

Comparison between diagnostic accuracy of RIPASA score and Alvarado score in the diagnosis of acute appendicitis

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Received: 15 May 2021

Accepted: 21 June 2021

Published: xx Month 2021

The Egyptian Journal of Surgery 2021, 40:1110–1115

Background

Acute appendicitis is the most common surgical condition presented in emergency departments worldwide. It is also the most common cause of abdominal pain requiring surgery, with a lifetime risk of 7%.

Objectives

The aim of this study was to compare between the diagnostic accuracy of RIPASA score and Alvarado score in the diagnosis of acute appendicitis.

Patients and methods

This randomized prospective study was carried out on 100 patients complaining of acute abdominal pain diagnosed as appendicitis undergoing open or laparoscopic appendectomy operation in the general surgery department of Mataria Teaching Hospital, from February 2020 to August 2020. Clinical examination and laboratory workup were done to the population of the study according to the scoring systems (Alvarado and RIPASA scoring systems). Scoring was documented to every patient in the study preoperatively. The decision to operate was made by the senior surgeon (consultant), based on clinical and laboratory findings not depending on the results of the scoring systems. All patients received information about the surgical technique and risks of the operation and other options for treatment. All patients participated in this study after providing informed consent and the study was approved by the ethical committee of Ain Shams University.

Results

In our study, we found that RIPASA score was more sensitive (100 vs. 95%, respectively), and Alvarado score was more specific (38 vs. 0%, respectively). The positive predictive value for Alvarado score is significantly higher than that of RIPASA score (89 vs. 84%, respectively). The negative predictive value for Alvarado score is significantly higher than that of RIPASA score (60 vs. 0%, respectively). In our study, by using receiver operating characteristic, the area under the curve of Alvarado score is 0.924, which is greater than that for RIPASA scoring, which is 0.918. The difference in the area under the curves of 0.6% is significant between two scoring systems. The *P* value for these two variables in both the scores is less than 0.001, which shows that there is significant association between these values. Previous studies by Arroyo-Rangel and colleagues and Pasumarthi and Madhu found that the area under the curve of RIPASA score is greater than that for Alvarado score with *P* value less than 0.001 also.

Conclusion

Alvarado score was more specific and RIPASA scores were more sensitive. Alvarado score is shown to have a better diagnostic accuracy than RIPASA score. More trials with more number of patients should be conducted to reach an ideal score in the diagnosis of acute appendicitis.

Keywords:

acute appendicitis, Alvarado score, RIPASA score

Egyptian J Surgery 40:1110–1115

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1110-1121

Introduction

Acute appendicitis is the most common surgical condition presented in emergency departments worldwide. It is also the most common cause of abdominal pain requiring surgery, with a lifetime risk of 7% [1]. The diagnosis of acute appendicitis is still difficult to make, especially in young persons, the elderly, and in reproductive-age women [2], as it is based purely on the clinical history and physical examination, combined with the results of laboratory

studies, such as a high white cell count [3]. Appendicitis is most common between the ages of 10 and 20 years, but no age is exempt. A male preponderance exists, with a male-to-female ratio of 1.4 : 1 [4].

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Different scoring systems have been created to increase the diagnostic accuracy of appendicitis that are low cost, noninvasive, and easy to use or reproduce [3]. They assign numerical values to define signs and symptoms. Clinical signs of abdominal pathology (type, pain location and migration, temperature, signs of peritoneal irritation, nausea, vomiting, and others) and laboratory findings (leukocytosis) are generally used [5]. The modified Alvarado score is probably the most widely used and accepted at emergency services, worldwide, with 68–82% sensitivity and 75–87.9% specificity [6]. RIPASA scoring system is relatively new. It was developed in 2010 at the RIPAS Hospital of Brunei and has improved sensitivity (98%) and specificity (83%) [7].

Aim

The aim of this study was to compare between the diagnostic accuracy of RIPASA score and Alvarado score in the diagnosis of acute appendicitis.

Patients and methods

Study design

This prospective study was carried out on 100 patients complaining of acute abdominal pain diagnosed as appendicitis undergoing open or laparoscopic appendectomy operation in the General Surgery Department of Mataria Teaching Hospital, from February 2020 to August 2020.

Clinical examination and laboratory workup were done to the population of the study according to the scoring systems (Alvarado and RIPASA scoring systems). Scoring was documented to every patient in the study preoperatively. The decision to operate was made by the senior surgeon (consultant), based on clinical and laboratory findings not depending on the results of the scoring systems. All patients received information about the surgical technique and risks of the operation and other options for treatment. All patients participated in this study after providing informed consent and the study was approved by the ethical committee of Ain Shams

University. All appendices removed were sent for pathological examination.

Inclusion criteria

- (1) All patients 18 years of age or older with suspected acute appendicitis.
- (2) All patients were capable of consenting and can understand the procedure.

Exclusion criteria

- (1) Patients with age less than 18 years.
- (2) Patients unfit for surgery.
- (3) Patients refusing to undergo the operation.

Methods of the study

- (1) Proper history taking.
- (2) Proper physical examination.
- (3) Laboratory investigations.
- (4) Scoring systems: all patients with suspected acute appendicitis had their scoring systems (Alvarado and RIPASA scores) calculated. Alvarado score was classified as three classes (Table 1). RIPASA score was classified as four classes (Table 2).
- (5) Histopathological examination: all specimens were sent for histopathology examination.
- (6) Statistical analysis: all collected data were revised for completeness and accuracy. Precoded data were entered on the computer using the Statistical Package of Social Science Software Program, Version 21 (SPSS) (SPSS 15.0 for windows; SPSS Inc, Chicago, IL, 2001) to be statistically analyzed. *P* value equal to or less than 0.05 was considered statistically significant.

Results

This prospective study recruited 100 patients complaining of acute abdominal pain diagnosed as appendicitis undergoing open or laparoscopic appendectomy operation in the General Surgery Department of Mataria Teaching Hospital, from February 2020 to August 2020.

Table 1 Alvarado score

Alvarado score					
Symptoms		Signs		Laboratory finding	
Migratory right iliac fossa pain	1	Tenderness on right iliac fossa	2	Leukocytosis	2
Anorexia	1	Rebound tenderness	1	Shift to left of neutrophils	1
Nausea/vomiting	1	Elevated temperature	1		

Class 1: score 1–4. Class 2: score 5–6. Class 3: score 7.

Table 2 RIPASA score

Demographic information	RIPASA score		
		Symptoms	
Male	1	Migratory right iliac fossa pain	0.5
Female	0.5	Right iliac fossa pain	0.5
Age <39	1	Anorexia	1
Age ≥40	0.5	Nausea/vomiting	1
Signs		Duration >48 h	0.5
Tenderness in right iliac fossa	1	Duration <48 h	1
Guarding	2	Laboratory findings	
Rebound tenderness	1	Elevated TLC	1
Rovsing sign	2	Negative urine analysis	1
Temperature >37 and <39	1		

Class 1: score <5.0. Class 2: score 5.0–7.0. Class 3: score 7.5–11.5. Class 4: score >12.

Table 3 Sex distribution

Sex	n (%)
Male	26 (26)
Female	74 (74)

There were 26 males and 74 females (Table 3): the age of the patients ranged between 18 and 53 years, with a mean of 26.16 years and SD 8.89. Majority of the cases (88 patients) were between 18 and 38 years of age.

RIPASA was sensitive by 100%, as it detected 84 cases of those who were prone to appendicitis (diagnosed by histopathology). But RIPASA was specific by 0%, as it could exclude 0 cases from the 16 cases that were normal (diagnosed by histopathology) (Table 4).

The test-result variable(s): RIPASA has at least one tie between the positive and the negative actual-state group. Statistics may be biased (Table 5).

Alvarado was sensitive by 95%, as it detected 80 cases from 84 cases who were prone to appendicitis (diagnosed by histopathology). But Alvarado was specific by 38%, as it could exclude six cases from the 16 cases that were normal (diagnosed by histopathology) (Table 6).

The test-result variable(s): Alvarado has at least one tie between the positive and the negative actual-state group. Statistics may be biased (Table 7).

The test-result variable(s): Alvarado and RIPASA have at least one tie between the positive and the negative actual-state group. Statistics may be biased (Table 8).

Discussion

In our study, we compare between the diagnostic accuracy (sensitivity and specificity) of RIPASA and

Alvarado score in the diagnosis of acute appendicitis. Sensitivity is the probability that the RIPASA/or Alvarado say a person suspected for appendicitis when in fact they are suspected for appendicitis. Specificity is the probability that the RIPASA/or Alvarado say a person is not suspected for appendicitis when in fact they are not suspected for appendicitis.

In our study of over 100 patients, sex distribution showed 26% males to 74% females, showing female predominance in the rate of acute appendicitis. Previous studies by Khan and Rehman [8] found that among these patients, 59 (59%) were female and 41 (41%) were male (male-to-female ratio 1 : 1.4).

In the study by Abbasi *et al.* [9], a total of 77 patients were included, among them 47 (61%) were males and 30 (39%) were females. Nanjundaiah *et al.* [10] in their study found that among their patients, there were 61.6% male patients and 38.4% female patients.

In our study, the age of the patients ranged between 18 and 53 years, with a mean of 26.16 years and SD 8.89. Majority of the cases (88 patients) were between 18 and 38 years of age. Previous studies by Rathod and colleagues found that the age distribution of appendicitis in the study sample varied from less than 20 years to more than 40 years of age. Majority of the cases (38%) were between 21 and 30 years of age [11].

Atema *et al.* [11] found that the median age of the included patients with appendicitis was 37 ranging from 27 to 50 years.

In our study of over 100 patients, the rate of negative appendectomy (normal appendix on histopathology) was 16%, provided that the decision to operate was taken by a senior consultant based on clinical signs and

Table 4 Sensitivity and specificity of RIPASA A

RIPASA	Histopathology of RIPASA [n (%)]		Total	χ^2	P value	Significance
	Normal	Appendicitis				
Normal	0	0	0	a	–	–
Appendicitis	16 (100)	84 (100)	100 (100)			

χ^2 test. ^aNo statistics are computed because RIPASA is a constant. Sensitivity=100% (95% CI=0.95, 1.0). Specificity=0% (95% CI=0.01, 0.24). Accuracy=84% (95% CI=0.75, 0.90). Positive predictive value=84% (95% CI=0.75, 0.90). Negative predictive value=0 {0, 0}.

Table 5 Receiver operating characteristic curve of RIPASA (area under the curve)

Test variable (s)	Area	SE (a)	P value. (b)	Asymptotic 95% confidence interval		Significance
				Lower bound	Upper bound	
RIPASA	0.918	0.027	<0.001	0.865	0.971	S

^aUnder the nonparametric assumption. ^bNull hypothesis: true area=0.5.

Table 6 Sensitivity and specificity of Alvarado

Alvarado	Histopathology		Total	χ^2	P value	Significance
	Normal	Appendicitis				
Normal	6 (37.5)	4 (4.8)	10 (10)	16.0	0.001	HS
Appendicitis	10 (62.5)	80 (95.2)	90 (90)			

χ^2 test. Sensitivity=95% (95% CI=0.88, 0.98). Specificity=38% (95% CI=0.16, 0.64). Accuracy=86% (95% CI=0.77, 0.92). Positive predictive value=89% (95% CI=0.80, 0.94). Negative predictive value=60% (95% CI=0.27, 0.86).

Table 7 Receiver operating characteristic curve of Alvarado (area under the curve)

Test variable (s)	Area	SE (a)	P value (b)	Asymptotic 95% confidence interval		Significance
				Lower bound	Upper bound	
Alvarado	0.924	0.026	<0.001	0.873	0.975	S

^aUnder the nonparametric assumption. ^bNull hypothesis: true area=0.5.

Table 8 Receiver operating characteristic curve of Alvarado, RIPASA (area under the curve)

Test variable(s)	Area	Std. error (a)	P value (b)	Asymptotic 95% confidence interval		Significance
				Lower bound	Upper bound	
Alvarado	0.924	0.026	<0.001	0.873	0.975	S
RIPASA	0.918	0.027	<0.001	0.865	0.971	S

^aUnder the nonparametric assumption. ^bNull hypothesis: true area=0.5.

symptoms and laboratory investigations and not depending on the results of the scoring systems. The rate of negative appendectomy decreased in comparison with the study of Walczak and Rathod. Walczak *et al.* [12] found that the normal appendix was removed in 26% of cases. Rathod *et al.* [13] in their study found that 20.69% were normal on histopathology. Khan and Rehman [8] in their study found that negative appendectomy rate in their study was 15.62%.

In our study by using χ^2 test, the sensitivity and specificity of RIPASA score were 100 and 0%, respectively. The sensitivity and specificity of Alvarado score were 95 and 38%, respectively.

RIPASA score demonstrated greater sensitivity compared with the Alvarado score, as it detected 84 cases from 84 cases of those who were appendicitis (diagnosed by histopathology) versus Alvarado score that detected 80 cases from 84 cases of those who were appendicitis (diagnosed by histopathology). The Alvarado score demonstrated greater specificity compared with RIPASA score, as it could exclude six cases from the 16 cases that were normal (diagnosed by histopathology) versus RIPASA score that could exclude 0 cases from the 16 cases that were normal (diagnosed by histopathology). The positive predictive value (PPV) of RIPASA was 84% and negative predictive value (NPV) 0%. The PPV for Alvarado was 89% and the NPV was 60%.

Table 9 Comparison between RIPASA score and Alvarado scoring regarding previous study [14–17]

	RIPASA score (%)				Alvarado scoring (%)			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
Sinnet <i>et al.</i>	95.5	65	92.39	76.47	65.16	90	96.6	36.73
Muduli <i>et al.</i>	97.26	75	89.87	92.3	68.49	84.37	90.1	54
Pasumarthi and Madhu	96.2	90.5	98.9	73.1	58.9	85.7	97.3	19.1
Arroyo-Rangel <i>et al.</i>	98.8	71.4	3.5	0.02	90.7	64.3	2.5	0.2
Our study	100	0	84	0	95	38	89	60

NPV, negative predictive value; PPV, positive predictive value.

Previous studies (Table 9) by Sinnet and colleagues and Muduli and colleagues also found that RIPASA score was more sensitive and Alvarado score was more specific, and that the PPV for Alvarado score is significantly higher than that of RIPASA score, but found that the NPV for RIPASA score is significantly higher than that of Alvarado score. Arroyo-Rangel and colleagues and Pasumarthi and Madhu found that the RIPASA score was more sensitive and specific than Alvarado score, and that the PPV and the NPV for RIPASA score is significantly higher than that of Alvarado score.

In our study by using receiver operating characteristic, the area under the curve of Alvarado score is 0.924, which is greater than that for RIPASA scoring, which is 0.918. The difference in the area under the curves of 0.6% is significant between two scoring systems. The *P* value for these two variables in both the scores is less than 0.001, which shows that there is significant association between these values.

Previous studies by Arroyo-Rangel and colleagues and Pasumarthi and Madhu found that the area under the curve of RIPASA score is greater than that for Alvarado score with *P* value less than 0.001.

In February 2018, in the study by Arroyo-Rangel *et al.* [17] in Mexico, 100 patients were included. The RIPASA score showed an area under the curve of 0.88 and the Alvarado scale of 0.80.

In another study, Pasumarthi and Madhu stated that by using receiver operating characteristic, the area under the curve is 0.982, which is greater than that for Alvarado score, which is 0.849. The difference in the area under the curves of 13.4% is significant between two scoring systems ($P < 0.001$) [16].

In our study of over 100 patients, the diagnostic accuracy of RIPASA score was 84%. The diagnostic accuracy of Alvarado score was 86%. Alvarado score is shown to have a better diagnostic accuracy than RIPASA score.

Previous studies by Muduli and colleagues, Chong and colleagues, and Shuaib and colleagues found that RIPASA score had a better diagnostic accuracy than Alvarado score.

Muduli *et al.* [15] in their study showed that the diagnostic accuracy was 90.47% for the RIPASA score and 73.33% for the Alvarado score.

In another study, Chong *et al.* [18] found that the diagnostic accuracy was 91.83% for the RIPASA score and 86.51% for the Alvarado score.

Also, Shuaib *et al.* [1] found that the diagnostic accuracy of Alvarado score was 77.94%. The RIPASA score results showed diagnostic accuracy of 93.38%.

Conclusion

Alvarado score was more specific and RIPASA scores were more sensitive.

Alvarado score is shown to have a better diagnostic accuracy than RIPASA score.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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