# **Original Research Article**

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# Validity of RIPASA scoring system as a diagnostic tool of acute appendicitis in comparison with Alvarado scoring system in the Arab population

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## **ABSTRACT**

**Background:** RIPASA scoring has been developed to replace the disappointingly low accuracy Alvarado score in Asian population for diagnosis of acute appendicitis. Objective of present study was to compare the RIPASA and Alvarado score in Arab population and determine their accuracy when applied to our patients in Egypt and Kingdom of Saudi Arabia (KSA).

**Methods:** By applying the RIPASA and Alvarado scores to 100 patients from KSA, 100 patients from Egypt who presented to emergency with right iliac fossa pain. The decisions for appendicectomy were based on clinical judgment only. Histopathology as gold standard was correlated with both scores. ROC curve analysis, sensitivity, specificity, positive predictive value and negative predictive value, diagnostic accuracy for RIPASA and Alvarado system were calculated using SPSS version 20.

**Results:** On comparing both the scoring system in patients of both hospital groups, we found that sensitivity of RIPASA scoring is greater than Alvarado scoring system 95.51% and 73.03% respectively in BTH group, and 97.56% and 79.27% respectively in KASH group, while the specificity of RIPASA scoring system is less than Alvarado scoring system 72.73% and 81.82% respectively in BTH group and 66.67% and 83.33% respectively in KASH group.

**Conclusions:** In our Arab population the RIPASA score could be applied in diagnosis of acute appendicitis with higher sensitivity, NPV and diagnostic accuracy compared to the Alvarado score.

Keywords: Acute appendicitis, Alvarado scoring, Arab population, RIPASA scoring

# INTRODUCTION

In abdominal surgery appendectomy remains the most frequent emergency operations. An individual risk of acute appendicitis with appendectomy is 8.6% in male and 6.7% in female. Typical clinical presentation of acute appendicitis is present only in 50% of the cases

making the exploration decision of the patient challenging.<sup>2</sup>

Diagnosis of acute appendicitis is difficult to be established particularly in reproductive age females, child and old age patients due to presence of gynecological and urinary conditions which can present with similar clinical picture.<sup>3</sup>

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The decision of early intervention in atypical presentation of acute appendicitis may lead to high negative appendectomy rates (20% - 40%).

The use of imaging (ultra-sonography or computed tomography) can improve diagnostic accuracy, but any delay in order to improve the accuracy of diagnosis, the risk of complications, morbidity and mortality will be increased.<sup>5</sup> Ultrasound is operator dependent which often misses or over-diagnose the condition, while CT is the most sensitive and specific in diagnosing the condition but with limited availability for every patient, especially in countries with limited resources.<sup>6</sup>

Various scoring systems developed trying to improve accuracy of diagnosis and lowering negative appendectomy rates and overcome the delay in diagnosis. This includes; Alvarado, Eskelinen, Samuel, Lindberg, Ohmann, Tzanakis, Fanyo and others.<sup>7</sup>

The most known and used scoring is Alvarado scoring systems (1986), which is practical and easy to use including 8 predictive factors, with a higher sensitivity and specificity especially if applied to the Western population. When applying Alvarado scoring systems to the middle Eastern, Asian or oriental populations It have been shown to achieve a sensitivity ranging from 50 to 59% and specificity ranging from 23 to 94% which was relatively low, and was attributed to different factors including diet and environmental factors. 9

In 2010, RIPASA scoring system was developed by doctors in a hospital in Brunei named Raja Isteri Pengiran Anak Saleha (RIPAS), which includes other parameters than Alvarado as gender, age, duration of pain. These parameters are shown to affect accuracy of the diagnosis of acute appendicitis and has been claimed to have better outcomes in Asian settings compared to the Alvarado scoring system.<sup>10</sup>

Many studies are available on validity of RIPASA scoring systems when applied to patients complaining of acute appendicitis in the Eastern population, but there are few studies available in other population. So, authors designed this prospective study to evaluate the validity of the RIPASA scoring system as diagnostic tools of acute appendicitis in Arab population and to compare this with the Alvarado scoring system.

#### **METHODS**

This study was carried out as a prospective study and conducted at two hospitals in two Arab countries; Benha teaching hospital (BTH) in Benha city, Egypt and King Abdulaziz Specialist Hospital (KASH), in Taif city, Kingdom of Saudi Arabia during the period from May 2017 to October 2017.

All adult patients presented to the emergency department with right iliac fossa (RIF) pain, clinical diagnosed to

have acute appendicitis and offered emergency appendectomy were included.

Patient with distension of abdomen, pregnant female, patient with mass in right iliac fossa, patients with history of urolithiasis and pelvic inflammatory disease (PID) were not included in the study.

All patients upon admission were subjected to clinical history and physical examination and preoperative investigations including CBC and urine analysis, and also radiological investigation if needed.

All patients were evaluated, and a specially designed Performa is filled for each of them, which was done only for the study purpose containing all variables based on Alvarado and RIPASA score, but did not contained the actual scores and guidelines, so the scores did not bias the surgeon decision for appendectomy, which was solely based on the surgeon's own clinical judgment after contributing all the clinical, laboratory and radiological findings.

These Performa include general information about the patients; age and gender, the presenting symptoms (RIF pain, anorexia, nausea and vomiting, and the duration of the pain more or less than 48), clinical signs (RIF tenderness, guarding, rebound tenderness, Rovsing's sign and fever), laboratory investigations (elevated white cell count, shift to left and negative urinalysis), admission and discharge dates, date of appendectomy, name and signature of confirming surgeon, post–operative complications if any.

All the patients were taken for emergency appendectomy and the operative finding was recorded, then the specimen was sent for histopathology examination. The histopathology reports of the resected appendix were used as a gold standard confirmation of an acute appendicitis diagnosis to be compared with the scoring system.

The Alvarado and RIPASA scoring systems were calculated for each patient. According to RIPASA score system the scores generated were: age (less than 40 years is 1 point; greater than 40 years is 0.5 point), gender (male is 1 point; female is 0.5 point), RIF pain (0.5 point), migration of pain to RIF (0.5 point), nausea & vomiting (1 point), anorexia (1 point), duration of symptoms (less than 48 hours is 1 point; more than 48 hours is 0.5 point), RIF tenderness (1 point), guarding (2 point), rebound tenderness (1 point) Rovsing sign (2 point), fever (1 point), raised white cell count (1 point), negative urinalysis (1point). We excluded foreign identity card (1point) because our study sample population consisting of the same country nationalities: either Egyptians in BTH group or Saudi in KASH group.

Ethical approval was obtained from the ethical committee of both hospitals and obtained informed consent from all patients participated in the study. Preserved confidentiality of patients was taken in consideration by not including names or identifying any details in the Performa.

## Statistical analysis

Statistical testing was conducted with the statistical package for the social science system (SPSS) version 20. The sensitivity, specificity, PPV, NPV, diagnostic accuracy and negative appendectomy rate for both scoring systems were calculated and analyzed comparatively with a chi-squared test and using histopathology as gold standard. ROC curves were performed for the two scoring systems and were compared using the area under the curve (AUC). For all statistical tests, a p value  $\leq 0.05$  was taken to indicate a significant difference.

#### RESULTS

The study included 100 patients from BTH and 100 patients from KASH who underwent appendectomy. The demographics of these patients (gender and age distribution) are shown in Table 1.

Table 1: Demographic data of study patients.

			No. of cases	Total	
ВТН	Corr	Male	40	100	
	Sex	Female	60	100	
	Age	<40yrs	91	100	
		>40 years	9		
KASH	Sex	Male	59	100	
		Female	41	100	
	Age	<40yrs	83	100	
		<40yrs >40 years	17		

Table 2: Presenting symptoms and signs.

Crumtoma and signs	BTH	KASH
Symptoms and signs	Frequency	Frequency
RIF	100	100
Migration of pain to RIF	91	72
Anorexia	86	82
Nausea and vomiting	81	74
Fever	63	72
Duration of symptoms <48h	83	89
Duration of symptom >48h	17	11
Tenderness in RIF	100	100
Rebound tenderness	96	94
Rovsing's sign	46	30
Guarding	66	58

All the patients presented with complaint of pain in RIF and the distribution of other clinical parameters was as follows: Migration of pain to RIF (91%, 72%), anorexia (86%, 82%), nausea and vomiting (81%, 74%), fever (63%, 72%) duration of symptoms <48 h (83%,89%) and

duration >48 h (17%, 11%) in BTH group and KASH group patients respectively (Table 2).

All the patients were having tenderness and nearly all have rebound tenderness. Rovsing's sign and guarding were present in 46% and 66% patient's respectively in BTH group and in 30% and 58% patients respectively in KASH group (Table 2).

Table 3: Laboratory investigation of the study patients.

Analysis investigation	BTH	KASH	
Analysis investigation	Frequency	Frequency	
Raised TLC	72	75	
Shift of WBC to the left	25	30	
Negative urinalysis	77	58	

Seventy-two patients had raised leucocytes count with shift to the left seen in 25 patients and negative urinalysis was present in 77 patients in BTH group while 75 patients had raised leucocytes count with shift to the left in 30 patients and negative urinalysis was present in 58 patients in KASH group (Table 3).

In BTH group, 65 patients underwent laparoscopic appendectomy and 35 patients underwent open appendectomy. While in KASH group, 77 patients underwent laparoscopic appendectomy and 23 patients underwent open appendectomy.

Table 4: Histopathology of excised appendix.

	Histopathology	No. of cases	Total	
втн	Positive	89	100	
БІП	Negative	11	100	
KASH	Positive	82	100	
	Negative	18	100	

Histopathology was the gold standard for confirmation of the diagnosis. Out of these 100 appendicectomies of BTH group; 89 patients were positive histo-pathologically, and of these 100 appendicectomies of KASH group; 82 patients were positive histo-pathologically (Table 4).

Table 5: Comparison of Alvarado Scoring Diagnosis with histopathology.

	Alvarado score	+ve Histopathology	-ve Histopathology
	≥7 (n=67)	65	2
ВТН	<7 (n=33)	24	9
	Total	89	11
KASH	≥7 (n=68)	65	3
	<7 (n=32)	17	15
	Total	82	18

According to Alvarado score, out of 67 patients were diagnosed to have appendicitis in BTH patients; 65

patients had evidence of appendicitis histopathologically, two patients were falsely diagnosed to have appendicitis. Out of 33 patients diagnosed by Alvarado as not having appendicitis, 24 patients were missed by this scoring system.

In KASH group, 68 patients diagnosed to have appendicitis by Alvarado score, out of those patients; 65 patients had evidence of appendicitis histo-pathologicall and three patients were falsely diagnosed to have appendicitis. Out of 32 patients diagnosed as not having appendicitis, 17 patients were missed by this scoring system.

Table 6: Comparison of RIPASA Scoring Diagnosis with histopathology.

	RIPASA score	+ve Histopathology	-ve Histopathology
	$\geq$ 7.5 (n=88)	85	3
втн	<7.5 (n=12)	4	8
	Total	89	11
KASH	≥7.5 (n=86)	80	6
	<7.5 (n=14)	2	12
	Total	82	18

In BTH patients, according to RIPASA score, 88 patients were diagnosed to have appendicitis. Out of these 88; 85 evidence of had appendicitis pathologically. Three patients were falsely diagnosed to have appendicitis by RIPASA scoring system. Out of the 12 patients diagnosed by RIPASA as not having appendicitis, four were missed. In KASH patients, 86 patients were diagnosed by RIPASA scoring system to have appendicitis. Out of these 86; 80 patients had evidence of appendicitis histo-pathologically. Six patients were falsely diagnosed to have appendicitis by RIPASA scoring system. Out of the 14 patients diagnosed by RIPASA as not having appendicitis, two were missed.

On comparing both the scoring system in all the 100 patients of BTH, we found that sensitivity of RIPASA scoring is greater than Alvarado scoring system 95.51% and 73.03% respectively, specificity of RIPASA scoring system is less than Alvarado scoring system 72.73% and 81.82% respectively. PPV of RIPASA scoring system is less than Alvarado scoring system 96.59% and 97.01% respectively. NPV of RIPASA scoring system greater than Alvarado scoring system 66.67% and 27.27% respectively. Accuracy of RIPASA scoring system is greater than Alvarado scoring system 93% and 74% respectively (Table 7).

Table 7: Comparison of the diagnostic accuracy of Alvarado and RIPASA score.

Variable	ВТН			KASH		
	Alvarado score	RIPASA score	P value	Alvarado score	RIPASA score	P value
Sensitivity (%)	73.03%	95.51%	< 0.0001	79.27%	97.56	0.0001
Specificity (%)	81.82%	72.73%	0.1	83.33%	66.67%	0.006
PPV (%)	97.01%	96.59%	0.8	95.59%	93.02%	0.4
NPV (%)	27.27%	66.67%	< 0.0001	46.88%	85.71%	< 0.0001
DA (%)	74%	93%	0.0003	80%	92%	0.01

PPV; Positive predictive value (%); PV; Negative predictive value (%), DA; Diagnostic accuracy

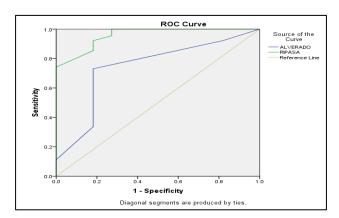


Figure 1: ROC curve analysis for Alverado and RIPASA scoring scores as diagnostic tool in acute appendicitis in BTH group.

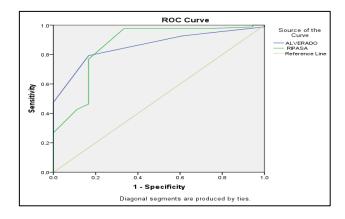


Figure 2: ROC curve analysis for Alverado and RIPASA scoring scores as diagnostic tool in acute appendicitis in KASH group.

The same finding was found on comparing both scores in patients of KASH, where sensitivity (97.56% and 79.27%), specificity (66.67% and 83.33%), PPV (93.02% and 95.59%), NPV (85.71% and 46.88%), accuracy (92% and 80%) of RIPASA scoring system and ALVARADO scoring system respectively.

## **DISCUSSION**

Acute appendicitis is a common surgical condition that is readily treated. However, if undiagnosed or diagnosed in an untimely manner, complications such as perforation, abscess, peritonitis can occur. The definitive diagnosis of appendicitis is only possible with histopathological examination.<sup>7</sup>

The decision to proceed to surgical excision of the appendix based only on the patient's signs and symptoms results in the removal of a normal appendix (negative appendectomy) in up to 40% of cases. The removal of a healthy appendix has been associated with greater risk for operative complications mainly abdominal adhesions. <sup>11</sup>

Although haematological parameters such as WBCs and C-reactive protein can assist in diagnosis, both are nonspecific and can be raised in a variety of inflammatory and infective conditions. Radiological tools utilized to aid in diagnosis including ultrasound, CT and MRI have cost implications, require expertise and are not available out of hours in the majority of institutions.<sup>12</sup>

Various scoring systems developed to aid in the diagnosis of acute appendicitis and decrease negative appendectomy rates, the Alvarado score is the most commonly used scoring systems in western populations. Overall sensitivity and specificity for both the Alvarado and the modified Alvarado score in Western populations range from 53 to 88% and 75 to 80%, respectively.<sup>13</sup>

The RIPASA score is a simple and easy to use quantitative scoring system. Containing fourteen parameters; this can be obtained easily by taking a complete history, conducting a clinical examination and two simple investigations. Hence a rapid diagnosis made without having to wait for the full investigations to be available and in terms of healthcare cost savings, they can help to reduce unnecessary inpatient admissions and expensive radiological investigation.<sup>14</sup>

In the Arab population, we still need a scoring system with acceptable sensitivity, specificity and negative appendectomy rate. Thus, in our study, we compared the diagnostic value of Alvarado scoring system and RIPASA scoring system for diagnosis of acute appendicitis and analyzed the negative appendectomy rate for the above two mentioned systems in two hospitals in two Arab countries.

In the present study, in both hospitals, the gender distribution was relatively equal which did not affect the

statistical analysis. While in Chong et al prospective study the gender was predominately male (62%) which affect their results.<sup>15</sup>

Most of the studied patients (91in BTH and 83 in KASH) belong to the age group less than 40 years. This was similar to the study of Dey et al.<sup>15</sup>

Regarding symptoms, RIP pain and tenderness were observed in all the patients in present study. This was consistent with the study done by Verma et al. 16

100 patients underwent emergency appendectomy in each hospital based on the surgeon's clinical judgment. Out of these, 89 cases were confirmed histologically in BTH group and 82 cases in KASH group as having acute appendicitis. This indicated a negative appendectomy rate of 11% in BTH group and 18% in KASH group when based on clinical decision only.

All the patients were scored according to both scoring systems from the data collected in the Performa. In Alverado scoring system we chose a cut off value of 7 and in RIPASA scoring system, we chose a score of 7.5 as Chong et al., demonstrated this score as the cut-off value with an optimal area under the curve in their prospective study of Asian patients.<sup>2</sup>

When Alvarado score was applied to BTH patients, 67 patients had their score  $\geq$ 7 (65 of them were positive his pathologically) and when RIPASA score was applied, 88 patients had their score >7.5(85 of them were positive his pathologically), while in KASH patients 68 (65 of them were positive his pathologically) patients had their score  $\geq$ 7 in Alvarado score, and 86 patients had their score >7.5 in RIPASA score (80 of them were positive his pathologically).

In BTH group when the RIPASA score was applied, 95.51% (sensitivity) of patients who actually had acute appendicitis were correctly diagnosed and placed in the high-probability group (RIPASA score >7.5) and managed appropriately, compared to only 73.03% (sensitivity) when using the Alvarado score on the same population sample. Thus, the Alvarado score failed to diagnose 22.4% of patients (n=20) with acute appendicitis and wrongly classified them in the low-probability group (Alvarado score <7.0).

Similarly, for patients who were classified in the true negative group (RIPASA score <7.5 and Alvarado score <7.0), the RIPASA score was found to be superior to the Alvarado score by correctly diagnosing 66.67% of patients (not having acute appendicitis) compared with the Alvarado score, which only managed to correctly diagnose 27.27%.

In KASH group when the RIPASA score was applied, 97.56% (sensitivity) of patients who actually had acute appendicitis were correctly diagnosed and placed in the

high-probability group (RIPASA score >7.5) and managed appropriately, compared to only 79.27% (sensitivity) when using the Alvarado score on the same population sample. Thus, the Alvarado score failed to diagnose 18.29% of patients (n=15) with acute appendicitis and wrongly classified them in the low-probability group (Alvarado score <7.0). For patients who were classified in the true negative group (RIPASA score <7.5 and Alvarado score <7.0), the RIPASA score again was better than the Alvarado score by diagnosing correctly 85.71% of patients (actually not having acute appendicitis) compared with the Alvarado score, which only managed to correctly diagnose 46.88%.

The difference in diagnostic accuracy between the RIPASA score and Alvarado score was 19% in BTH group and 12% in KASH group which was statistically significant (p<0.0003 and p<0.01 respectively) indicating that the RIPASA score is a much better diagnostic tool for the diagnosis of acute appendicitis in both studied groups.

For BTH group, ROC curves were calculated for the Alvarado and RIPASA scoring systems (Figure 1). The AUC was 0.74 for the Alvarado and 0.95 for the RIPASA score. The difference in the AUCs was significant between the scoring systems (P<0.0001). While in KASH group, ROC curves were calculated for the Alvarado and RIPASA scoring systems (Figure 2). The AUC was 0.86 for the Alvarado and 0.87 for the RIPASA score. The difference in the AUCs was significant between the scoring systems (P<0.0001).

Thus, the RIPASA scoring system, have a higher sensitivity and Higher NPV when compared to Alverado scoring system. Similar results were obtained by Malik et al and Subramani et al. 16,17

#### **CONCLUSION**

In the present study, we concluded that RIPASA score could be considered a better score than the commonly used Alvarado score when applied for our Arab population.

The RIPASA score analytically demonstrated significant higher sensitivity, NPV and diagnostic accuracy in comparison to the Alvarado score. This scoring system could be done quickly and the decision to operate could be based on the good clinical examination and simple laboratory tests which improves diagnostic accuracy and thus consequently reduces complication rates. This approach is considered an improvement in patient care in one of the most commonly performed surgical operations worldwide.

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