

A Comparative Study of Modified Alvarado Score System versus Ripasa (Raja Isteri Pengiran Anak Saleha Appendicitis) Score in Diagnosing Acute Appendicitis

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Abstract

Background: Acute appendicitis is the most common surgically manageable cause of acute abdomen¹, although the diagnosis remains challenging in many instances. Arriving at the correct diagnosis is essential, as a delay in diagnosis may allow progression to perforation and cause a significant increase in morbidity and mortality. Features include Central abdominal pain is associated with anorexia, nausea, and usually one or two episodes of vomiting that follow the onset of pain (Murphy's Triad). Various clinical scoring systems have been devised for accurate and early diagnosis of Acute Appendicitis. In this study, we compare the Modified Alvarado score system (MASS) with RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) score system.

Methods: A prospective study is conducted on 182 patients with pain in Right Iliac Fossa (RIF), who attend Sri Venkateshwara RamnaraianRuya Government General Hospital, Tirupati, from September 2018 to September 2019. Patients fulfilling the inclusion and exclusion criteria are included in the study. Based on the MASS and RIPASA scoring system, patients are divided into four categories D-Definitive, HP-High Probability, LP-Low Probability, and U- Unlikely according to their score in each scoring system. Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and Diagnostic Accuracy of each scoring system in diagnosing Acute Appendicitis is calculated and compared.

Results: In the present study, Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and Diagnostic Accuracy of RIPASA (53.08%, 97.02%, 93.47%, 72.05%, and 77.47% respectively) is higher than Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and Diagnostic Accuracy of MASS (46.91%, 87.12%, 74.50%, 67.17%, and 69.23%). Overall, RIPASA is a better clinical scoring system in the diagnosis of Acute Appendicitis.

Conclusion: This study concludes that using the RIPASA score system, the patients under category D and HP can be directly taken for surgery. Category LP would benefit the maximum using the CT imaging modality, thus reducing the cost burden on the healthcare system. Category U can be worked up for non-appendiceal causes of Right Iliac Fossa pain. Hence, RIPASA is clinically and statistically a better scoring system for the diagnosis of acute appendicitis, as compared to MASS.

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I. Introduction

Acute appendicitis is the most common surgically manageable cause of acute abdomen¹, although the diagnosis remains challenging in many instances. Some of the signs and symptoms may not be present in all instances and can be difficult to analyze to both the clinician and the patient. Arriving at the correct diagnosis is essential, as a delay in diagnosis may allow progression to perforation and cause a significant increase in morbidity and mortality.

The classical presentation of acute appendicitis begins with crampy, intermittent abdominal pain, maybe either periumbilical or diffuse and difficult to localize. Any delay in the diagnosis leads to appendicular perforation, adding up new symptoms such as diffuse pain abdomen as the generalized peritonitis ensues. This emphasizes the importance of early accurate diagnosis of acute appendicitis.

Having understood that clinical evaluation provides the best and most accurate diagnosis for appendicitis, many clinical scoring systems have been developed over the years². This has given rise to the next problem, of finding the single best scoring system or the scoring system with maximum sensitivity and diagnostic accuracy. The most commonly used scoring system worldwide is the Alvarado and the Modified Alvarado Scoring System (MASS)³, these have almost been considered as an undocumented gold standard scoring system among clinicians. RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) is a relatively newer

scoring system developed in 2008, by RIPAS Hospital, Brunei, Darssalem⁴, as Alvarado and MASS were found to have reduced sensitivity in the middle eastern and modern population. In the present study, MASS and RIPASA are compared to evaluate which scoring system is accurate and aids early diagnosis of acute appendicitis.

II. Materials & Methods

After consultation with the statistician, the sample size was calculated with the following formula and set as 182.

$$n = \frac{4pq}{l^2}$$

INCLUSION CRITERIA

- All patients with suspected Acute Appendicitis.
- Patients with age above 12 years.

EXCLUSION CRITERIA:

- Patients with right iliac fossa mass
- Patients with previous history of urolithiasis and pelvic inflammatory disease will also be excluded from the study
- Patients with Pregnancy
- Known case of Tuberculosis Abdomen
- Age group <12 years
- Patients with appendicular perforation

This is a cross-sectional, comparative study conducted at S.V. MEDICAL COLLEGE & SVRRGGH, Tirupati, for a period of 1 year, from September 2018 to September 2019. The first 182 patients who presented to the Surgery OPD and Emergency Department satisfying inclusion and exclusion criteria 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	6-7
LP (Low Probability)	5-7.5	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 CT scanning 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.

III. Results

In the present study, patients of age group >12 years were included, with the mean age being 28.7±11.6 years. The maximum number of patients belonged to the 2nd and 3rd decades (Fig. 1). 35% of the patients belonged to the 25-35 years age group, followed by 31% belonging to 12-25 years age group, while only 10% belonged to the age group above 45 years. Both sexes were affected with a slight male preponderance (61% males and 39% females). (Fig. 2)

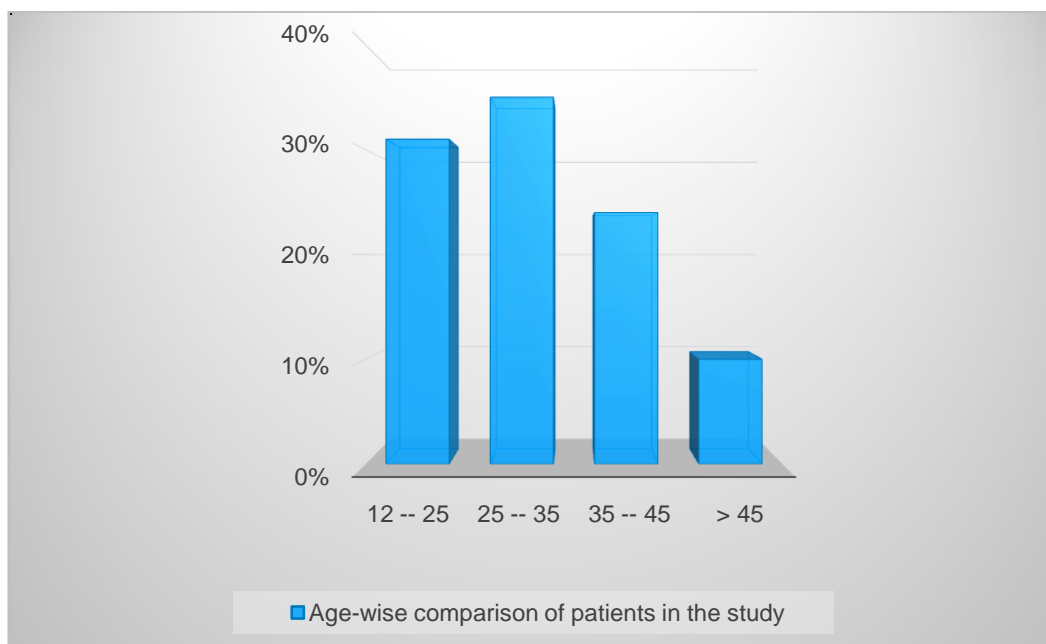


Figure 1 : Age-wise distribution in the study

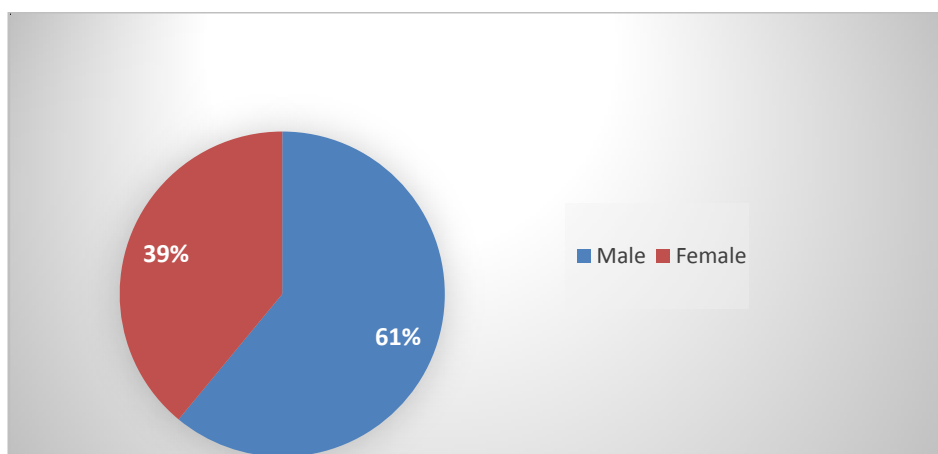


Figure 2 : Gender distribution in the study

As planned, RIPASA and MASS was applied to all the 182 patients who presented with RIF pain.

Analysis of RIPASA SCORING (Fig. 3)

81% belonged to the age group below 40 years, and 19% above. Gender difference was male 61% and female 39%. 28% presented within 48 hours of onset of symptoms and 72% after. 100% of the patients had RIF pain, as was the inclusion criteria of the study. 82% of them had RIF tenderness, 58% had a negative urinalysis, 54% had fever and 48% had a raised TC. 49% of the patients had nausea or vomiting.

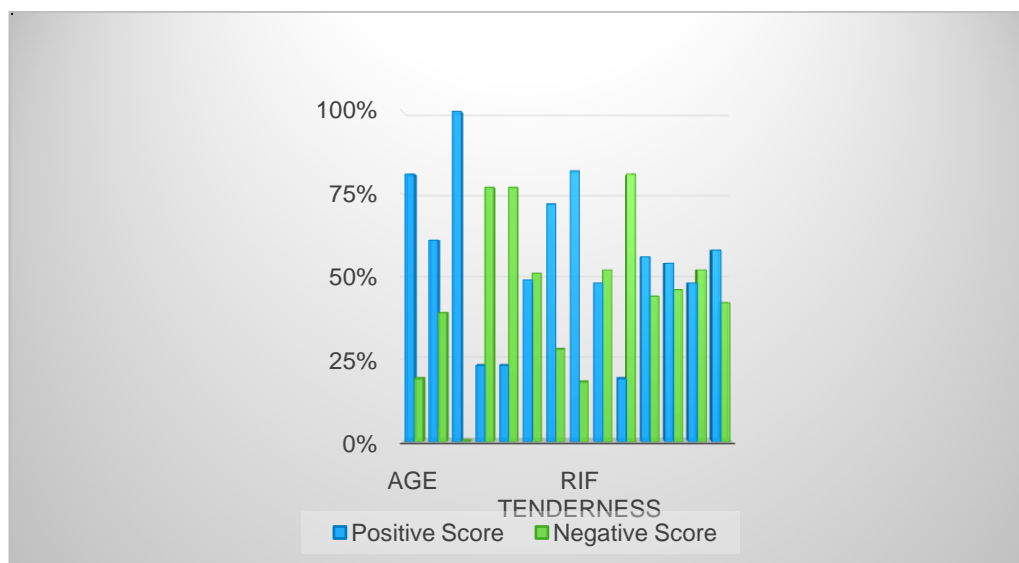


Figure 3 : Parameters of RIPASA score in the sample of present study

Finally, out of the total score, the patients were categorized under 4 categories. 4% of the patients had a score of >12 and were categorized as D, 21% with a score of 7.5-12 fell under the category HP, 38% had a score of 5-7.5 and were categorized as LP and 37% with a score <5 were termed U. (Fig. 4)

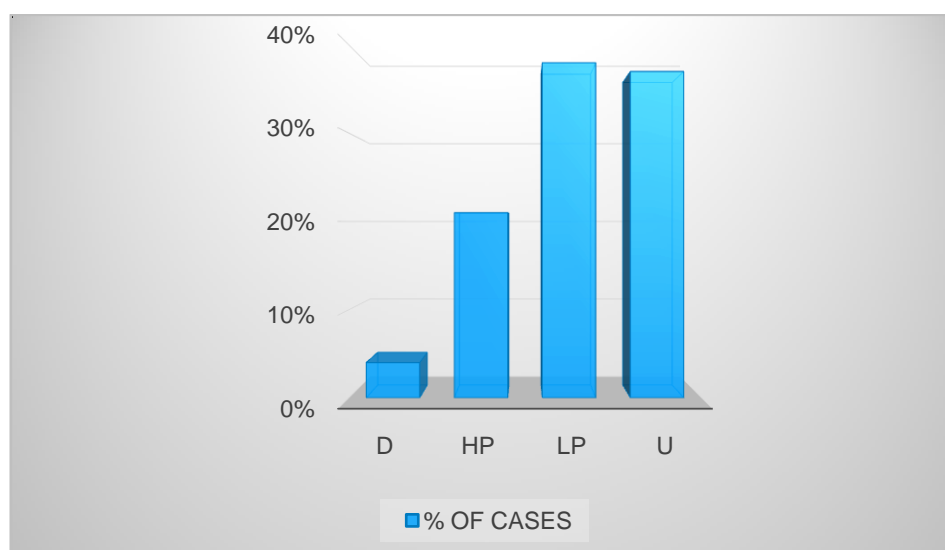


Figure 4 : Categories in final score of RIPASA
D- Definite, HP- High Probability, LP- Low Probability, U- Unlikely.

For all 182 patients, MASS was applied.

Analysis of MASS(Fig. 5)

82%, 54%, 48% and 49% had RIF tenderness, fever, raised TC and nausea/vomiting respectively. 23% patients had migratory pain and anorexia in 23% and about 19% had rebound tenderness.

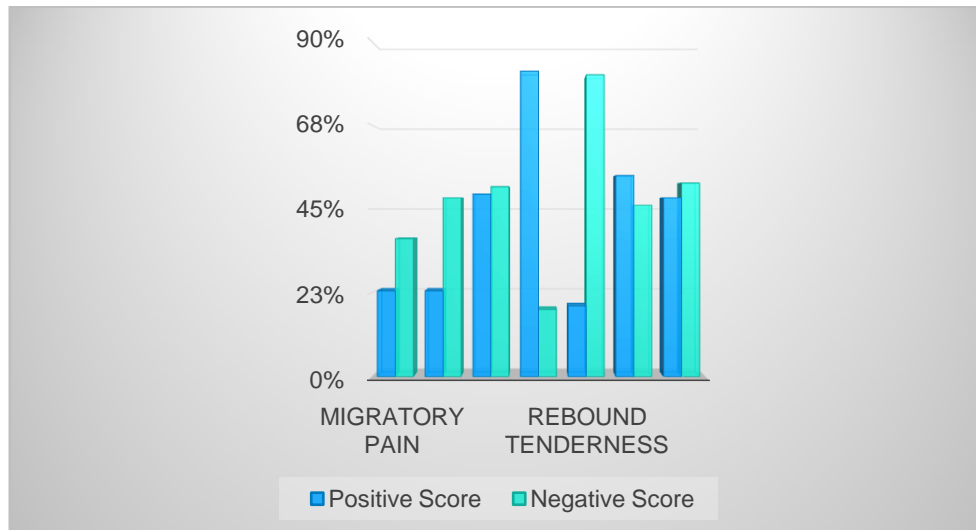


Figure 5 : Parameters of MASS in the sample of present study

With the final score, patients were classified into 4 categories. 13% with score >8 fell under D, 15% with 6-7 were under HP, 18% with score 5-6 were under LP, and 54% with score <5 were under U. (Fig. 6)

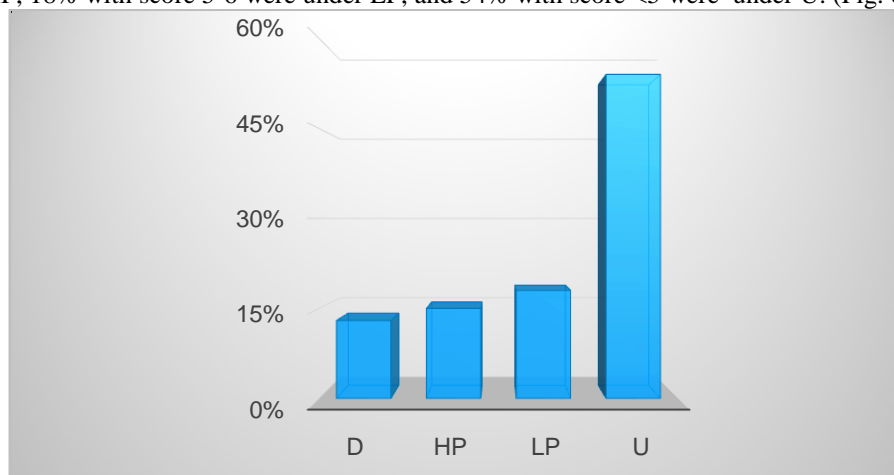


Figure 6 : Categories in final score of MASS
D- Definite, HP- High Probability, LP- Low Probability, U- Unlikely

As decided in the protocol, plan of management was carried out as per RIPASA score. Patients with U were subjected to USG scanning and other investigations to find out cause for pain abdomen and were either conservatively managed or referred to other specialist departments based on the diagnosis. Patients with LP were subjected to CECT Abdomen since it has a high sensitivity and specificity for diagnosis of appendicitis. The findings in the CT scan among the LP patients were as follows- Among the 69 patients who fell under LP category of RIPASA, 55% were diagnosed with appendicitis (A) and 45% had other non-appendiceal (NA) causes of pain abdomen. (Fig. 7)

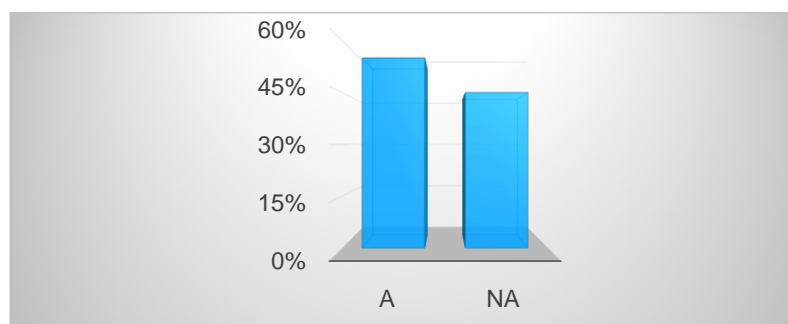


Figure 7: CECT results in LP cases of RIPASA
A-Appendicitis, NA-Non-Appendiceal causes

The total number of cases that underwent surgery (S), conservative management(C) and referrals (R) according to their categories are as follows-

Among the 46 cases that fell under HP/D, all cases were operated upon with a diagnosis of appendicitis, among which 2 cases turned out to be non-appendiceal causes - one was Meckel’s diverticulum, for which resection-anastomosis and appendectomy was done (Case No.163), and the other was a case of Ruptured Right Ovarian Cyst for which Right Oophorectomy was done (Case No.95). 1 case was thought to be Appendicitis and final diagnosis was Carcinoid tumor of Appendix (Case No.58).

Among the 69 cases that fell under LP, CECT abdomen was done for all cases. 38 were diagnosed with appendicitis. Out of these 38 cases, 24 cases underwent appendectomy. 6 cases were diagnosed to have appendicular mass and were initially managed conservatively according to Ochsner-Sherren regimen and taken up for interval appendectomy after 6 weeks (Cases No. 81,107, 128, 145, 170, 176). 8 cases with proven non-obstructive pathology on CECT, were chosen to be managed conservatively due to delayed presentation (>72 hours) and resolving symptoms. All these 14 cases were followed up on regularly up to 6 weeks period, among which 10 cases did not have recurrence, 1 case was lost to follow up and 3 cases had recurrence and underwent interval appendectomy.

Among the 67 cases under U, 49 were managed conservatively for various reasons ranging from urological causes like ureteric calculus and cystitis, to gastrointestinal causes like colitis. 18 cases were referred to OBG department for gynecological pathologies. (Fig. 8)

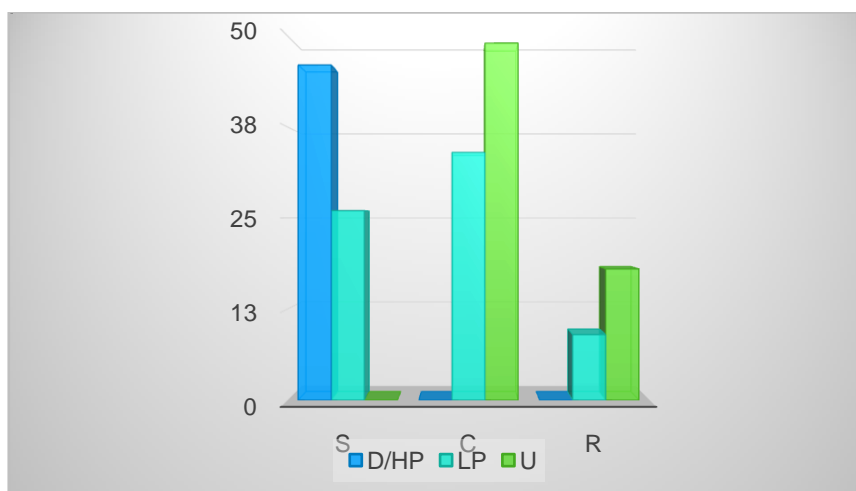


Figure 8 : Final mode of treatment in the sample in the study
D- Definite, HP- High Probability, LP- Low Probability, U- Unlikely
S-Surgery, C-Conservative Management, R-Referral to specialist department

Final diagnosis was confirmed with CECT, intra-operative findings and post-operative histopathology report. Among the 182 cases in the study, 44.5% had a final diagnosis of appendicitis and the remaining 55.5% had varied causes of pain abdomen – urological, gastrointestinal, gynecological, and non-specific. (Fig. 9)

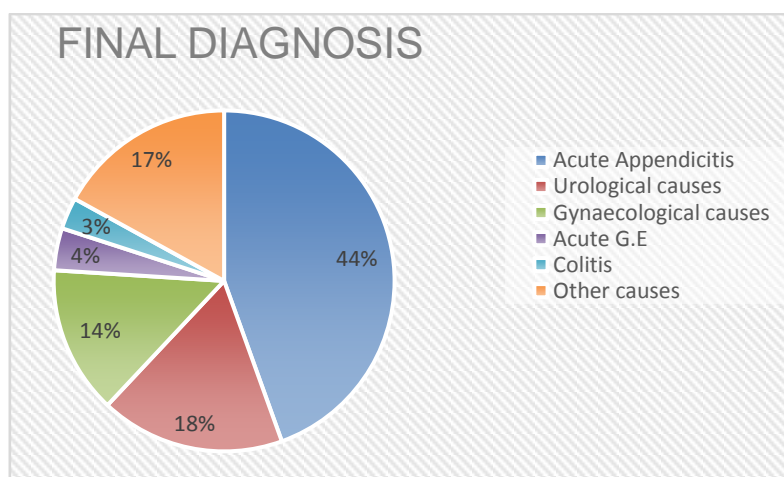


Figure 9 : Proportion of Final diagnoses in present study

To further compare RIPASA and MASS, category-wise analysis was done among the 44.5% of finally diagnosed appendicitis cases.

In retrospective comparison between final diagnosis of appendicitis and HP/D categories of RIPASA and MASS, it was seen that 93.4% of HP/D among RIPASA were appendicitis (Fig. 10), whereas only 74.5% of HP/D categories under MASS were appendicitis. (Fig. 11)

Under LP category, in RIPASA only 55% were appendicitis (Fig. 12) whereas in MASS, 80% were appendicitis (Fig. 13). Under the U category, RIPASA had 0 appendicitis cases, i.e. it proved that 100% of the cases were unlikely (Fig. 14), whereas in MASS, 17% cases were found to have appendicitis (Fig. 15). Statistical analysis was done with the help of OpenEpi, Version 2 and SPSS software Version 16. Results were as follows-

RIPASA SCORING SYSTEM

Table 1 : Diagnostic evaluation of RIPASA with Final diagnosis

RIPASA	Final Diagnosis- A	Final Diagnosis - NA	Total
Score Positive	43	3	46
Score Negative	38	98	136
Total	81	101	182

Final Diagnosis-A : Appendicitis as confirmed by CECT/Intra-op findings/Postop HPE report.

Final Diagnosis-NA : Non-Appendiceal cause as confirmed by CECT/Intra-op findings/Postop HPE report
Score Positive- Score>7.5, under HP/D categories. Score Negative- Score<7.5, under LP & U categories.

Statistical Analysis of RIPASA

In this study, Sensitivity was 53.08% with 95% confidence interval (42.59, 63.62), and specificity was 97.02% with 95% confidence interval (91.41, 99.05). Positive Predictive Value (PPV) showed an estimate 93.47% with 95% confidence interval (82.06, 97.94). Diagnostic accuracy of RIPASA is also high 77.47%.

MODIFIED ALVARADO SCORING SYSTEM –

Table 2 : Diagnostic evaluation of MASS with Final diagnosis

MASS	Final Diagnosis- A	Final Diagnosis - NA	Total
Score Positive	38	13	51
Score Negative	43	88	131
Total	81	101	182

Final Diagnosis – A : Appendicitis as confirmed by CECT/Intra-op findings/Postop HPE report

Final Diagnosis - NA : Non-Appendiceal cause as confirmed by CECT/Intra-op findings/Postop HPE report
Score Positive- Score>6, under HP/D categories. Score Negative- Score<6, under LP & U categories.

Statistical analysis of MASS

In this study, Sensitivity was 46.91% with 95% confidence interval (36.42, 57.45), and specificity was 87.12% with 95% confidence interval (36.42, 57.45). Positive Predictive Value (PPV) showed an estimate 74.50% with 95% confidence interval (36.42, 57.45). Diagnostic accuracy of MASS is 69.23%.

Table 3 : Comparison between RIPASA and MASS

PARAMETER	RIPASA	MASS
Sensitivity	53.08%	46.91%
Specificity	97.02%	87.12%
Positive Predictive Value	93.47%	74.50%
Negative Predictive Value	72.05%	67.17%
Diagnostic Accuracy	77.47%	69.23%

SIGNIFICANCE

Sensitivity of both RIPASA and MASS are comparable, but there seems to be a definite upgrade in specificity, positive predictive value, and to a certain amount in diagnostic accuracy as well in RIPASA scoring over MASS.

IV. Discussion

Pain abdomen is one of the most common complaints in the emergency department. Arriving at accurate diagnosis is necessary to plan the required adequate management strategies for the patient. Even though there are many investigation modalities to arrive at the diagnosis, there are several limitations to the usage of the ideal investigations. They are:

- unavailability of the investigation facilities
- cost-effectiveness of the investigations
- delay due to the investigation reporting

Table 4: MODIFIED ALVARADO SCORING SYSTEM (MASS)⁵

SYMPTOMS	SCORE
Migratory RIF pain	1
Nausea/Vomiting	1
Anorexia	1
SIGNS	
Tenderness in RIF	2
Rebound tenderness in RIF	1
Elevated temperature	1
LABORATORY FINDINGS	
Leucocytosis	2
TOTAL	9

Score <5 – Unlikely to be appendicitis

5-6 – Low Probability to be appendicitis

6-7 – High Probability to be appendicitis

>8 – Definite appendicitis

Table 5 : RIPASA SCORINGSYSTEM⁴

PATIENT'S DEMOGRAPHIC	SCORE
Female	0.5
Male	1.0
Age< 39.9 years	1.0
Age> 40 years	0.5
SYMPTOMS	
RIF pain	0.5
Pain migration to RIF	0.5
Anorexia	1.0
Nausea & vomiting	1.0
Duration of symptoms < 48 hrs	1.0
Duration of symptoms > 48 hrs	0.5
SIGNS	
RIF tenderness	1.0
Guarding	2.0
Rebound tenderness	1.0
Rovsing's sign	2.0
Fever>37 ⁰ C ,<39 ⁰ C	1.0
INVESTIGATIONS	
Raised WBC count	1.0
Negative urinalysis	1.0
ADDITIONAL SCORES	
Foreign NRIC	1.0

Score <5 – Unlikely to be appendicitis

5-7.5 – Low Probability to be appendicitis

7.5-12 – High Probability to be appendicitis

>12 – Definite appendicitis

Since its introduction in 1986, Alvarado is one of the most well-known and studied scores for acute appendicitis⁶. Its modification MASS has been equally in common use. MASS consists of three symptoms, three signs, and one basic lab investigation, which are very easy to assess. As this is the most popular and commonly

used scoring system, we planned to compare the newer scoring system (RIPASA) with it and study its efficacy in terms of sensitivity, specificity, and diagnostic accuracy, among other factors.

Keeping all these factors in mind, the present study was analyzed category-wise. We retrospectively analyzed the proven appendicitis cases with the RIPASA and MASS scoring systems. Based on the score value, patients were categorized into four groups, as described in the methods of collection of data. They are Definite (D), High Probability (HP), Low Probability (LP), and Unlikely (U). We found that among the HP/D categories, RIPASA picked up 93.4% cases as the high probability of appendicitis, whereas MASS picked up only 74.5% as high probability cases. Hence, we understood that by using the RIPASA score, cases that fall under the HP/D category could be more confidently taken up for surgery without the need for any imaging modality. Among the D/HP category under the RIPASA scoring system, 46 cases were operated with a pre-operative diagnosis of acute appendicitis. Among these 2 cases had intra-operative findings of non-appendiceal causes - one had Meckel's diverticulum, and the other had ruptured right ovarian cyst. One case had the post-operative histopathological diagnosis of the Carcinoid tumor of the Appendix and was referred to concerned Speciality.

Under the LP category in RIPASA, a CT scan was done for all patients, and 58% of them turned out to be acute appendicitis, as compared to 80% in MASS. This further strengthens the point that RIPASA filters out low probability cases better than MASS. Hence, it can be inferred that the patients who fall under the LP category (RIPASA 5-7.5) will benefit the most from a CT scan.

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 17% cases under the unlikely (U) category, which were finally diagnosed as appendicitis. Hence, the number of missed cases would have been higher in MASS.

Hence in the present study, comparatively RIPASA seems to be better than MASS clinically as well as statistically.

V. Conclusion

The present study concludes that, in the diagnosis of acute appendicitis, the RIPASA score is more sensitive, specific than the Modified Alvarado Score, and also has a higher Positive Predictive Value, Negative Predictive Value, and Diagnostic Accuracy. For the surgeon, this score gives a more unambiguous categorization of planning management of patients with RIF pain, suggesting that in most cases, patients in the HP/D category can straight away be taken up for surgery without any additional imaging modality, thus reducing the cost burden. Patients in the LP category would benefit the maximum from CT imaging and that patients in the U category can be worked up for non-appendiceal diagnoses. RIPASA reduces the number of "missed appendicitis" cases to a great extent. Hence, RIPASA is clinically and statistically a better scoring system for the diagnosis of acute appendicitis, as compared to MASS.

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