

Diagnostic Accuracy of Alvarado and Ripasa Scoring Systems for Diagnosis of Acute Appendicitis Taking Histopathology as Gold Standard

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ABSTRACT

Aim: To determine diagnostic accuracy of Alvarado and RIPASA scoring systems for diagnosis of acute appendicitis taking histopathology as gold standard.

Study Design: Cross Sectional study

Setting and Duration: Surgery Department (A&E), King Edward Medical University/ Mayo Hospital Lahore, Pakistan from March 2016 to February 2017.

Methodology: Total 520 patients (aged 18-80 years) of either gender presenting with right iliac fossa pain within 7 days, who were admitted from emergency surgery department of Mayo Hospital Lahore were included. Demographic information like name, age, sex, address were obtained. RIPASA score and Alvarado score calculated as described in annexure I and II. After appendicectomies, resected specimen were sent for histopathological examination by consultant pathologist at Pathology department of Mayo hospital Lahore. All patients were diagnosed on Alvarado Score and RIPASA Score. Non Probability consecutive Sampling technique was applied and the collected data was entered and analyzed using SPSS version 20. Post stratification chi-square test performed to see significance of effect modifiers. p-value ≤ 0.05 will be considered as significant.

Results: The mean age of patients was 37.27 ± 13.83 years. There were 381 (73.3%) male and 139 (26.7%) female patients. The sensitivity, specificity, Positive predictive value (PPV), Negative Predictive value (NPV) of RIPASA score was 99.4%, 95.72%, 97.64% and 98.9%. The sensitivity, specificity, PPV, NPV of Alvarado score was 98.5%, 96.79%, 98.2% and 97.31%. The diagnostic accuracy of RIPASA (98.08%) was higher than the diagnostic accuracy of Alvarado score (97.88%).

Conclusion: The diagnostic accuracy of RIPASA score was found high when compared to Alvarado score taking histopathology as gold standard. In future we can confidently use RIPASA instead of Alvarado score to diagnose acute appendicitis and decrease the rate of negative appendectomy and morbidity caused due to missed diagnosis.

Key Words: Appendix, Alvarado, RIPASA, Histopathology, negative appendectomy

INTRODUCTION

Acute appendicitis is a common surgical emergency which, even with modern diagnostic facilities, remains a challenging task for the surgeon¹ with lifetime prevalence is 7-8%². The variations in presentation pertaining to time, signs and symptoms can baffle even by the very experienced surgeons^{1,3}. The diagnosis of acute appendicitis is solely based on history, physical examination and few laboratory investigations (such as complete blood count, C-reactive protein and urinalysis)^{2,3}. A definitive diagnosis could only be obtained at surgery and after pathological examination of the surgical specimen^{2,4}. A negative appendectomy rate of 15-40% has been reported in literature and many surgeons would accept this rate as inevitable². Alvarado score widely used is a simple, easy to apply, cheap tool and an effective means of stratifying patients according to the risk of acute appendicitis which helps to reduce the negative appendectomy rate². On the other hand, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a new diagnostic scoring system developed for the diagnosis of acute appendicitis⁴⁻⁷.

In 2011 it was reported that at the optimal cut-off threshold score of 7.5 derived from the ROC, the sensitivity and specificity of RIPASA score were 98.0% and 81.3% respectively⁵. At the cut-off threshold score of 7.0 for the Alvarado score, the sensitivity and specificity 68.3 % and 87.9%⁵. One more study reported that Sensitivity and specificity of RIPASA score (cut of value > 7.5) were 96.2% and 90.5% respectively. The sensitivity and specificity of Alvarado score (cut of value >7.0) were 58.9% and 85.7% respectively.⁸ Moreover in 2012 it is also reported that the Alvarado score presented a sensitivity of 89.5% and a specificity of 69.2%, whereas RIPASA presented a sensitivity of 91.2% and specificity of 84.6%⁹. Moreover at 7.5 cut-off threshold, the calculated sensitivity and specificity of RIPASA were 88.46% and 66.67%. The PPV and NPV were 93.00% and 53.00%, respectively with diagnostic accuracy was 80.50%⁶.

Although since 2010 a lot of work has been done on their comparison with consistent Sensitivity and inconsistent Specificity (90.5⁸ - 53%⁶) of RIPASA at cut off value > 7.5^{5,7,8,9}. On the other hand for Alvarado (at cut of value >7) sensitivity and specificity is given in very wide range i.e., sensitivity 58.9%⁸ – 89.5⁹ and specificity 69.9%⁹ – 89.9% respectively⁵. No local study is available for comparisons of RIPASA and Alvarado and in our clinical practice we still rely on Alvarado scoring system (that is

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inconsistent) for the diagnosis of acute appendicitis. The diagnostic accuracy concluded by the study will guide us the actual parameters to diagnose acute appendicitis and decrease the rate of negative appendectomy and morbidity caused due to missed diagnosis.

MATERIAL AND METHOD

A cross sectional study for a period of March 2016 to February 2017 was conducted at Surgery Department (A&E) at Mayo Hospital, Lahore, Pakistan. Research analysis carried out after approval from the Institutional Review Board and ethical committee. Patients (aged 18-80 years) of either gender with right iliac fossa pain within 7 days presenting to Department of Surgery (A&E) at Mayo Hospital, Lahore, Pakistan were admitted and inducted. After taking an informed consent from patients/attendants their demographic information like name, age, sex, address was obtained. Alvarado score and RIPASA score were calculated as described in annexure -I and II. The diagnosis of appendicitis was made by consultant surgeon (having clinical experience of five years in emergency surgery department). After appendicectomies, resected appendix were sent for histopathological examination by consultant pathologist at, Pathology Department of Mayo hospital Lahore. All patients were diagnosed on Alvarado (if a patient gets a score of > 7 be considered as having acute appendicitis (Table 1) and RIPASA (if a patient gets a score of > 7.5 be considered as having acute appendicitis (Table 2). The data was collected by researcher himself on formulated proforma attached signifying all relevant data. All the data collected was entered and analyzed using SPSS version 20. For quantitative variables like age of patients, RIPASA score and Alvarado score mean ± S.D was calculated. For qualitative variables like gender of patients, diagnosis of appendicitis on histopathology, RIPASA and Alvarado score (as per operational definition) frequencies and percentages were calculated. Diagnosis of appendicitis on histopathology, Alvarado and RIPASA was tabulated in the form of table to calculate sensitivity, specificity, predictive values for the positive and negative value of both scores taking results of histopathology as gold standard. Data was stratified by age, gender and duration of symptom to address effect modifiers. Non Probability consecutive Sampling technique applied and the collected data was entered and analyzed using SPSS version 20. Post stratification chi-square test performed to see significance of effect modifiers. p-value ≤ 0.05 will be considered as significant.

Table 1: Alvarado scoring for appendicitis

	Score
Symptoms	
Pain Migrating to RIF for > 24 hours	01
Anorexia	01
Nausea – Vomiting	01
Sign	
RIF tenderness	02
Rebound tenderness	01
Fever at presentation	01
Investigation	
Raised WBC (>10,000 cells/mm(3))	02
Shift of WBC to left	01
Total score	10

Table 2: RIPASA scoring for appendicitis

	Score
Patients	
Female	0.5
Male	1
Age < 39.9	1
Age > 40	0.5
Symptoms	
RIF pain	0.5
Pain migrating to RIF	0.5
Anorexia	1
Nausea and vomiting	1
Duration of symptoms < 48 hours	1
Duration of symptoms > 48 hours	0.5
Sign	
RIF tenderness	1
Guarding	2
Rebound tenderness	1
Rovsing sign	2
Fever > 37°C < 39° C at presentation	1
Investigation	
Raised WBC (>10,000 cells/mm(3))	1
Negative urine analysis	1
Additional score	
Foreign NRIC	1
Total score	17.8

RESULTS

The mean age of patients was 37.27±13.83 years with minimum and maximum ages of 18.00 years and 80.00 years respectively. There were 436 (83.8%) patients in 18-45 years age and rest of 84 (16.2%) were in 46-80 years age group. There were 381 (73.3%) males and 139 (26.7%) females included in this study. The mean duration of symptoms was 4.11 ±1. 83 days with minimum and maximum duration of 1 day and 7 days respectively. The duration of symptoms was 1-3 days in 333 (64.00%) patients and 4-7 days in 187 (36.00%) patients. The mean RIPASA score was observed to be 8.45±3.84 with minimum and maximum recorded score of 1.00 and 17.50 respectively. The RIPASA score was positive in 339 (65.2%) patients and negative in 181 (34.8%) patients. The mean Alvarado score was observed to be 7.21±2.41 with minimum and maximum recorded score of 2.00 and 10.00 respectively. The Alvarado score was positive in 334 (64.2%) patients and negative in 186 (35.8%) patients. The Histopathology score was positive in 333 (64.00%) patients and negative in 187 (36.00%) patients. The sensitivity of RIPASA keeping Histopathology as gold standard was observed as 99.4%, the specificity was 95.72%, the Negative Predictive Value was 98.9% and Positive Predictive Value was 95.64%. The diagnostic accuracy of RIPASA score was 98.08. The sensitivity of Alvarado keeping Histopathology as gold standard was observed as 98.5%, the specificity was 96.79%, the Negative Predictive Value was 98.2% and Positive Predictive Value was 97.31%. The diagnostic accuracy of Alvarado score was 97.88. When stratified, RIPASA had significant association with age categories, gender and duration of pain. Similarly, Alvarado score was also significantly associated with age categories, gender and duration of pain.

Table 1: Comparison of ripasa score and histopathology findings

		Histopathological findings		Total	
		Positive	Negative		
Alvarado score	Positive	328	06	334	Sensitivity 98.5% Specificity 96.79% Positive Predictive Value 98.2% Negative Predictive Value 97.31% Diagnostic Accuracy 97.88%
	Negative	05	181	186	
Total		333	187	520	
RIPASA score	Positive	331	08	339	Sensitivity 99.4% Specificity 95.72% Positive Predictive Value 97.64% Negative Predictive Value 98.9% Diagnostic Accuracy 98.08%
	Negative	02	179	181	
Total		333	187	520	

Table 2: Comparison of alvarado score and histopathology findings with respect to age groups, gender and duration of symptoms

Age (groups)			Histopathological findings		p-value
			Positive	Negative	
18-45	Alvarado score	Positive	278	05	<0.001
			98.6%	3.2%	
		Negative	04	149	
			1.4%	96.8%	
> 45	Alvarado score	Positive	50	01	<0.001
			98.0%	3.0%	
		Negative	01	32	
			2.0%	97.0%	
Gender					
Male	Alvarado score	Positive	246	04	< 0.001
			100.0%	3.0%	
		Negative	00	131	
			0.0%	97.0%	
Female	Alvarado score	Positive	82	02	< 0.001
			94.3%	3.8%	
		Negative	05	50	
			5.7%	96.2%	
Duration of Symptoms (days)					
1-3 days	Alvarado score	Positive	229	00	<0.001
			99.1%	0.0%	
		Negative	02	102	
			0.9%	100.0%	
4-7 days	Alvarado score	Positive	99	06	<0.001
			97.1%	7.1%	
		Negative	03	79	
			2.9%	92.9%	

Table 3: Comparison of ripasa score and histopathology findings with respect to age groups, gender and duration of symptoms

Age (groups)			Histopathological findings		p-value
			Positive	Negative	
18-45	RIPASA score	Positive	280	06	<0.001
			99.3%	3.9%	
		Negative	02	148	
			0.7%	96.1%	
> 45	RIPASA score	Positive	51	02	<0.001
			100.0%	6.1%	
		Negative	00	31	
			0.0%	93.9%	
Gender					
Male	RIPASA score	Positive	245	05	<0.001
			99.6%	3.7%	
		Negative	01	130	
			0.4%	96.3%	
Female	RIPASA score	Positive	86	03	<0.001
			98.9%	5.8%	
		Negative	01	49	
			1.1%	94.2%	
Duration of Symptoms (days)					
1-3 days	RIPASA score	Positive	230	00	<0.001
			99.6%	0.0%	
		Negative	01	102	
			0.4%	100.0%	
4-7 days	RIPASA score	Positive	101	08	<0.001
			99.0%	9.4%	
		Negative	01	77	
			1.0%	90.6%	

DISCUSSION

Appendicitis is a progressive inflammatory process which may result in perforation, abscess formation, generalized peritonitis, bowel obstruction and rarely death with a mortality rate of 0.08%, rising to 0.5% in the event of a perforated appendix. It is the most common abdominal emergency and accounts for more than 40 000 hospital admissions in England every year (approximately 1 per 1500 population).¹⁰ The incidence of appendicitis is approximately 1 per 1,000 per year.¹¹ There is a male to female ratio of 1.1:1 and an overall lifetime risk of 8.6% for males and 6.7% for females.¹² Despite being a common problem, acute appendicitis remains a difficult diagnosis to establish, particularly among the young, the elderly and females of reproductive age, where a host of other genitourinary and gynaecological inflammatory conditions can present with signs and symptoms that are similar to those of acute appendicitis.¹² The importance of accurate diagnosis has also been associated with different diagnostic markers of acute appendicitis elevated white cell count (WCC), C-reactive protein (CRP), and bilirubin. A study showed a significant difference in the results between patients with negative and positive appendicitis with regards to CRP (32 vs 73; $P < 0.001$), mean total WCC (10.9 vs 14.0; $P < 0.001$), and the mean levels of bilirubin (10.9 vs 17.2; $P < 0.001$).¹³ Several scoring systems have been devised to aid decision making in doubtful cases, including the Ohmann, Alvarado, Eskelinen, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and several others. However, differences in sensitivities and specificities were observed if the scores were applied to various populations and clinical settings, usually with worse performance when applied outside the population in which they were originally created.^{14,15}

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a new diagnostic scoring system developed for the diagnosis of acute appendicitis and has been shown to have significantly higher sensitivity, specificity and diagnostic accuracy than that reported for the Alvarado or Modified Alvarado scores, particularly when the latter two scores were applied in an Asian or oriental population.¹⁶ Although the RIPASA score is more extensive than Alvarado score but it is simple to apply and has several parameters that are absent in the Alvarado score, such as age, gender and duration of symptoms prior to presentation. These parameters have been shown to affect the sensitivity and specificity of the Alvarado and Modified Alvarado scores.

In this study, the mean age of patients was 37.27 ± 13.83 years with minimum and maximum ages of 18.00 years and 80.00 years respectively. There were 436 (83.8%) patients in 18-45 years age and rest of 84 (16.2%) were in 46-80 years age group. Also, there were 381 (73.3%) males and 139 (26.7%) females in our study. The mean duration of symptoms was 4.11 ± 1.83 days with minimum and maximum duration of 1 day and 7 days respectively. The duration of symptoms was 1-3 days in 187 (36%) patients and 4-7 days in 333 (64%) patients. The study assessed the reliability and practical applicability of the widely used Alvarado, Eskelinen, Ohmann and Raja

Isteri Pengiran Anak Saleha Appendicitis (RIPASA) scoring systems in patients with suspected acute appendicitis.

Erdem, et al carried out a study which included one hundred and thirteen patients with suspected acute appendicitis and among them 62 were males and 51 were females. The mean age in this study was 30.2 ± 10.1 with minimum and maximum ages of 18 to 67 years respectively. They also reported regarding patient symptoms that there was no similar pain history among the 64 patients that were diagnosed with acute appendicitis, while 13 patients had a similar pain history. It was found that not having a similar pain history was statistically significant for acute appendicitis ($P < 0.001$). The studied groups differed significantly from each other with regard to the starting point of pain ($P = 0.021$) and relocalization of the pain to the lower right quadrant ($P = 0.020$).¹⁷ Also, when they assessed the sensitivity and specificity levels of the scoring systems, they were 82% and 75% for the Alvarado and 100% and 28% for the RIPASA. When a cut-off value for the Alvarado system was set at 6.5, its sensitivity was calculated as 81%. When a cut-off value for the RIPASA system was set at 10.25, its sensitivity was calculated as 83.1%.¹⁷ When we compared these diagnostic parameters with our results we found that sensitivities and specificities of both RIPASA and Alvarado in our study were higher than these results.

The sensitivity of RIPASA keeping Histopathology as gold standard was observed as 99.4%, the specificity was 95.72%, the Negative Predictive Value was 98.9% and Positive Predictive Value was 95.64%. The diagnostic accuracy of RIPASA score was 98.08. The sensitivity of Alvarado keeping Histopathology as gold standard was observed as 98.5%, the specificity was 96.79%, the Negative Predictive Value was 98.2% and Positive Predictive Value was 97.31%. The diagnostic accuracy of Alvarado score was 97.88. Also in this study, the mean RIPASA score was observed to be 8.45 ± 3.84 with minimum and maximum recorded score of 1.00 and 17.50 respectively. The RIPASA score was positive in 339 (65.2%) patients and negative in 181 (34.8%) patients. The mean Alvarado score was observed to be 7.21 ± 2.41 with minimum and maximum recorded score of 2.00 and 10.00 respectively. The Alvarado score was positive in 334 (64.2%) patients and negative in 186 (35.8%) patients. The Histopathology score was positive in 333 (64.00%) patients and negative in 187 (36%) patients.

Another study carried out by Chong, et al prospectively compared the RIPASA score with the Alvarado score for the diagnosis of acute appendicitis. In their study, 200 consecutive patients who presented with right iliac fossa pain were recruited among whom 192 were finally included in study. Both the RIPASA and Alvarado scores were derived, but decisions for appendectomy were based on clinical judgment. The mean age of the patients (92 male, 100 female) was 25.1 ± 12.7 years. Ultrasonography was performed in only 46 out of the 192 patients (24%), with 73.9% of the procedures conducted in female patients. The majority of the ultrasonography procedures were performed in patients with RIPASA score < 7.5 (58.3%) or Alvarado score < 7.0 (75%).¹⁸ They reported that at the optimal cut-off threshold score of 7.5 for the RIPASA score, the calculated sensitivity and specificity

were 98.02% (95% confidence interval [CI] 93.03%-99.76%) and 81.32% (95% CI 71.78%-88.72%), respectively compared with 68.32% (95% CI 58.31%-77.22%) and 87.91% (95% CI 79.40%-93.81%), respectively for Alvarado score at an optimal cut-off threshold of 7.0. The PPV and NPV for the RIPASA score were 85.34% and 97.37%, respectively compared with 86.25% and 71.43%, respectively for the Alvarado score. This study is similar to our results, NPV was significantly higher for the RIPASA score compared to that for the Alvarado score ($p < 0.0001$)¹⁸.

Alnjadat, et al study aimed to compare both RIPASA and Alvarado systems in terms of diagnostic accuracy. They included 600 patients in their study with mean age of 26.52 years. Negative appendectomy rate was 17%. Sensitivity for RIPASA and Alvarado scores were 93.2 and 73.7, respectively (P value <0.001). RIPASA accuracy (91.5) was significantly higher than Alvarado score accuracy (74.3). Predicted negative appendectomy rates for RIPASA and Alvarado systems were 7.8% and 8%, respectively (P value=0.88). They concluded that both RIPASA and Alvarado scoring systems could significantly lower negative appendectomy rate. However, RIPASA could identify a significant proportion of patients who would be otherwise missed by Alvarado score¹⁹. Although studies have established that both RIPASA as well as Alvarado scores are advantageous in detecting appendicitis with high diagnostic accuracy, the rates of negative findings on appendectomy have not decreased much. Clinical judgment is still the most important factor in the management of patients with suspected acute appendicitis²⁰. However, on comparison the RIPASA score is slightly better in sensitivity, specificity, PPV, NPV and diagnostic accuracy as compared to Alvarado score.

CONCLUSION

Through this study we found high diagnostic accuracy of RIPASA score when compared to Alvarado score taking histopathology gold standard. In future we can confidently use RIPASA instead of Alvarado score to diagnose acute appendicitis and decrease the rate of negative appendectomy and morbidity caused due to missed diagnosis.

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