Original Research Article

A hospital-based study for comparison of RIPASA score and modified ALVARADO score in diagnosis of acute appendicitis

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ABSTRACT

Background: Acute appendicitis is a common cause of emergency abdominal surgery. Delayed or inaccurate diagnosis may lead to increased morbidity and healthcare costs. Scoring systems like the Modified Alvarado Score (MAS) and the RIPASA score have been developed to enhance diagnostic accuracy. This study aimed to compare the diagnostic performance of RIPASA and Modified ALVARADO scoring systems, with histopathological findings as the gold standard.

Methods: A prospective comparative study was conducted at GMERS Medical College and Hospital, Himmatnagar, including 100 adult patients presenting with right iliac fossa pain and suspected acute appendicitis. Each patient was assessed using both scoring systems. Decisions for surgery were made independently by experienced surgeons. The final diagnosis was confirmed via histopathological examination. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy were calculated for each scoring system.

Results: The mean age of patients was 27.32 years; 64% were male. Histopathological confirmation of appendicitis was found in 75% of cases. The Modified Alvarado Score demonstrated a sensitivity of 58.7%, specificity of 88%, PPV of 93.6%, NPV of 41.5% and diagnostic accuracy of 66%. In comparison, the RIPASA score showed higher sensitivity (89.3%), specificity (84%), PPV (94.4%), NPV (72.4%) and diagnostic accuracy (88%). ROC curve analysis also favoured the RIPASA score (AUC=0.891) over the Modified ALVARADO Score (AUC = 0.702).

Conclusions: The RIPASA score outperformed the modified ALVARADO score in diagnosing acute appendicitis, offering superior sensitivity, NPV and overall diagnostic accuracy. Given its applicability using basic clinical and laboratory data, the RIPASA score is particularly valuable in emergency and resource- limited settings to guide timely surgical decisions and reduce unnecessary imaging or admissions.

Keywords: Acute appendicitis, Diagnostic accuracy, Histopathological confirmation, Modified alvarado score, Ripasa score

INTRODUCTION

Acute appendicitis is among the most frequent conditions that necessitate emergency surgical intervention.[1] Around 6% of individuals are expected to experience acute appendicitis at some point in their lives. As a result, significant emphasis has been placed on prompt diagnosis and treatment, which has effectively reduced mortality rates to below 0.1% in uncomplicated cases, 0.6% in gangrenous appendicitis and up to 5% when perforation occurs.[2] Fitz first described the typical signs and symptoms of acute appendicitis in 1886. Since that time, it has continued to be the leading cause of hospital admissions necessitating laparotomy.[3,4] Because simple appendicitis can advance to perforation leading to significantly increased morbidity and mortality surgeons often choose to operate based on a probable diagnosis rather than waiting for confirmation. To mitigate the risk

of delayed intervention, they commonly accept a negative laparotomy rate of 15–30% as an acceptable margin of safety.[5]

The long-standing surgical approach of 'when in doubt, take it out' is now questioned due to the potential for both major and minor complications after an appendectomy. Diagnosing acute appendicitis remains challenging and can test the expertise of even seasoned surgeons. To improve diagnostic accuracy, methods such as computer-assisted analysis, ultrasound imaging, laparoscopy and even nuclear medicine techniques have been employed.[8-11] Due to its wide range of clinical manifestations, acute appendicitis remains a frequent yet challenging condition to diagnose. Reported diagnostic accuracy varies between 76% and 92%, largely influenced by the clinician's level of experience.[12]

Several scoring systems have been developed to assist in the early detection and timely treatment of acute appendicitis. These tools typically rely on a combination of patient history, physical examination and laboratory test results. One widely used method is the ALVARADO score, which was introduced to enhance diagnostic accuracy by incorporating eight clinical indicators. The scoring system has a maximum of 10 points and evaluates symptoms such as nausea and loss of appetite; physical signs like fever, localized pain in the right lower abdomen, rebound tenderness and pain migration; along with lab findings including elevated white blood cell count and neutrophilia. Among these, right lower quadrant tenderness and leukocytosis each account for 2 points, while the remaining criteria contribute 1 point each.[13]

Kalan and colleagues developed a modified version of the score by excluding the 'shift to the left' parameter, as this laboratory finding is not commonly accessible in many clinical settings.[14] The modified ALVARADO score (MAS) has been widely accepted after it was successfully tested in different studies.[15]

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a recently developed diagnostic tool for acute appendicitis, demonstrating notably higher sensitivity, specificity and overall accuracy compared to previous systems in Asian population.[16] Unlike the ALVARADO score, RIPASA incorporates additional factors such as age, gender and symptom duration before presentation, which have been found to influence the diagnostic performance of the ALVARADO system.[17]

The RIPASA Score is a recently developed diagnostic tool for acute appendicitis that has demonstrated greater sensitivity, specificity and accuracy than the ALVARADO Score, especially in Asian populations.[18-20] There is limited research in India comparing the RIPASA and modified ALVARADO scoring systems for diagnosing acute appendicitis. Therefore, we conducted a prospective study to evaluate and compare these two scores in patients presenting to our hospital with right iliac fossa pain suggestive of acute appendicitis.

Aims and objectives

To evaluate the diagnostic accuracy of Modified ALVARADO scoring system in the preoperative diagnosis of acute appendicitis. To evaluate the diagnostic accuracy of RIPASA scoring system in the preoperative diagnosis of acute appendicitis. To determine which of the two scoring system has better diagnostic ability in pre-operative diagnosis for acute appendicitis, taking histopathology as gold standard.

METHODS

Study design

This was a comparative prospective study.

Study area

The study was conducted in the Department Of Surgery at GMERS Medical College and Hospital, Himmatnagar in Gujarat.

Study population

All the patients suspected of acute appendicitis coming to our hospital and giving informed consent.

Sample size calculation

The incidence of acute appendicitis on histopathology in patients who were operated based on clinical suspicion of acute appendicitis was reported to be around 81.8% to 95% 26. Therefore assuming 88% to be positive on histopathology and 7% margin of error, the minimum required sample size at 5% level of significance is 83 patients.

Formula used

$$n = \frac{Z^2 pq}{d^2}$$

p is the observed incidence

q = 1 - p

d is the margin of error

$Z_{\alpha/2}$ is the ordinate of standard normal distribution at α% level of significance

Calculations

p=0.88
q=0.12
d=0.07

$Z_{2.5\%}$ = 1.96 at α = 5% level of significance

$$n= \frac{1.96^2 \times 0.88 \times 0.12}{0.07^2} = 83$$

By rounding off, we decide to take 100 study subjects. Consecutive type of non- probability sampling will be used for selection of study subjects.

Study duration

The study duration was from December 2023 to March 2025.

Inclusion criteria

All patients (>18 years) with right lower abdomen pain with clinical diagnosis of acute appendicitis.

Exclusion criteria

Appendicular lump, history of urolithiasis, history of PID, adverse anesthetic history, suspected/proven malignancy, pregnancy

The detailed history, clinical examination, laboratory investigations were conducted for each patient. The investigation included routine hematological investigations, urine routine, X-ray KUB (Kidney ureter and bladder) and USG abdomen and pelvis in some equivocal cases. Two specially designed proforma were filled in for each patient. These proforma had general demographic information about the patient plus eight variables based on the modified ALVARADO scoring system.[21] The second proforma had similar patient details along with the fourteen variables based on RIPASA scoring system.[16]

Table 1: Modified ALVARADO score.

	Score	Score obtained
Symptoms		
Migratory right iliac fossa pain	1	
Anorexia	1	
Nausea and vomiting	1	
Signs		
Tenderness right iliac fossa	2	
Rebound tenderness	1	
Elevated temperature (1)	1	
Laboratory		
Leucocytosis (2)	2	
Total score obtained	9	

Temperature ≥98.9°F or ≥37.2°C, TLC ≥11000/mm³.

The decision to proceed with surgical intervention versus conservative management was based solely on the clinical suspicion of an experienced surgeon who was not involved in the study. The diagnosis of acute appendicitis was confirmed by operative findings and histopathological assessment of the appendicectomy specimen with the ultimate criterion for the final diagnosis of acute appendicitis being the histological demonstration of polymorphonuclear leucocytes throughout the thickness of the appendix wall. Those patients who were treated conservatively and subsequently discharged were reviewed in the surgical outpatient within a week. A score of 7 or above is taken as high probability of acute appendicitis for modified ALVARADO scoring system, while a score of 7.5 or above was taken as high probability of acute appendicitis for RIPASA scoring system.[16,21]

Table 2: RIPASA scoring.

Patient Characteristics	Score	Score obtained
Gender		
Male	0.5	-
Female	1.0	-
Age (in years)		
<40	1.0	-
>40	0.5	-
Symptoms		
Right iliac fossa pain	0.5	-
Pain migrating to right iliac fossa	0.5	-
Anorexia	1.0	-
Nausea and vomiting	1.0	-
Duration of symptoms		
<48 Hours	1.0	-
>48 Hours	0.5	-
Signs		
Rif tenderness	1.0	-
Guarding	2.0	-
Rebound tenderness	1.0	-
Rovsings sign	2.0	-
Fever >-37 or <39 C	1.0	-
Investigations		
Raised white cell counts	1.0	-
Negative urine analysis	1.0	-
Foreign national record of identity card (NRIC)	1.0	-
Total score	17.5	-

Statistical analysis

All the data was noted down in a pre-designed study proforma. Qualitative data was represented in the form of frequency and percentage. Quantitative data was represented using Mean±SD and Median and IQR (Interquartile range). Diagnostic accuracy was evaluated by calculating sensitivity, specificity, PPV and NPV using standard formulae. A p value<0.05 was taken as level of significance. Results were graphically represented where deemed necessary. SPSS Version 21 was used for most analysis and Microsoft Excel 2010 for graphical representation.

RESULTS

Mean age of the study cases was 27.32 years with maximum number of cases between 21-40 years of age (67%). Out of 100 patients enrolled in the study 64 were males (64%) and 36 were females (36%). Pain in right iliac fossa was reported in all cases while anorexia and nausea/vomiting was reported in 76% and 72% cases respectively. Tenderness over right iliac fossa was observed in 85% cases while rebound tenderness and increased temperature was observed in 50% and 65% cases respectively. Diagnosis of acute appendicitis as per modified ALVARADO Score was made in 47% cases.

Diagnosis of acute appendicitis as per RIPASA Score was made in 71% cases. Diagnosis of acute appendicitis was confirmed on histopathology by 75% cases. Sensitivity and specificity of modified ALVARADO score in diagnosing Appendicitis was 58.7% and 88% while PPV and NPV was 93.6% and 41.5%. Overall diagnostic accuracy was 66%.

Sensitivity and specificity of RIPASA score in diagnosing Appendicitis was 89.3% and 84% while PPV and NPV was 94.4% and 72.4%. Overall diagnostic accuracy was 88%.

Table 3: Distribution of study subjects as per age group and gender.

	N	%
Age group (years)		
≤20	9	9.0
21-40	67	67.0
41-60	21	21
> 60	3	3
Total	100	100
Mean age - 27.32±10.16 years		
Gender		
Female	64	64.0
Male	36	36.0
Total	100	100.0

Table 4: Distribution of study subjects as per symptoms and signs.

Symptoms	N	%
Pain to RIF	100	100.0
Anorexia	76	76.0
Nausea/vomiting	72	72.0
Signs		
Tenderness over RIF	85	85.0
Rebound tenderness	50	50.0
Increased temperature	65	65.0

Table 5: Distribution of study subjects as per modified ALVARADO Score and as per RIPASA score.

Modified ALVARADO Score	N	%
<7	53	53.0
≥7	47	47.0
Total	100	100.0
RIPASA score		
<7.5	29	29.0
≥7.5	71	71.0
Total	100	100.0

Table 6: Distribution of study subjects as per histopathological diagnosis.

| Appendicitis (histopathology)	N	%
Yes	75	75.0
No	25	25.0
Total	100	100.0

Table 7: Screening efficacy of modified ALVARADO score.

Modified ALVARADO Score	Appendicitis (Histopathology)		Total
	No	Yes	
<7	22	31	53
≥7	3	44	47
Total	25	75	100
Parameters	%		
Sensitivity	58.70		
Specificity	88.00		
PPV	93.60		
NPV	41.50		
Accuracy	66.00		

Table 8: Screening efficacy of RIPASA score.

RIPASA Score	Appendicitis (Histopathology)		Total
	No	Yes	
<7.5	21	8	29
≥7.5	4	67	71
Total	25	75	100
Parameters	%		
Sensitivity	89.3		
Specificity	84.0		
PPV	94.4		
NPV	72.4		
Accuracy	88.0		

Table 9: Receiver's operative characteristics curve for screening efficacy of Modified ALVARADO and RIPASA Score.

Area under the curve					
Test result variable(s)	Area	SE	P value	Asymptotic 95% CI	
				Lower Bound	Upper Bound
Modified ALVARADO score	0.702	0.104	<0.01	0.498	0.907
RIPASA score	0.891	0.095	<0.01	0.651	0.972
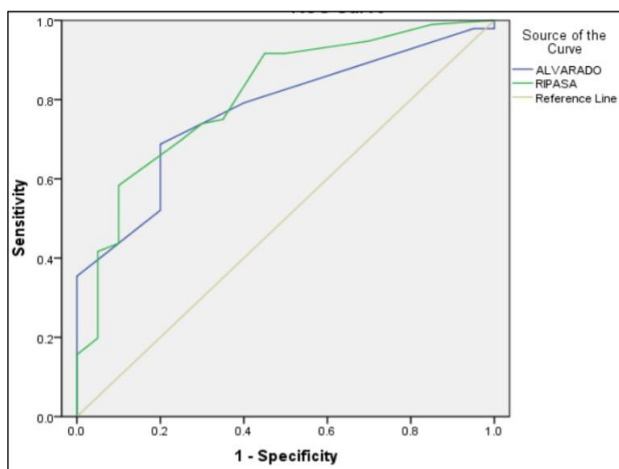
Figure 1: ROC curve analysis.

ROC curve analysis was done to evaluate for screening efficacy of Modified ALVARADO & RIPASA Score.

Both scores showed good efficacy in screening the cases appendicitis. However, overall screening efficacy of RIPASA score was better than modified ALVARADO Score (AUC–0.891 vs 0.702).

DISCUSSION

Acute appendicitis is a common cause of acute abdominal pain requiring emergency surgical intervention. Prompt and accurate diagnosis is essential to prevent complications such as perforation, abscess and generalized peritonitis. While imaging modalities like ultrasonography and CT scan can assist diagnosis, they are not always immediately available or affordable in low-resource settings.

Hence, clinical scoring systems such as the Modified ALVARADO score and RIPASA score offer a valuable, cost-effective alternative for early decision-making. Our prospective study aimed to compare the diagnostic utility of these two scores in patients presenting with suspected

acute appendicitis, while also comparing each parameter with existing literature.

Objective

This prospective study aimed to evaluate and compare the diagnostic utility of two widely used scoring systems modified ALVARADO score and the RIPASA score in patients presenting with suspected acute appendicitis in an Indian clinical setting.

Demographics

In our study of 100 patients, the mean age was 27.32 years, with 67% of cases between 21–40 years. There was a male predominance (64%). These findings are consistent with studies by Pasumarthi et al, Regar et al, and Zulfiquar et al, all of which reported similar age and sex distributions.[15,18,24] This reaffirms the global trend of appendicitis predominantly affecting young adult males.

Clinical features

Clinically, all patients presented with right iliac fossa pain (100%), while anorexia (76%), nausea/vomiting (72%), tenderness in RIF (85%), rebound tenderness (50%) and fever (65%) were common findings. These findings are comparable to studies by Nanjundaiah et al and Chong et al, which also report Murphy's triad (pain, vomiting, fever) and RIF tenderness as prevalent features.[19,20] These similarities validate the consistency of appendicitis presentation across populations.

Histopathological findings

In our study, 75% of cases were confirmed as acute appendicitis on histopathology. This is in close agreement with results from Zulfiquar et al, (77%) and Pasumarthi et al, (82.8%).[15,18] This histological correlation supports the reliability of clinical scoring systems in guiding diagnosis before imaging or operative intervention.

Diagnostic performance of modified ALVARADO score

At a cut-off of ≥7, the modified ALVARADO score showed, sensitivity: 58.7%, specificity: 88%, PPV: 93.6%, NPV: 41.5%, diagnostic accuracy: 66%. These values are consistent with Nanjundaiah et al sensitivity 58.9%, specificity 85.7%.[19] Chong et al: sensitivity 68.3%, specificity 87.9%, accuracy 86.5%.[20] Pasumarthi et al: accuracy 77%, sensitivity 64.7%.[15] While the ALVARADO score shows good specificity and positive predictive value, its lower sensitivity and NPV suggest it may miss cases in early or atypical presentations, limiting its role as a sole screening tool.

Diagnostic performance of RIPASA score

At a cut-off of ≥7.5, the RIPASA score showed sensitivity: 89.3%, specificity: 84%, PPV: 94.4%, NPV: 72.4%, diagnostic accuracy: 88%.

Comparable findings include Nanjundaiah et al: sensitivity 96.2%, accuracy 94%.[19] Chong et al: sensitivity 98%, accuracy 91.8%.[20] Pasumarthi et al: sensitivity 85%, accuracy 86%.[15]

RIPASA demonstrated superior sensitivity, NPV and diagnostic accuracy compared to ALVARADO, making it more effective for early and confident diagnosis, especially in equivocal or borderline cases. It includes demographic and additional clinical parameters (e.g., duration of symptoms, urinalysis), making it more tailored for Asian populations.

ROC curve analysis

RIPASA score

Area under curve (AUC)=0.891. Modified ALVARADO score: AUC =0.702.

This is consistent with Chong et al: RIPASA AUC 0.9183 vs. ALVARADO AUC 0.8651.[20] Pasumarthi et al: RIPASA AUC 0.810 vs. ALVARADO AUC 0.770.[15] Nanjundaiah et al: RIPASA AUC 0.878 vs. ALVARADO AUC 0.713.[19]

The ROC analysis in our study confirms that RIPASA has superior screening efficacy, with a higher AUC value reflecting better diagnostic discrimination.

Clinical relevance

Given its higher sensitivity and diagnostic accuracy, the RIPASA score is particularly useful in the emergency setting, where immediate imaging may not be available. It can guide timely admission, surgical decision-making and reduce the rate of negative appendectomies. RIPASA's inclusion of region-specific variables makes it especially valuable in the Indian and Southeast Asian healthcare context.

The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to rural or primary healthcare settings. The sample size of 100 patients may not be large enough to detect subtle differences in subgroups (e.g., pediatric or elderly populations).

Inter-observer variability in clinical examination and subjective scoring may have introduced bias. Additionally, no imaging modalities like ultrasound or CT were uniformly used for comparison, which could have further validated the scoring systems. Lastly, long-term outcomes such as postoperative complications or recovery time were not assessed.

CONCLUSION

We thus conclude that RIPASA score is currently a much better diagnostic scoring system for acute appendicitis

compared to the ALVARADO score. RIPASA had significantly higher sensitivity, NPV and diagnostic accuracy in our study group. The 14 fixed parameters can be easily and rapidly obtained in any population setting by taking a complete history and conducting a clinical examination and two simple investigations. In remote settings or emergency, a quick decision can be made with regards to referral to an operating surgeon or observation. The use of RIPASA scoring would help in decreasing the unwarranted patient admissions and also expensive radiological investigations.

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