







A comparative study of the RIPASA and Alvarado scores in geriatric patients diagnosed with acute appendicitis

Davut Tekyol¹ , Rohat Ak^{2*} , Nihat Müjdat Hökenek² , Mazlum Kılıç³ , Kübra Kaytaç Tekyol⁴ , Doğan Erdoğan⁵ 

SUMMARY

OBJECTIVE: While abdominal pain is one of the most prevalent reasons for seeking medical attention, diagnosing elderly adults with acute appendicitis (AA) may be difficult. In this study, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Alvarado ratings were evaluated for diagnostic accuracy in patients who reported to the emergency department complaining of abdominal pain and received surgery for AA.

METHODS: The data of patients over the age of 65 years who reported to the ER and had appendectomy after being diagnosed with AA were evaluated in this retrospective cohort study. For each patient, the diagnostic accuracy of the Alvarado and RIPASA scores was determined individually.

RESULTS: A total of 86 patients were included in the research. The average patient was 71.2 years old, with a male preponderance of 46.5%. Alvarado's score was found to have an area under the curve (AUC) of 0.799, the Youden's index of 0.549, and a p-value of 0.001 after a receiver operating characteristic (ROC) study of the Alvarado score in identifying the diagnosis of AA. The AUC was 0.886 (95%CI 0.799–0.944), the Youden's index was 0.642, and a p-value of 0.001 was found in the ROC analysis of the RIPASA score in identifying the diagnosis of AA.

CONCLUSIONS: When comparing the two scores used to diagnose AA, we found no statistically significant difference between the RIPASA and Alvarado scores ($p=0.09$), although the Youden's index for the RIPASA score was higher.

KEYWORDS: Elderly. Geriatrics. Appendicitis. Alvarado score. RIPASA score.

INTRODUCTION

Although acute appendicitis (AA) is a prevalent cause of abdominal pain in geriatric patients, diagnostic challenges persist^{1,2}. Complication rates are particularly greater in older patients than younger individuals, who more commonly report to the emergency room with stomach discomfort and unusual symptoms³. Similarly, the death rate for people with AA over the age of 65 years may grow to 8%⁴. Age more than 65 years was shown to be a significant risk factor for death in a large observational study including 164,579 people diagnosed with AA⁵.

Due to the fact that a delayed diagnosis of AA in senior patients increases morbidity and mortality, current evidence-based recommendations urge the adoption of scoring systems in this age range⁶. The Alvarado score, which was created in 1986, is one of the most popular of these grading systems. The Alvarado score is composed of eight components, which include patient complaints, physical examination results, and laboratory data⁷. In 2010, a new scoring system, called the Raja Isteri Pengiran

Anak Saleha Appendicitis (RIPASA), was created for the diagnosis of AA, which has 15 parameters⁸. It was claimed that when applied to the Asian population, the sensitivity and specificity of this scoring system will rise⁹.

The goal of this study was to compare the RIPASA and Alvarado scoring systems in patients who arrived at the emergency department with abdominal pain and had AA surgery.

METHODS

Study design

Between January 1, 2018 and January 1, 2021, this retrospective cohort study was conducted in the emergency department at the Haydarpaşa Numune Education and Research Hospital. The institutional review board authorized the analysis and waived permission (Ethics Committee Ruling number: HNEAH-KAEK 2022/88).

¹Haydarpaşa Numune Education and Research Hospital, Department of Emergency Medicine – Istanbul, Turkey.

²Kartal Dr. Lütfi Kırdar City Hospital, Department of Emergency Medicine – Istanbul, Turkey.

³Fatih Sultan Mehmet Education and Research Hospital, Department of Emergency Medicine – Istanbul, Turkey.

⁴Kovancılar State Hospital, Department of General Surgery – Elazığ, Turkey.

⁵Haydarpaşa Numune Education and Research Hospital, Department of General Surgery – Istanbul, Turkey.

*Corresponding author: rohatakmd@gmail.com

Conflicts of interest: the authors declare there is no conflicts of interest. Funding: none.

Received on April 05, 2022. Accepted on June 30, 2022.

Selection of patients

The study population comprised all patients over the age of 65 years who attended to an emergency room with abdominal discomfort and received open or laparoscopic appendectomy throughout the study period. Histopathological studies validated the diagnosis of AA. Each patient's medical computerized data were examined retrospectively, and the Alvarado and RIPASA ratings were computed independently (Table 1). Patients with missing data necessary for the scoring criteria, as well as those under the age of 65 years, were excluded from the study. Using an area under the curve (AUC) value of at least 0.7 as the minimum needed sample size for the investigation, a minimum of 62 patients was computed.

The statistical analyses were conducted using SPSS Statistics version 19.0 (IBM Corp., Armonk, NY, USA) and MedCalc version 19. The mean, standard deviation, median, and interquartile range values were used to describe the data. The Kolmogorov-Smirnov test was used to determine if the data were normally distributed.

The receiver operating characteristic (ROC) curve analysis was utilized to estimate the Alvarado and RIPASA cutoff values

for AA diagnosis prediction. The ROC curves of these scores were compared. The DeLong approach was used to compute the appropriate cutoff, 95% confidence interval (CI), AUC, positive predictive (PPV), and negative predictive (NPV) values using Youden's index (YJI). The value 0.05 was chosen as the threshold of significance.

RESULTS

The study was completed with 86 patients who met the inclusion criteria. The mean age of these patients was 71.2 ± 5.9 years, and 46.5% were men. As a result of the statistical analysis, it was determined that the median values of the white blood cell and neutrophil counts, Alvarado, and RIPASA scores were statistically substantially higher in individuals with an appendicitis histological diagnosis compared to those without appendicitis. The negative appendectomy rate of the patients included in the study was found to be 24.4% (Table 2).

As a result of the ROC analysis of the Alvarado score in determining the diagnosis of AA, the AUC value was 0.799 (95%CI 0.698–0.877), YJI was 0.549, and the p-value was 0.001. According to the statistical analysis, the Alvarado score was statistically significant in determining the diagnosis of AA ($p=0.001$). At a cutoff value of >4 , the Alvarado score had a sensitivity of 69.2%, specificity of 85.7%, PPV of 93.7%, and NPV of 47.4% in predicting a diagnosis of AA (Table 3).

The ROC analysis of the RIPASA score in determining the diagnosis of AA revealed that the AUC value was 0.886 (95%CI 0.799–0.944), YJI was 0.642, and the p-value was 0.001. According to the statistical analysis, the RIPASA score was statistically significant in determining the diagnosis of AA ($p=0.001$). At a cutoff value of >8 , the RIPASA score had 78.5% sensitivity, 85.7% specificity, 94.4% PPV, and 56.2% NPV in predicting an AA diagnosis (Table 3).

When the two scoring systems' values for diagnosing AA were compared, despite the fact that the RIPASA score's YJI value was greater, there was no statistically significant difference ($p=0.09$) (Table 3).

DISCUSSION

This study evaluated the adequacy of the Alvarado and RIPASA scores in determining the diagnosis of AA in patients who underwent appendectomy for AA. It was concluded that both scores had high diagnostic accuracy, and neither was superior to the other.

Early detection of AA is critical in older individuals with a high rate of death and morbidity. In a study conducted in

Table 1. Comparison of Alvarado and RIPASA scoring systems.

	Alvarado score	RIPASA score
Sex	–	Female +0.5
Male +1		
Age (years)	–	<40 +1
>40 +0.5		
Duration of symptoms	–	<48 h +1
>48 h +0.5		
Anorexia	1	1
Nausea or vomiting	1	1
RIF pain/tenderness	2	0.5 +1*
Elevated temperature	1	2
Guarding	–	2
Rebound tenderness	1	1
Rovsing's sign	–	2
Migration of pain to RIF	1	0.5
Leukocytosis (>10,000)	2	1
Leukocyte left shift (>75%)	1	–
Normal urine analysis	–	1
Total	10	16
Possible diagnosis appendicitis	>6–7	>7.5

RIF: right iliac fossa. *Score combined: 0.5 point for RIF pain (symptom) and 1 point for right iliac fossa tenderness (sign).

Finland, the data of 164,579 patients who underwent appendectomy surgery over a 20-year period were examined, and it was reported that mortality increased 39 times in patients aged over 65 years. Similarly, the same study determined that negative appendectomy increased mortality fourfold¹⁰. In the literature, the rate of negative appendectomy in geriatric patients ranges from 17% to 31%¹¹⁻¹³. In the current cohort, the rate of negative appendectomy was found to be 24.4%, which is consistent with the literature.

Due to increased life expectancy, diseases previously associated with younger populations, including AA, have a growing incidence among elderly patients¹⁴. Although the lifetime risk of AA is 7% for the general population, this rate can rise to 10% in the elderly population¹⁵. As in many diseases, the clinical diagnosis process in AA is more difficult in the geriatric population than in young people. This is partly due to pain sensations altered by changes in nerve conduction due to aging, resulting in overlooking the classical findings of AA¹⁶. Since a delayed diagnosis will increase mortality and morbidity, many guidelines recommend using clinical score systems in the initial evaluation process of patients⁶.

Alvarado⁷, a 10-point scale based on indications, symptoms, and laboratory data, is one of the most widely used and examined scoring systems for the AA assessment. A score of 5 or 6 points on the Alvarado scale is considered consistent with the diagnosis of AA; a score of 7 or 8 suggests a plausible diagnosis of AA; and a score of 9 or 10 indicates a very probable diagnosis of AA. This diagnostic score is designed to assist clinicians in making clinical decisions by objectively determining which patients should be observed and which should receive surgery. This is a limited research examining the Alvarado score's relevance in the older population. A retrospective analysis of 96 patients over the age of 65 years revealed that using the Alvarado scoring system with a cutoff value of 5 resulted in accurate findings in senior individuals. It was noted in a study that an Alvarado score of 5–10 indicated a greater risk of appendicitis in the elderly¹⁷. In another study, the Alvarado and Lintula scores were compared in senior patients undergoing appendectomy, and the former was shown to be a more helpful prediction tool, with an AUC value of 96.9%¹⁸. A research indicated that the Alvarado score is ineffective at differentiating between difficult and simple AA in older people¹⁹.

Table 2. Comparison of some characteristics between the patients with (+) and without (-) a histopathological diagnosis of appendicitis.

		n	Mean	Median	IQR	p-value
Age	-	21	72.48	71.0	10	0.235*
	+	65	70.72	70.0	7	
Body temperature	-	21	36.39	36.4	0.2	0.146*
	+	65	36.50	36.5	0.4	
White blood cell count	-	21	9,277.14	9300	4,690	0.002*
	+	65	12,933.85	13,330	7,820	
Neutrophil count	-	21	7,201.43	6490	5,155	0.001*
	+	65	10,295.38	10,860	6,560	
Neutrophil percentage	-	21	74.40	72.1	20.8	0.286*
	+	65	77.93	79.6	12.2	
Alvarado score	-	21	3.48	3.0	1.0	0.001*
	+	65	5.29	6.0	2.5	
RIPASA score	-	21	5.90	5.5	3.3	0.001*
	+	65	9.63	10.0	2.5	

IQR: interquartile range. *Mann-Whitney U test.

Table 3. Comparison of the Alvarado and RIPASA scores in determining the diagnosis of acute appendicitis.

	AUC	Cutoff	Sensitivity	Specificity	+LR	-LR	PPV	NPV	Youden's index	p-value
Alvarado	0.799 (0.698–0.877)	>4	69.2 (56.6–80.1)	85.7 (63.7–97.0)	4.85	0.36	93.7	47.4	0.549	0.09
RIPASA	0.886 (0.799–0.944)	>8	78.5 (66.5–87.7)	85.7 (63.7–97.0)	5.49	0.25	94.4	56.2	0.642	

AUC: area under the curve; LR: likelihood ratio; PPV: positive predictive value; NPV: negative predictive value.

The RIPASA score, which we compared with the Alvarado score in our study, is one of the scoring systems developed in 2010 and has since been widely adopted. This score has 14 parameters, including clinical history, physical examination, and various laboratory data. In this scoring system, the total score varies between 3 and 16.5. A score below 7 is associated with a low AA risk, and a score of 7.5 and above is associated with a high AA risk⁸. In a study conducted in Ireland, it was reported that a RIPASA score of 7.5 and above provided higher sensitivity and specificity than the Alvarado score²⁰. In a retrospective cohort of 68 patients over the age of 65 years who underwent appendectomy, the sensitivity of the RIPASA score was determined as 86.2%, specificity as 40%, PPV as 89.3%, and NPV as 33.3%²¹. In the current cohort, the RIPASA score had a sensitivity of 78.5%, specificity of 85.7%, PPV of 94.4%, and NPV of 56.2%, while for the Alvarado score, these values were 69.2%, 85.7%, 93.7%, and 47.4%, respectively.

There are some limitations to our study. First, our results cannot be generalized to the general population since they were obtained from a single center. Second, since this study was retrospective, it is possible that the results were influenced by inadequate or erroneous data in hospital records. Another disadvantage is the small patient population.

REFERENCES

1. Tantarattanapong S, Arwae N. Risk factors associated with perforated acute appendicitis in geriatric emergency patients. *Open Access Emerg Med.* 2018;10:129-34. <https://doi.org/10.2147/OAEM.S17393>
2. Bayrak S, Tatar C, Cakar E, Colak S, Gunes ME, Tekesin K, et al. Evaluation of the predictive power of laboratory markers in the diagnosis of acute appendicitis in the elderly. *North Clin Istanb.* 2019;6(3):293-301. <https://doi.org/10.14744/nci.2019.93457>
3. Fan SM, Grigorian A, Smith BR, Kuza CM, Lekawa M, Schubl SD, et al. Geriatric patients undergoing appendectomy have increased risk of intraoperative perforation and/or abscess. *Surgery.* 2020;168(2):322-7. <https://doi.org/10.1016/j.surg.2020.04.019>
4. Kraemer M, Franke C, Ohmann C, Yang Q, Acute Abdominal Pain Study Group. Acute appendicitis in late adulthood: incidence, presentation, and outcome. Results of a prospective multicenter acute abdominal pain study and a review of the literature. *Langenbecks Arch Surg.* 2000;385(7):470-81. <https://doi.org/10.1007/s004230000165>
5. Kotaluoto S, Ukkonen M, Pauniahio SL, Helminen M, Sand J, Rantanen T. Mortality related to appendectomy; a population based analysis over two decades in Finland. *World J Surg.* 2017;41(1):64-9. <https://doi.org/10.1007/s00268-016-3688-6>
6. Fugazzola P, Ceresoli M, Agnoletti V, Agresta F, Amato B, Carcoforo P, et al. The SIFIPAC/WSES/SICG/SIMEU guidelines for diagnosis and treatment of acute appendicitis in the elderly (2019 edition). *World J Emerg Surg.* 2020;15(1):19. <https://doi.org/10.1186/s13017-020-00298-0>

CONCLUSIONS

Diagnosing AA in the elderly continues to be difficult owing to the broad number of potential diagnoses and clinical manifestations seen in this group. It is necessary to use clinical risk scoring systems that will help identify patients with AA early. In this study, we concluded that both the RIPASA and Alvarado scores had high diagnostic accuracy in the detection of AA in the geriatric patient group, and neither had any superiority over the other.

AUTHORS' CONTRIBUTIONS

DT: Conceptualization, Data curation, Project administration, Resources, Writing – original draft, Writing – review & editing. **RA:** Conceptualization, Project administration, Writing – original draft, Writing – review & editing. **NMH:** Validation, Visualization, Writing – original draft, Writing – review & editing. **MK:** Software, Supervision, Writing – original draft, Writing – review & editing. **KKT:** Project administration, Writing – original draft, Writing – review & editing. **DE:** Project administration, Resources, Software, Supervision, Validation, Visualization.

7. Alvarado A. A practical score for the early diagnosis of acute appendicitis. *Ann Emerg Med.* 1986;15(5):557-64. [https://doi.org/10.1016/s0196-0644\(86\)80993-3](https://doi.org/10.1016/s0196-0644(86)80993-3)
8. Chong CF, Adi MIW, Thien A, Suyoi A, Mackie AJ, Tin AS, et al. Development of the RIPASA score: a new appendicitis scoring system for the diagnosis of acute appendicitis. *Singapore Med J.* 2010;51(3):220-5. PMID: 20428744
9. Ak R, Doğanay F, Akoğlu EU, Akoğlu H, Uçar AB, Kurt E, et al. Predictive value of scoring systems for the diagnosis of acute appendicitis in emergency department patients: is there an accurate one? *Hong Kong Journal of Emergency Medicine.* 2019;27(5):262-9. <https://doi.org/10.1177/1024907919840175>
10. Kotaluoto S, Ukkonen M, Pauniahio SL, Helminen M, Sand J, Rantanen T. Mortality related to appendectomy; a population based analysis over two decades in Finland. *World J Surg.* 2017;41(1):64-9. <https://doi.org/10.1007/s00268-016-3688-6>
11. Joshi MK, Joshi R, Alam SE, Agarwal S, Kumar S. Negative appendectomy: an audit of resident-performed surgery. How can its incidence be minimized? *Indian J Surg.* 2015;77(Suppl 3):913-7. <https://doi.org/10.1007/s12262-014-1063-0>
12. Chamisa I. A clinicopathological review of 324 appendices removed for acute appendicitis in Durban, South Africa: a retrospective analysis. *Ann R Coll Surg Engl.* 2009;91(8):688-92. <https://doi.org/10.1308/003588409X12486167521677>
13. Chooi WK, Brown JA, Zetler P, Wiseman S, Cooperberg P. Imaging of acute appendicitis and its impact on negative appendectomy and perforation rates: the St. Paul's experience. *Can Assoc Radiol J.* 2007;58(4):220-4. PMID: 18186433

14. Deiters A, Drozd A, Parikh P, Markert R, Shim JK. Use of the Alvarado score in elderly patients with complicated and uncomplicated appendicitis. *Am Surg.* 2019;85(4):397-402. PMID: 31043201
15. Omari AH, Khammash MR, Qasaimeh GR, Shammari AK, Yaseen MKB, Hammori SK. Acute appendicitis in the elderly: risk factors for perforation. *World J Emerg Surg.* 2014;9(1):6. <https://doi.org/10.1186/1749-7922-9-6>
16. Emektar E, Dağar S, Karaatlı RH, Uzunosmanoğlu H, Buluş H. Determination of factors associated with perforation in patients with geriatric acute appendicitis. *Ulus Travma Acil Cerrahi Derg.* 2022;28(1):33-8. <https://doi.org/10.14744/tjtes.2020.25741>
17. Shchatsko A, Brown R, Reid T, Adams S, Alger A, Charles A. The utility of the Alvarado score in the diagnosis of acute appendicitis in the elderly. *Am Surg.* 2017;83(7):793-8. PMID: 28738954
18. Konan A, Hayran M, Kiliç YA, Karakoç D, Kaynaroğlu V. Scoring systems in the diagnosis of acute appendicitis in the elderly. *Ulus Travma Acil Cerrahi Derg.* 2011;17(5):396-400. PMID: 22090323
19. Deiters A, Drozd A, Parikh P, Markert R, Shim JK. Use of the Alvarado score in elderly patients with complicated and uncomplicated appendicitis. *Am Surg.* 2019;85(4):397-402. PMID: 31043201
20. Malik MU, Connelly TM, Awan F, Pretorius F, Fiuza-Castineira C, El Faedy O, et al. The RIPASA score is sensitive and specific for the diagnosis of acute appendicitis in a western population. *Int J Colorectal Dis.* 2017;32(4):491-7. <https://doi.org/10.1007/s00384-016-2713-4>
21. Bardakci O, Tatli F. The effectiveness of the Raja Isteri Pengiran Anak Saleha Appendicitis Score in the diagnosis of acute appendicitis in elderly patients. *Signa Vitae.* 2021;17(3):214-7. <https://doi.org/10.22514/sv.2021.027>

