis, and foreign nationality. Half a point (0.5) is assigned for female sex, age over 40 years, right lower quadrant pain, migration of pain to the right lower quadrant, and symptom duration longer than 48 hours. Guarding in the right lower quadrant is assigned 2 points. The total score is calculated by summing these parameters.^[5]

Statistical analyses were performed using SPSS version 22.0. Descriptive statistics were presented as numbers, percentages, means, standard deviations, and medians (interquartile

range). The normality of variable distribution was assessed using visual methods (histograms and probability plots) and analytical tests (Kolmogorov–Smirnov and Shapiro–Wilk tests). Continuous variables were compared between the two groups using the Student's *t*-test. Nominal and categorical variables were analyzed using the chi-square test or Fisher's exact tests. The predictive value and diagnostic performance of the scoring systems for identifying perforation and negative appendectomy were evaluated using receiver operating characteristic (ROC) curve analysis. ROC results were expressed as the area under the curve (AUC) with 95% confidence intervals. The optimal cutoff value for diagnostic performance was determined using the Youden index. Diagnostic performance at the selected cutoff was reported in terms of sensitivity, specificity, positive likelihood ratio (+LR), negative likelihood ratio (–LR), positive predictive value (PPV), and negative predictive value (NPV). A *p*-value <0.05 was considered statistically significant for all analyses. Statistical analyses were performed using IBM SPSS Statistics, version 22.0 (IBM Corporation, Armonk, New York, United States).

RESULTS

The study included 153 patients with a mean age of 35.2±14.1 years (range: 18–82 years). Of these, 62.1% were male, corresponding to a male-to-female ratio of 1.6:1. CT was performed in 115 patients, while USG was used in 38 patients. Perforation was detected in 15.8% of patients in the USG group and 6.1% in the CT group. The mean RIPASA score was 7.3±1.5 (range: 4–11), and the mean MASS score was 5.8±1.8 (range: 1–10). Overall, perforation was observed in 24.8% of cases. A laparoscopic approach was used in most surgeries (74.5%), with conversion to open surgery required in 6.5% of patients. The negative appendectomy rate was 11.8%.

Descriptive characteristics were further analyzed according to the presence of perforation. Patients with perforation were significantly older (*p*=0.002). They also had significantly higher RIPASA (*p*<0.001) and MASS scores (*p*<0.001), as well as longer hospital stays (*p*<0.001). Among patients without perforation, USG suggested perforation in two cases; however, in all cases where CT indicated perforation, the diagnosis was confirmed.

Descriptive characteristics were also compared according to the presence of negative appendectomy. Patients who underwent negative appendectomy were significantly younger (*p*=0.002) and had significantly lower RIPASA (*p*=0.001) and MASS (*p*<0.001) scores. In one case evaluated by USG, findings were not consistent with acute appendicitis.

The predictive accuracy of the scoring systems for perforated acute appendicitis was assessed using ROC analysis. Both RIPASA (AUC=0.689, cutoff>7, *p*<0.001) and MASS (AUC=0.697, cutoff>6, *p*<0.001) were identified as signifi-

Table 1. Predictive value of the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Modified Alvarado Scoring System (MASS) scores for perforation and negative appendectomy

	AUC	95% CI	p value
Perforated appendicitis			
RIPASA	0.689	0.609-0.761	<0.001
MASS	0.697	0.618-0.769	<0.001
USG	0.753	0.587-0.878	0.014
CT	0.613	0.518-0.702	0.003
RIPASA >7 + USG	0.726	0.557-0.858	0.001
RIPASA >7 + CT	0.641	0.546-0.728	0.004
MASS >6 + USG	0.735	0.567-0.865	0.005
MASS >6 + CT	0.706	0.614-0.787	<0.001
Negative appendectomy			
RIPASA	0.754	0.678-0.820	<0.001
MASS	0.737	0.660-0.805	<0.001

Table 2. Diagnostic performance of the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Modified Alvarado Scoring System (MASS) scores for predicting perforation and negative appendectomy

	Cutoff	Sensitivity	Specificity	+LR	-LR	PPV	NPV
Perforated appendicitis							
RIPASA	>7	71.1	54.7	1.57	0.53	34.2	85.1
MASS	>6	63.1	68.7	2.02	0.54	40.0	84.9
USG	–	57.1	93.5	8.86	0.46	66.7	90.6
CT	–	22.5	100.0	–	0.77	100.0	77.8
RIPASA >7 + USG	–	100.0	45.1	1.82	–	29.2	100.0
RIPASA >7 + CT	–	70.9	57.1	1.66	0.51	37.9	84.2
MASS >6 + USG	–	85.7	61.2	2.21	0.23	33.3	95.0
MASS >6 + CT	–	70.9	70.2	2.38	0.41	46.8	86.8
Negative appendectomy							
RIPASA	<6.5	67.6	70.5	2.30	0.46	94.8	21.4
MASS	<4	83.8	58.8	2.04	0.28	94.2	31.3

cant predictors. USG demonstrated higher predictive accuracy for perforation (AUC=0.753, p=0.014) compared with CT (AUC=0.613, p=0.003). When imaging modalities were combined with scoring systems, the strongest predictors of perforation were MASS >6 + USG (AUC=0.735, p=0.005) and RIPASA >7 + USG (AUC=0.726, p=0.001) (Table 1).

A RIPASA score >7 yielded a sensitivity of 71.1% and a specificity of 54.7% for detecting perforation. When combined with USG, RIPASA >7 demonstrated 100% sensitivity and 45.1% specificity, while combination with CT resulted

in 70.9% sensitivity and 57.1% specificity. A MASS score >6 demonstrated a sensitivity of 63.1% and a specificity of 68.7% for detecting perforation. In combination with USG, MASS >6 achieved 85.7% sensitivity and 61.2% specificity; when combined with CT, it showed 70.9% sensitivity and 70.2% specificity. For predicting negative appendectomy, a RIPASA score <6.5 demonstrated 67.6% sensitivity and 70.5% specificity, whereas a MASS score <4 showed 83.8% sensitivity and 58.8% specificity. The ROC curves of RIPASA and MASS for predicting perforation are presented in Figure 1, and detailed results are summarized in Table 2.

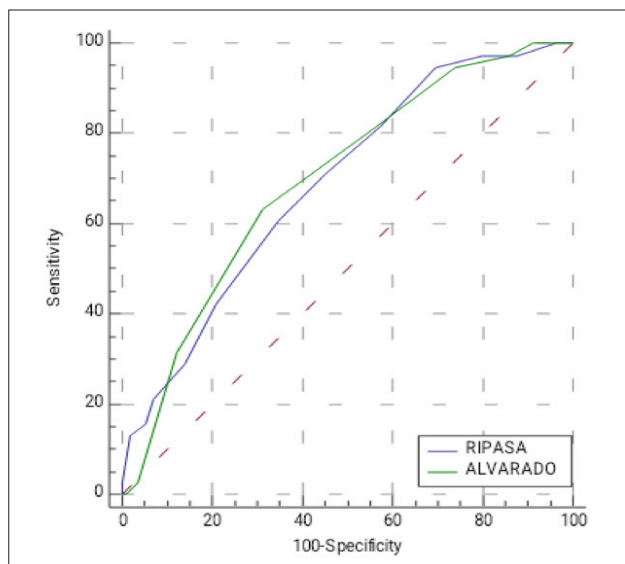


Figure 1. Receiver operating characteristic (ROC) curves of the Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Modified Alvarado Scoring System (MASS) scores for predicting perforation.

DISCUSSION

The definitive diagnosis of acute appendicitis is established through histopathological examination. However, given that delays in diagnosis and treatment increase morbidity and mortality, rapid and accurate clinical diagnostic tools are essential. In current clinical practice, patients with suspected acute appendicitis are typically first evaluated using ultrasonography; if the findings are inconclusive, a CT is subsequently performed. Although these imaging modalities demonstrate high sensitivity and specificity, they are not always readily available in all healthcare settings. Additionally, factors such as retrocecal positioning of the appendix, perforation, and patient obesity may reduce the sensitivity and specificity of these imaging techniques.^[6] Their use also contributes to increased healthcare costs. Furthermore, CT raises concerns regarding radiation exposure, leading to ongoing debate about its routine use.^[7]

The most widely used scoring system worldwide, the MASS, has been debated in terms of its effectiveness in Eastern populations, as it was primarily developed based on Western cohorts. Consequently, the RIPASA scoring system, developed specifically for Eastern populations, has been reported to demonstrate higher specificity and sensitivity.^[10] In a study by Memon et al.,^[11] the sensitivity and specificity of MASS in Eastern populations were reported as 93.5% and 80.6%, respectively. The 2015 World Society of Emergency Surgery (WSES) Jerusalem guidelines stated that an Alvarado score <5 is sufficiently sensitive to exclude acute appendicitis but lacks specificity to confirm the diagnosis.^[12]

In a study by Chong et al.,^[13] the RIPASA score with a cutoff value of 7.5 demonstrated higher specificity and sensitivity

than MASS. Similarly, studies by Radhoth et al.,^[14] Nanjundiah et al.,^[15] and Erdem et al.^[16] have shown that RIPASA outperforms MASS in both sensitivity and specificity. In the study conducted by Mumtaz et al.,^[4] the RIPASA score demonstrated a sensitivity of 96% and a specificity of 82%. Compared with our findings, these values indicate substantially higher sensitivity and specificity. This discrepancy may be explained by the retrospective design of our study, which limited the inclusion of patient-reported symptoms in the scoring. However, some studies have reported no significant difference between RIPASA and MASS in diagnosing suspected appendicitis.^[17] In one study including 72 patients, the sensitivity and specificity of RIPASA were 93.3% and 8.3%, respectively, whereas those of MASS were 75% and 41.6%, respectively. Notably, that study used a cutoff value of 8.5 for RIPASA and 6 for MASS.

To our knowledge, no previous studies have examined the correlation between imaging findings and RIPASA and MASS scores as investigated in our study. Among our patients, the mean RIPASA score was 8.1 ± 1.4 in perforated cases and 7.0 ± 1.4 in non-perforated cases. The mean MASS score was 6.7 ± 1.3 in perforated cases and 5.5 ± 1.8 in non-perforated cases. ROC curve analysis for perforated appendicitis identified cutoff values of 7 for RIPASA and 6 for MASS. A RIPASA score >7 demonstrated a sensitivity of 71.1% and a specificity of 54%, while a MASS score >6 showed a sensitivity of 63.1% and a specificity of 68.7%. These values are lower than those reported in similar studies.^[13-15,19] This discrepancy may be attributed to the heterogeneity of our study population.

In a prospective study conducted by Koroth et al.,^[20] appendicitis cases were stratified according to pathological stage using RIPASA-based risk groups (low, moderate, and high). No cases of perforated appendicitis were observed in the low-risk group, while a perforation rate of 0.9% was reported in the moderate-risk group. In contrast, the high-risk group (RIPASA score ≥ 12) demonstrated a perforation rate of 17.3%.

Perforated appendicitis is a major cause of mortality and morbidity, particularly in elderly patients. Delays in diagnosis and treatment are associated with prolonged hospital stays and increased healthcare costs. Therefore, in settings where imaging modalities are unavailable or a general surgeon is not present, the RIPASA scoring system can be used to assess patient risk and guide transfer decisions based on clinical urgency. Such an approach may also help reduce unnecessary workload in centers with high surgical or emergency department volume.

This study has several limitations. The retrospective design and incomplete data for some patients represent important constraints. Additional limitations include the relatively small sample size, the heterogeneity of the study population, and the lack of internal risk stratification within the scoring systems.

CONCLUSION

Compared with the MASS score, the RIPASA score demonstrates higher sensitivity and specificity and better reflects the severity of inflammation when elevated. Therefore, the RIPASA scoring system may be considered a valuable tool in routine clinical practice, facilitating faster, more efficient, and cost-effective decision-making in emergency departments and general surgery settings.

Ethics Committee Approval: This study was approved by the University of Health Sciences Gülhane Health Practice and Research Center Scientific Research Evaluation Board (Date: 10.07.2024, Decision No: 14/3).

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Conflict of Interest: None declared.

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ORİJİNAL ÇALIŞMA - ÖZ

RIPASA ve Modifiye Alvarado Skorlarının perforate apandisitleri tanımadaki etkinliğinin karşılaştırılması

AMAÇ: Akut apandisit dünya genelinde en sık karşılaşılan ve acil cerrahi müdahale gerektiren genel cerrahi acillerinden birisidir. Akut apandisit erken dönemde tedavi edilmediği takdirde perforasyon, sepsis ve mortalite ile seyredebilir; bu nedenle erken tanı ve tedavi önemlidir. Bu çalışmada, perforate akut apandisitlerin tanısında Raja İsteri Pengiran Anak Saleha Appendicitis (RIPASA) ve Modifiye Alvarado Skor Sistemi'nin (MASS) etkinliğini araştırmayı amaçladık.

GEREÇ VE YÖNTEM: Bu çalışmaya, genel cerrahi kliniğine Haziran 2023-Aralık 2023 tarihleri arasında akut apandisit ön tanısıyla yatırılan 164 hasta alındı. Hastaların cinsiyet, yaş, başvuru esnasındaki MASS ve RIPASA skorları, preoperatif görüntüleme bulguları, yapılan ameliyatın türü, hastaların yatış süresi ve postoperatif patoloji sonuçları retrospektif olarak Hastane Bilgi Yönetimi Sistemleri (HBYS) üzerinden toplandı.

BULGULAR: Çalışmaya alınan 153 hastanın yaş ortalaması 35.2 ± 14.1 yıl idi (dağılım, 18-82 yaş). Ultrasonografi (USG) ile değerlendirilen olguların %15.8'inde, Bilgisayarlı Tomografi (BT) ile değerlendirilenlerin %6.1'inde perforasyon bildirildi. RIPASA skorunun 7'nin üzerinde olması perforasyon için %71.1 sensitivite, %54.7 spesifite göstermekteydi. Perforasyon izlenen olguların RIPASA ($p < 0.001$) ve MASS ($p < 0.001$) skorları daha yüksek, hospitalizasyon süresi daha uzundu ($p < 0.001$).

SONUÇ: RIPASA skoru MASS skoruna göre daha yüksek sensitive ve spesifiteye sahiptir ve RIPASA skorunun daha yüksek değerlerde olması daha şiddetli inflamasyonun bir göstergesidir. Bu nedenle acil servislerde ve genel cerrahi pratiğinde daha hızlı, etkin ve düşük maliyetli işlemler yapabilmek için günlük pratiğe hızlıca alınmalıdır.

Anahtar sözcükler: Akut apandisit; Modifiye Alvarado skor sistemi; perforasyon; RIPASA.

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