ORIGINAL RESEARCH

The validation of RIPASA scoring system for diagnosis of acute appendicitis

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ABSTRACT
Acute appendicitis is the most common condition encountered in general surgical practice. Alvarado and Modified Alvarado scores (MASS) are the commonly used scoring systems for its diagnosis, but its performance has been found to be poor in certain populations. Hence, we compared the RIPASA score with MASS, to find out which is a better diagnostic tool for acute appendicitis in the Indian population. We enrolled 180 patients who presented with RIF pain in the study. Both RIPASA and MASS were applied to them, but management was carried out as per RIPASA score. Final diagnosis was confirmed either by CT scan, intra-operative finding, or post-operative HPE report. Final diagnosis was analysed against both RIPASA and MASS. Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic Accuracy was calculated for both RIPASA and MASS. It was found that RIPASA was statistically superior to MASS in terms of Specificity (97% v/s 93%), Positive Predictive Value (96% v/s 85%), Diagnostic Accuracy (68% v/s 56%),Sensitivity (47% vs 28%) and Negative Predictive Value (57% v/s 48%). RIPASA is a more specific and accurate scoring system in our local population, when compared to MASS. It reduces the number of missed appendicitis cases and also convincingly filters out the group of patients that would need a CT scan for diagnosis.
Key words: Acute appendicitis, modified alvarado score, RIPASA score

INTRODUCTION

The abdomen is compared to the box of Pandora, and with good reason. Since the abdomen comprises innumerable viscera and other anatomical components, abdominal diseases give rise to a lot of clinical curiosity. Careful assessment of the abdomen and clinical correlation is one of the most important diagnostic methods and is the cornerstone of management of many conditions of abdominal pain. Despite developments in the field of medicine in terms of imaging and other methods of investigation, the importance of clinical review cannot be emphasized enough[1].

Acute appendicitis is one of the most common causes of acute abdomen in practice of general surgery. Since it was first described by Reginald Heber Fitz in 1886, serial research has remained a subject of numerous factors, ranging from its aetiology to its management options [2].

One of the most researched areas of appendicitis is the one involving diagnosis. Over the years, different forms of investigations, including laboratory and radiological, have been analyzed in depth with the help of trials. They were performed in the hope of discovering the most sensitive test for acute appendicitis. However, despite significant advancements in the field of medicine, numerous clinicians and authors have consistently opined that appendicitis is one condition whose diagnosis relies primarily on clinical features. As quoted by Bailey & Love, "Notwithstanding advances in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of appendicitis remains essentially clinical, requiring a mixture of observation, clinical acumen, and surgical science"[3,4].

There has been a lot of focus on the different diagnostic approaches, only because the same is extremely important. Appendicitis, which, if caught early and properly treated, may be the most uneventful surgery, although the other end of the spectrum is also true that appendicitis, when missed, can turn into a disease with high morbidity and mortality[5].

As a result, having understood the significance of early and proper diagnosis and having understood that clinical assessment is the safest and most reliable

735

diagnostic tool for appendicitis, a variety of clinical scoring systemshave been developed over the years. This has helped the clinician to a large extent to get the correct diagnosis and early management. What started as a single score system has evolved over the years, with people continuously modifying current scoring systems on the basis of local demographics or adding more variables. This brought with it the next challenge, the finding of a single best scoring system, or a scoring system with maximum sensitivity and diagnostic accuracy. As a result, several experiments have been performed in randomized controlled trials comparing various scoring systems in different parts of the world. To date, Alvarado and Modified Alvarado Score Systems (MASS) have become the most widely used scoring method in the world. As a result, they have almost been considered an undocumented gold standard scoring system by clinicians worldwide so much, so that any new scoring system that has been developed is usually first compared to this[6].

Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a fairly new score system system developed in 2008, where a study was conducted at RIPAS Hospital, Brunnei Darssalem to find a more favorable scoring system than Alvarado and Modified Alvarado, as these have been found to have low sensitivity and specificity in the Middle East and Asian populations. Following its development, a randomized control trial was also performed in the same hospital, comparing RIPASA and Alvarado scoring systems and showing the superiority of the former over the latter[7,8].

In this study, RIPASA and Modified Alvarado Scoring Systems (MASS) are compared among the local population in the Indian subcontinent to find out which scoring system is more appropriate and applicable to support early diagnosis of acute appendicitis.

METHODOLOGY
After consultation with the statistician, the sample size was calculated with the formula and set as 180.

INCLUSION CRITERIA
All patients presenting with Right Iliac Fossa (RIF) pain.

EXCLUSION CRITERIA
Patients presenting with non-RIGHT ILIAC FOSSA pain and those who have beenadmitted by other specialties for other complains but who subsequently developed RIGHT ILIAC FOSSA pain.

180 patients who presented to the Surgery OPD and Emergency Department with RIF pain were included in the study. Relevant history, examination and laboratory investigations done. Patients were scored according to both Modified Alvarado Scoring System (MASS) and RIPASA Scoring, and both were documented in the proforma. In both groups after final scoring, patients were categorized into 4 groups.

Category	RIPASA	Mass
D (Definite)	>12	>8
HP (High Probability)	7.5-12	7-8
LP (Low Probability)	5-7	5-6
U (Unlikely)	<5	<5

After this, the management of the patient was carried out according to the RIPASA Scoring system.
- Patients who fell under HP/D category, were taken up for surgery immediately.
- Patients who fell under LP category were subjected to further investigation for diagnosis.
- Patients who fell under U category were worked up for other causes of pain abdomen, other than appendicitis, by means of imaging and other appropriate laboratory studies.

Conservatively managed patients were discharged and followed up in the OPD, while for the patients who were operated upon directly, diagnosis was confirmed by intraoperative findings and HPE report. With the final diagnosis confirmation got from either CT scan or Intra-operative finding, or Post-operative HPE report, an analysis was done comparing both RIPASA and MASS.

RESULTS

Table 1. Diagnostic evaluation of RIPASA with Final diagnosis

RIPASA	Final Diagnosis-A	Final Diagnosis-NA	Total
Score Positive	49	2	51
Score Negative	55	74	129
Total	104	76	180

Final Diagnosis-A: Appendicitis as confirmed by USG
Final Diagnosis-NA: Non-Appendiceal cause as confirmed by USG
Score Positive-Score>7.5, under HP/D categories.
Score Negative-Score<7.5, under LP & U categories.

Table 2: Statistical Analysis of RIPASA

Parameter RIPASA	Estimate	Lower-Upper 95% CIs
Sensitivity	47.11%	40.82 - 53.39
Specificity	97.36%	96.22 - 98.50
Positive Predictive Value	96.07%	94.63 - 97.51
Negative Predictive Value	57.36%	53.68 - 61.04
Diagnostic Accuracy	68.33%	64.87 - 71.79

In this study, Sensitivity was 47.11% with 95% confidence interval (40.82-53.39), and specificity was 97.36% with 95% confidence interval (96.22-98.50). Positive Predictive Value (PPV) showed an estimate 96.07% with 95% confidence interval (94.63-97.51). Diagnostic accuracy of RIPASA is also high (68%).

Table 3: Diagnostic evaluation of MASS with Final diagnosis

MASS	Final Diagnosis-A	Final Diagnosis-NA	Total
Score Positive	30	5	35
Score Negative	74	71	145
Total	104	76	180

Final Diagnosis-A: Appendicitis as confirmed by USG.
Final Diagnosis-NA: Non-Appendiceal cause as confirmed by USG.
Score Positive-Score>6, under HP/D categories.
Score Negative-Score<6, under LP & U categories.

Table 4: Statistical analysis of MASS

Parameter MASS	Estimate	Lower-Upper 95% CIs
Sensitivity	28.8%	25.43 - 32.17
Specificity	93.4%	91.55 - 95.25
Positive Predictive Value	85.71%	83.11 - 88.31
Negative Predictive Value	48.96%	45.25 - 52.67
Diagnostic Accuracy	56.11%	52.42 - 59.80

In this study, Sensitivity was 28.8% with 95% confidence interval (25.43-32.17), and specificity was 93.4% with 95% confidence interval (91.55-95.25). Positive Predictive Value (PPV) showed an estimate 85.71% with 95% confidence interval (83.11-88.31). Diagnostic accuracy of MASS is 56.11%.

Our study found the difference in sensitivity, positive predictive value and diagnostic accuracy between RIPASA and MASS to be statistically significant at p value of <0.05. Therefor RIPASA has better sensitivity, positive predictive value and diagnostic accuracy when compared to MASS. (Table 5)

Table 5: Comparison between RIPASA and MASS scoring system

Parameter	RIPASA	MASS	P value
Sensitivity	47.11%	28.8%	0.000*
Specificity	97.36%	93.4%	0.073
Positive Predictive Value	96.07%	85.71%	0.000*
Negative Predictive Value	57.36%	48.96%	0.190
Diagnostic Accuracy	68.33%	56.11%	0.016*

*Statistically significant different.

The ROC curve for MASS and RIPASA was found to be corresponding AUC (area under curve) for both RIPASA and MASS. (Figure 30)
The ROC curve when compared for the area under curve was found to be high for both RIPASA and MASS but it was higher for RIPASA than MASS. (Table 6)

Table 6: AUC for RIPASA and MASS scoring system in predicting acute appendicitis

Scoring system	Area	P value	95% Confidence interval	
			Lower bound	Upper bound
RIPASA	0.930	0.000	0.879	0.980
MASS	0.922	0.000	0.870	0.970

RIPASA scoring of HP/D category correctly identified 90.1% of patient to have appendicitis while MASS correctly identified 85.7%. Under the grade of LP, MASS scoring predicted 97.5% to have appendicitis and RIPASA predicted 93.5%. All patients classified under U in the RIPASA scoring system did not have appendicitis while 33.3% who were classified has unlikely to have appendicitis in MASS scoring actually had appendicitis. (Figure 29)
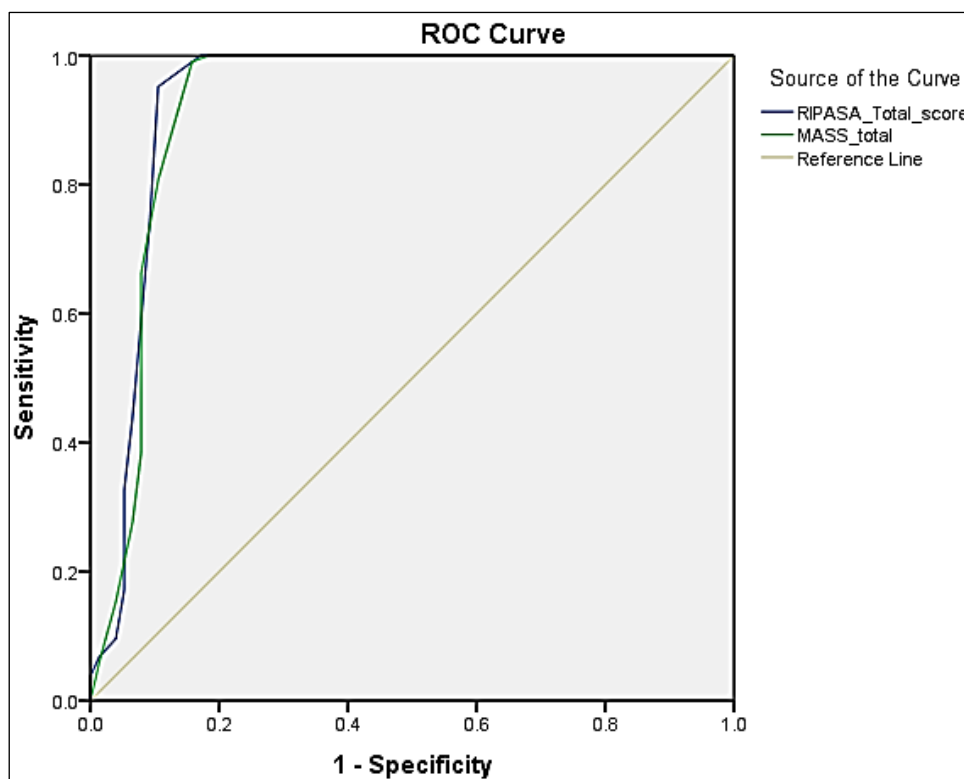

Figure 1: ROC curve (Receiver operating curve) comparing RIPASA and MASS

Discussion

RIPASA, during its development by Chong *et al.*, was found to have a sensitivity and specificity of 88% and 67% respectively. But few studies have been done consecutively, showing better results.

Table 7: Sensitivity and Specificity of RIPASA by Chong *et al.*,

Chong *et al.*,[9]	
Sensitivity	72%
Specificity	54%

Butt MQ *et al.*, conducted a cross-sectional study on 267 patients and found RIPASA score to have a sensitivity and specificity of 96.7% and 93% respectively. Its Positive predictive value was 98% and negative predictive value was 95%. Hence, they concluded that RIPASA was a useful tool in diagnosis of appendicitis.

Table 8: Sensitivity and Specificity of RIPASA by Butt MQ *et al.*,

Butt MQ *et al.*,[10]	
Sensitivity	96.7%
Specificity	95%

A few studies have been done comparing RIPASA with MASS with the following results-
Chong *et al.*, after developing RIPASA score, continued to evaluate their new score by prospectively enrolling 200 adults and children in a comparison of the RIPASA and Alvarado Scores. In this group of patients, the RIPASA was statistically superior to the Alvarado Score in Sensitivity (98% vs. 68%), NPV (97% vs. 71%) and accuracy (92% vs. 87%). Specificity (81.3% vs 87.9%) and PPV were similar between the 2 scores.

Table 9: Comparison of the RIPASA and Alvarado Scores by Chong et al.,

Chong et al.,[9]	RIPASA	Alvarado Score
Sensitivity	98%	68.3%
Specificity	81.3%	87.9%
Positive predictive value	85.3%	86.3
Negative predictive value	97.4%	71.4%
Accuracy	91.8%	86.5%

N.N., Mohammed et al., compared RIPASA and Alvarado and found RIPASA to be a more convenient, accurate and specific score with the resulting comparative values of RIPASA and Alvarado as follows-Sensitivity-96% and 58% respectively, Specificity-90% and 85% respectively.

Table 10: Comparison of the RIPASA and Alvarado Scores by N.N.Mohammed et al.,

N.N.Mohammed et al.,[11]	RIPASA	Alvarado Score
Sensitivity	96%	58%
Specificity	90%	85%

Erdem et al., studied 113 patients in a tertiary care centre and compared four clinical scoring systems-Alvarado, Eskelinen, Ohmann and RIPASA. They found a sensitivity level of 81%, 80.5%, 83.1% and 83% for each respectively. They concluded that Ohmann and RIPASA scores were the most specific in diagnosis of acute appendicitis.

Table 11: Comparison of four clinical scoring systems-Alvarado, Eskelinen, Ohmann and RIPASA by Erdem et al.,

Erdem et al.,[12]	Sensitivity
Alvarado Score	81%
Eskelinen	80.5%
Ohmann	83.1%
RIPASA	83%

As compared to literature, in the present study, RIPASA was found to have a sensitivity, specificity, PPV and NPV of 49.4%, 96.9%, 93% and 69% respectively.

Over the last few years, since the advent of newer imaging systems, and due to the varied clinical accuracy of scoring systems, studies have also been done to evaluate the use of imaging techniques like CT scanning in diagnosis of appendicitis.

Li SK conducted a retrospective study on 396 patients and concluded that MASS along with CT scan was very useful in identifying the pathological type of appendicitis, and hence aided in choosing the right therapeutic option.

Liu W et al., did a study in 297 patients who had undergone a CT for diagnosis of appendicitis, and retrospectively compared them with RIPASA and Alvarado scores. Their respective results were as follows-Sensitivity-98.9% v/s 95.2% v/s 63.1%, Specificity-96.4% v/s 73.6% v/s 80.9%, Diagnostic accuracy-98% v/s 87.2% v/s 69.7%. They concluded that Multislice CT was the optimal tool for diagnosis of acute appendicitis, followed by RIPASA and then Alvarado scoring.

Table 12: Comparison of CT, RIPASA and Alvarado Scores by Liu W et al.,

Liu W et al.,[13]	CT	RIPASA	Alvarado Score
Sensitivity	98.9%	95.2%	63.1%
Specificity	96.4%	73.6%	80.9%
Diagnostic accuracy	98%	87.2%	69.7%

Although studies show that CT scanning has maximum sensitivity and specificity in diagnosis of acute appendicitis, this has not been very widely in use, at least in a developing country like India. This is due to multiple factors-not only universal factors like risk of radiation exposure, but also other economic and practical causes like cost and availability. Hence some studies were done to try and find out which group of patients benefitted from CT scan, to try and filter the availableresources.

Tan WJ et al., prospectively compared Alvarado and CT scan, and found that CT scan was mainly beneficial in patients with Alvarado score <6 in males, and <8 infemales[14].

Jones et al., in their study concluded that adults with an Alvarado score less than 3 were unlikely to benefit from a CT scan[15].

Keeping all these factors in mind, the present study was analysed category-wise. When we retrospectively analysed the proven appendicitis cases with the

scores, we found that among the HP/D categories, RIPASA picked up 96% cases as high probability of appendicitis, whereas MASS picked up only 85% as high probability cases. Hence, we understood that by using the RIPASA score, cases that fall under HP/D category can be more confidently taken up for surgery, without the need for any imaging modality.

Under the LP category in RIPASA, USG/CT scan was done for all patients, and 93% of them turned out to be acute appendicitis, as compared to 97% in MASS.

Under the U category, or "Unlikely to be appendicitis" category, RIPASA had 0 appendicitis cases. That means, it proved that 100% of the cases were unlikely. Meanwhile, MASS had 30% cases under unlikely category which were finally diagnosed as appendicitis. Hence, the number of missed cases would have been higher in MASS.

CONCLUSION

The present study concludes that, in the diagnosis of acute appendicitis, RIPASA score is more specific than Modified Alvarado Score, and also has a higher Positive Predictive Value and Diagnostic Accuracy. For the clinician, it gives a clearer categorization of management of patients with RIF pain-suggesting that in most cases, patients in HP/D category can be taken up for surgery after confirming with imaging modality, patients in LP category would benefit the maximum from USG/CT imaging and that patients in the U category can be worked up for non-appendiceal diagnoses. RIPASA also reduces the number of "missed appendicitis" cases. Hence, RIPASA is clinically and statistically a better scoring system for the diagnosis of acute appendicitis, as compared to MASS.

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