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Research Article

COMPARISON OF ALVARADO SCORE WITH RIPASA SCORE IN DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT

Introduction: Acute appendicitis accounts for approximately 1% of all surgical operations.¹ A prompt diagnosis and treatment is must to decrease in morbidity and mortality. Careful history and physical examination remains the most effective diagnostic modality². Diagnostic scoring systems have been developed in an attempt to improve the diagnostic accuracy of acute appendicitis.^{11,12} The most prominent of those scoring systems is Alvarado system which is based on clinical and laboratory evidence of acute appendicitis. Another scoring system RIPASA score has been derived for Asian countries that takes into consideration for age, sex, urine analysis, guarding, Rovsing sign, in addition to the variables in Alvarado score.¹³ The confirmation of the diagnosis is done by histopathology post-operatively. This study is an attempt to compare both the scoring systems in diagnosing acute appendicitis and correlating both the scoring systems with the intraoperative and histopathological findings.

Aim: To assess the accuracy of Alvarado score and RIPASSA score in diagnosing acute appendicitis and to correlate the two scoring systems with histopathological confirmation.

Methods: A prospective study of 80 patients who were diagnosed clinically as acute appendicitis were assessed by Alvarado and RIPASSA scoring system. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy and negative appendectomy rates in both scoring systems with respect to histopathology was calculated. Relevant statistical tools were applied to compare the two scoring systems.

Results: Alvarado scoring system is more specific (66.67%) as compared to RIPASA scoring system (33.33%). RIPASA scoring system is more sensitive (98.65%) as compared to Alvarado scoring system (94.59%). PPV of Alvarado scoring system is 97.22% as compared to 94.81% in RIPASA scoring system. NPV of RIPASA scoring system is 66.67% as compared to 50% in Alvarado scoring system. Diagnostic accuracy of RIPASA scoring system is 93.75% as compared with 92.50% in Alvarado scoring system. Negative appendectomy rate with Alvarado scoring system is 2.78% as compared to 5.19% with RIPASA scoring system. ROC analysis depicts cut off point for Alvarado score to be 7, for diagnosis with maximum sensitivity and specificity, similar to the original cutoff while RIPASA scoring cutoff point comes to be 7.5, consistent with the original cut off 7.5. There has been increase in scores in both the scoring systems with increase in severity on histopathological examination.

Conclusion: Both Alvarado and RIPASSA score were equally good in predicting acute appendicitis and correlated well with the histopathology report and there is not much difference between the two scoring systems.

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INTRODUCTION

Acute appendicitis accounts for approximately 1% of all surgical operations.¹ A prompt diagnosis and treatment is must to decrease morbidity and mortality. Careful history and physical examination remains the most effective diagnostic modality². Raised TLC which may be seen in acute appendicitis is associated with other cases of inflammation³. Role of X-rays is limited in diagnosis of acute appendicitis. It may rule out acute abdomen due to appendicular perforation.

Ultrasound is operator dependent and often misses or over-diagnoses the condition.⁴ CECT Scan is the investigation of choice with high sensitivity and specificity but is expensive and is not available at all centres.^{5,6} CECT exposes the patient to significant radiation, cannot be used during pregnancy, allergy to IV contrast and some patients cannot tolerate the oral ingestion of luminal dye, particularly in the presence of nausea and vomiting.⁷ Indiscriminate use of CT scans may lead to the detection of low grade appendicitis that would otherwise have resolved spontaneously.^{8,9,10} Diagnostic scoring systems have

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been developed in an attempt to improve the diagnostic accuracy of acute appendicitis.^{11,12} The most prominent of those scoring systems is Alvarado system which is based on clinical and laboratory evidence of acute appendicitis. Another scoring system RIPASA score has been derived for Asian countries that takes into consideration for age, sex, urine analysis, guarding, Rovsing sign, in addition to the variables in Alvarado score.¹³ Confirmation of diagnosis is done by histopathology post-operatively.

This study is an attempt to compare both the scoring systems in diagnosing acute appendicitis and correlating both the scoring systems with the intraoperative and histopathological findings.

Aims

1. To compare ALVARADO with RIPASA scoring in diagnosis of acute appendicitis.
2. To correlate intra-operative and histopathological findings with both scoring systems.

METHODS

This prospective study of 80 patients who were diagnosed clinically as acute appendicitis, was conducted in The Department of General Surgery, North Delhi Municipal Corporation Medical College & Hindu Rao Hospital, Delhi. The sample size was calculated on the basis of similar studies (Subotic AM *et al*,¹⁴ Walczak DA *et al*,¹⁵ Erdem H *et al*¹⁶) and as per our hospital record.

All patients of age greater than 18 years with clinical features suggestive of acute appendicitis were included. Exclusion criteria included appendicular lump, appendicular abscess, peritonitis due to appendicular perforation, appendicitis associated with any other abdominal pathology during operation.

Pre-operative work up included history, clinical examination to calculate Alvarado and RIPASA score on a pro forma. Other intra-operative findings such as position of appendix, length of appendix, presence of gangrene, free fluid and presence of fecolith too were recorded. Histopathological report was recorded as acute appendicitis, acute suppurative appendicitis, acute gangrenous appendicitis, peri appendicitis or normal. Sensitivity, specificity, positive predictive value, negative predictive value, diagnostic accuracy and negative appendectomy rates in both scoring systems with respect to histopathology were calculated.

Statistics: The quantitative variables were expressed in terms of mean ± sd and compared using ANOVA. The qualitative variables are expressed in terms of frequencies/percentages and their associations established using Fisher’s Exact test. Sensitivity analysis and ROC curves were made to find the critical values of the parameters. A p-value < 0.05 is considered statistically significant. Statistical Package for Social Sciences (SPSS) version 15.0 software is used for the analysis

RESULTS

Of the 80 patients included in the study 59 (74%) were males and 21 (26%) females with age ranging from 18 to 66 years. Of these 68 (85%) patients were < 40 years of age and 12 (15%) patients’ ≥40 years, the mean age being 29.54 ±11.20

years. Most patients presented with duration of symptoms less than 48 hours were 69 (86%). Presenting symptoms were: Right iliac fossa pain was present in all patients 80 (100%). Anorexia was present in 71 (89%) patients. Nausea and vomiting was present in 58 (73%) patients. Fever was present in 54 (68%) patients. Migration of pain to right iliac fossa was present in 32 (40%) patients.

Amongst presenting signs, tenderness was present in all 100% patients rebound tenderness was present 58 (73%) patients, guarding was present in 19 (24%) patients while Rovsing sign in 12 (15%) patients. All signs had a statistical significance with a p value of 0.013.

Results of blood tests of 80 patients were as: 73 (91%) patients had raised total leucocyte count while WBC with left shift was seen in 33 (41%) patients while Urine routine microscopy was normal in 68 (85%) patients.

Alvarado score was < 7 (no appendicitis) in 8 (10%) patients and ≥7 (acute appendicitis) in 72 (90%) patients.

RIPASA score was <7.5 (no appendicitis) in 3 (4%) patients and ≥7.5 (acute appendicitis) in 77 (96 %).

On analysing the cross table by Fisher’s exact test, there is definitive agreement that both the scoring systems are positively correlating with each other with respect to diagnosis of the disease (p value <0.01).

All 80 clinically diagnosed cases of acute appendicitis in the study were Histopathologic examination of all 80 cases diagnosed as acute appendicitis, 74 (92.5%) cases were confirmed acute appendicitis while 6 (7.5%) were normal.

On comparing Alvarado score with histopathology report; of the 8 patients with < 7 score; 4 (5.41%) had acute appendicitis while 4 (66.67%) did not have acute appendicitis. Of the 72 patients with a score >7, 70 (94.59%) had acute appendicitis while 2 patients (33.33%) did not have acute appendicitis.

Table 1 Comparison of Alvarado score with Histopathology report

p-value	<0.001
Sensitivity	94.59%
Specificity	66.67%
Predictive Value of Positive test	97.22%
Predictive value of Negative test	50.00%
Negative Appendectomy	2.78%
Diagnostic Accuracy	92.50%

Fischer’s exact test was applied and diagnosis by Alvarado scoring system correlates well with histopathological diagnosis. P value is <0.001.

Sensitivity of the scoring system in this study is 94.59%; specificity comes out to be 66.67%. The positive and negative predictive values are 97.22% and 50%. Accuracy of the scoring system is 92.5%.

On comparing RIPASA score with histopathology report; of the 3 patients with < 7.5 score; 1 (1.35%) had acute appendicitis while 2 (33.33%) did not have acute appendicitis. Of the 77 patients with a score >7.5, 73 (98.65%) had acute appendicitis while 4 patients (66.67%) did not have acute appendicitis.

Table 2 Comparison of RIPASA score with Histopathology report

p-value	<0.001
Sensitivity	98.65%
Specificity	33.33%
Predictive Value of Positive test	94.81%
Predictive value of Negative test	66.67%
Negative Appendectomy	5.19%
Diagnostic Accuracy	93.75%

Fischer’s exact test was applied and RIPASA scoring system diagnosis correlates well with the histopathological diagnosis. P value is <0.001.

Sensitivity of the scoring system in the study is 98.65%; specificity comes out to be 33.33%.The positive and negative predictive values are 94.81% and 66.67%. Accuracy of the scoring system is 93.75%.

Table 3 Comparison of Alvarado with RIPASA score in diagnosis of Acute Appendicitis

	Alvarado	RIPASA
Sensitivity	94.59%	98.65%
Specificity	66.67%	33.33%
Predictive Value of Positive test	97.22%	94.81%
Predictive value of Negative test	50.00%	66.67%
Negative Appendectomy	2.78%	5.19%
Diagnostic Accuracy	92.50%	93.75%

Finally to correlate both the scoring systems with histological report, acute appendicitis group has been divided into 3 groups according to increase in severity, namely acute appendicitis, acute suppurative appendicitis and acute gangrenous appendicitis.

Table 4 Histopathological Diagnosis grading and Distribution

Histopathological	Frequency (n)	%
Acute appendicitis	32	40%
Acute suppurative appendicitis	33	41%
Acute gangrenous appendicitis	9	11%
Normal	6	7.50%
Total	80	100%

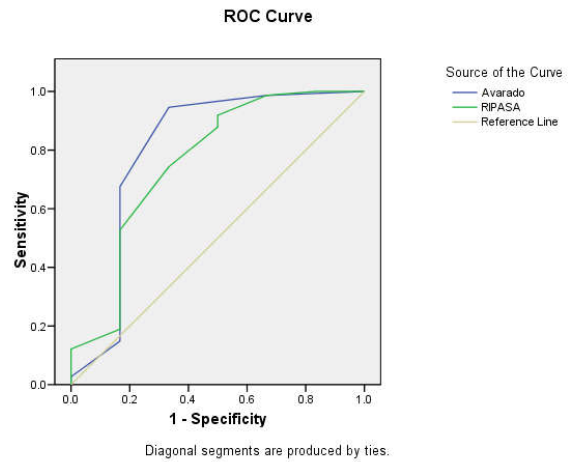
There was increase in Alvarado score with increase in histopathological severity. The mean score for acute, acute suppurative and acute gangrenous appendicitis was 7.25±0.76, 7.94±0.50, and 9.11±0.60 respectively.

There was also an increase in mean RIPASA score with increase in histopathological severity. The mean score for acute, acute suppurative and acute gangrenous appendicitis was 8.66, 10.27, and 12.00.

Of all the symptoms only nausea and vomiting was statistically significant (p value < .001) in correlating with acute appendicitis while for all signs only rebound tenderness was statistically significant (p value 0.013).

On applying Fischer’s exact test there was a correlation between increase in length of appendix with increase in RIPASA score (p value < 0.01). But there was also no relation between Alvarado score (p value is 0.176) or RIPASA score (p value is 0.146) and position of appendix. Alvarado scores correlation with presence of free fluid correlated was statistically significant (p 0.019) but was not statistically significant (p 0.110) with RIPASA score. Correlation between Alvarado score ≥7 and gangrene was statistically difference is significant (p value 0.160) but there was less correlation

between RIPASA score and gangrene (p value 0.278) but for fecoliths both scores had no statistical correlation (p 0.95 and 0.218).



Area Under the Curve

Test Result Variable	Area	Std. Error ^a	p-value ^b	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Avarado	.803	.135	.014	.539	1.067
RIPASA	.758	.125	.036	.514	1.002

The test result variable(s): Avarado, RIPASA has at least one tie between the p group and the negative actual state group. Statistics may be biased.

- a. Under the nonparametric assumption
- b. Null hypothesis: true area = 0.5

Remarks: The Area under the curve for Alvarado score is 80.3% (p-value = 0.014) while that of RIPASA is 75.8% (p-value = 0.036). Hence Alvarado score is a better predictor of histopathological diagnosis as compared to RIPASA.

DISCUSSION

Acute appendicitis is one of the most common surgical emergencies encountered in the world particularly in age group less than 30 years.¹⁷ Surgeon’s good clinical assessment is considered to be the most important in the diagnosis of acute appendicitis but this is very subjective. Several other conditions can mimic this clinical condition.¹⁸ Only CECT can diagnose the condition with very high sensitivity and specificity but it is not feasible to have this investigation done for each and every patient suspected to be appendicitis, particularly in countries with limited resources.^{5,6}

There has been a need of scoring system that can overcome these problems with acceptable sensitivity, specificity and negative appendectomy rate. One of the most commonly used is the Alvarado scoring system which incorporates symptoms, signs and laboratory investigations to reach the diagnosis.¹² Another scoring system RIPASA score has been developed, claimed to have better outcomes in Asian settings.¹³

This study is an attempt to compare both the scoring systems in the diagnosis of acute appendicitis and to assessthe accuracy between these scoring systems with intraoperative and histopathological findings.

In our study the only symptom that came out to be statistically significant was nausea and vomiting. In a study by Korner H *et al*¹⁹ nausea and vomiting, and pain migration to the RIF were the two symptoms that were statistically significant. Present study agreed with the study by Korner H *et al* but did not find pain migration as statistically significant. The difference was probably due to poor communication skills amongst the uneducated and illiterate population coming to our hospital.

Out of all the clinical signs, rebound tenderness was found to be statistically significant and this finding has been found in agreement with the study by Wagner JM.²⁰

Table 5 Alvarado Score compared in other studies

S. No.	Study	Sensitivity	Specificity	PPV	Negative appendectomy rate
1	This study	94.59%	66.67%	97.22%	2.78%
2	Dey <i>et al</i>	94.20%	70%	86.90%	13%
3	Khan <i>et al</i>	59%	23%	84.30%	15.60%
4	Jawaid <i>et al</i>	78%	89%	97%	7%

Dey *et al*²¹ in their study reported the sensitivity and specificity of Alvarado score to be 94.2% and 70% respectively, positive and negative predictive values of Alvarado score were 86.9% and 69.80%. Negative appendectomy rate in that study was 13%. The sensitivity in the present study was nearly equal with the quoted study, specificity being 4 % lower in present study which is nearly comparable with the quoted study. It can be concluded from studies by Jawaid *et al*, Dey S *et al*, Baidya N *et al*, Chan MY *et al*, Khan *et al* that sensitivity, specificity, positive predictive value and negative predictive value of Alvarado scoring system range from 59% to 89%, 23% to 70%, 77% to 98% and 69.8% to 98% respectively.^{22,23,24,25}

Table 6 RIPASA score compared in other studies

S. NO	Study	Sensitivity	Specificity	PPV	NPV	Diagnostic Accuracy
1	This study	98%	33.33%	94.81%	66.67%	93.75%
2	Chong CF <i>et al</i> ¹³	88%	67%	93%	53%	81%
3	Chong CF <i>et al</i> ⁸⁹	98%	81.30%	85.30%	97.40%	91.80%

Chong CF *et al* study based on retrospective and ROC analysis quoted that the expected sensitivity and specificity of the RIPASA scoring systems were 88% and 67% respectively, and diagnostic accuracy being 81%.¹³ The positive and negative predictive values were expected to be 93% and 53% respectively.¹³ which compared well to our study.

In a prospective study by Chong CF *et al*, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of the RIPASA score were 98.0 percent, 81.3 percent, 85.3 percent, 97.4 percent and 91.8 percent respectively when compared to Alvarado score with sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of 68.3 percent, 87.9 percent, 86.3 percent, 71.4 percent and 86.5 percent, respectively.²⁶ The authors of the RIPASA scoring system have claimed in this comparative prospective study that RIPASA score is better than Alvarado score in Asian settings.²⁶ But there is a paucity of published studies by other authors comparing these scoring systems.

Receptor operative curve analysis was done in the present study to look for the cut off scores for both the scoring systems, with good sensitivity and specificity. Alvarado score cut off

was found to be 7, which is consistent with the original scoring system cut off.⁹ The sensitivity and specificity at score 7 was found to be 94.59% and 66.67% respectively.

RIPASA score cut off came out to be 7.5, which was consistent with the original cut off 7.5.¹³ The sensitivity and specificity was found to be 86.3% and 60% respectively at cut off 8.5, when compared with sensitivity and specificity of 98.65% and 33% respectively at cutoff 7.5 in the present study. The cutoff value needs to be evaluated in further studies with increased sample size and in different geographical conditions.

There is paucity of studies that correlate scoring systems with the intraoperative and histopathological findings. In studies by Lewis FR and Althoubaity FK, it was observed that all the gangrenous appendicitis were associated with Alvarado score more than 8.^{27,28} The present study has found the mean of scores of gangrenous appendicitis to be 9.11±0.60, which is found consistent with previous observational studies. The mean scores for acute appendicitis and acute suppurative appendicitis were 7.25±0.76 and 7.94 ±0.50 respectively. In RIPASA scoring system, mean scores of 8.66±0.85, 10.27±1.19 and 12.0 ±0.94 respectively for acute appendicitis, suppurative and gangrenous appendicitis were observed. There has been an increase in the score, in both the scoring systems, with increase in the histopathological severity. There is lack of published studies which correlate intraoperative findings with scoring systems and further analysis through multicentric prospective studies is needed.

CONCLUSION

1. Alvarado scoring system is more specific (66.67%) as compared to RIPASA scoring system (33.33%).
2. RIPASA scoring system is more sensitive (98.65%) as compared to Alvarado scoring system (94.59%).
3. PPV of Alvarado scoring system is 97.22% as compared to 94.81% in RIPASA scoring system.
4. NPV of RIPASA scoring system is 66.67% as compared to 50% in Alvarado scoring system.
5. Diagnostic accuracy of RIPASA scoring system is 93.75% as compared with 92.50% in Alvarado scoring system.
6. Negative appendectomy rate with Alvarado scoring system is 2.78% as compared to 5.19% with RIPASA scoring system.
7. ROC analysis depicts cut off point for Alvarado score to be 7, for diagnosis with maximum sensitivity and specificity, similar to the original cutoff while RIPASA scoring cutoff point comes to be 7.5, consistent with the original cut off 7.5.
8. There has been increase in scores in both the scoring systems with increase in severity on histopathological examination.
9. For acute appendicitis, acute suppurative appendicitis and acute gangrenous appendicitis mean scores in Alvarado scoring system are 7.25±0.76, 7.94±0.50 and 9.11±0.60 respectively and are 8.66±.085, 10.27±1.19 and 12.00±0.94 respectively, in RIPASA scoring system.
10. Intra- operative findings such as increase in length of appendix and presence of free fluid are consistent with increase in Alvarado score at >7 and are statistically significant.

11. Only increase in length of appendix has been consistent with increase in RIPASA score at ≥ 7.5 and is statistically significant.
12. Presence of gangrene at scores ≥ 8 for Alvarado and ≥ 12 for RIPASA score is significant statistically.
13. There is paucity of studies that compare intraoperative and histopathological findings with both these scoring systems and needs to be evaluated further by prospective studies.

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