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# Efficacy of Ripasa Over Alverado Score in the Diagnosis of Acute Appendicitis

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**Abstract:** ***The Alvarado score was developed for the Caucasian population, and it renders a low sensitivity and specificity when applied in an oriental population. To mitigate this low sensitivity and specificity, a new scoring system was devised in Malaysia, namely RIPASA. The RIPASA scoring's sensitivity and specificity are tested in the Indian population in this study.***

**Keywords:** RIPASA Score, ALVARADO Score, Acute Appendicitis

## 1. Introduction

Acute appendicitis is the most common cause of abdominal pain in both developed and developing countries. The gender-based lifetime risk of acute appendicitis reported in males and females is 8.6%, 6.7% respectively with the lifetime risk of having an appendectomy reported to be 12% for men and 25% for women. Acute appendicitis is the most common surgical emergency, and early surgical intervention improves outcome.[1,2] Being very common in surgical practice, the diagnosis of acute appendicitis remains elusive even to the best of clinicians. Appendicitis being a clinical diagnosis, is arrived at by a careful history, physical examination and also with the help of a scoring system such as the Alvarado. This time tested tool has high sensitivity and specificity in segregating patients into high, moderate and low suspicion of appendicitis. The Alvarado score was developed for the Caucasian population, and it renders a low sensitivity and specificity when applied in an oriental population. To mitigate this low sensitivity and specificity, a new scoring system was devised in Malaysia, namely RIPASA. The RIPASA scoring's sensitivity and specificity are tested in the Indian population in this study.

## 2. Aim of the Study

To compare the efficacy of RIPASA over Alvarado score in the diagnosis of acute appendicitis.

## 3. Results

**Table 1:** Descriptive analysis of age in the study population

| Age | N | Minimum (Yrs) | Maximum (Yrs) | Mean | Std Deviation |
|---|---|---|---|---|---|
| Valid N | 100 | 15 | 65 | 29.84 | +/- 12.2 |

**Table 2:** Descriptive analysis of Age Distribution in the study population

| Age (Yrs) | Male | Female | Total |
|---|---|---|---|
| 15-20 | 20 | 09 | 29 |
| 21-30 | 25 | 06 | 31 |
| 31-40 | 17 | 06 | 23 |
| 41-50 | 06 | 05 | 11 |
| 51-60 | 05 | 00 | 05 |
| 61-70 | 01 | 00 | 01 |
| Total | 74 | 26 | 100 |

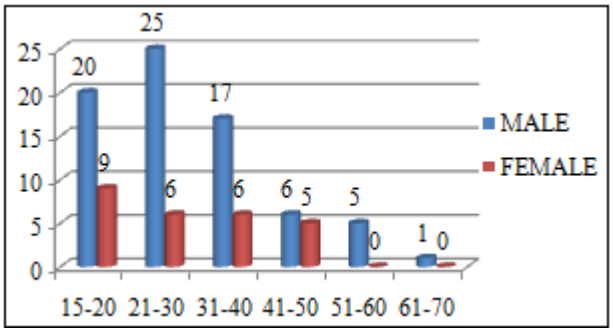


**Figure 1:** Bar chart of age & sex distribution of the study population

From analysing the demographic data, it was found that most of the patients were less than 40 years of age. There was a steep decrease in the incidence of acute appendicitis as the age increased. The mean age was 29.84 years. The youngest patient was 15 years old, and the oldest patient was 65 years old.

**Table 3:** Descriptive analysis of gender incidence in the study population

| Sex | No. of Patients | Percentage | Cumulative Percentage |
|---|---|---|---|
| Male | 74 | 74% | 74% |
| Female | 26 | 26% | 100% |

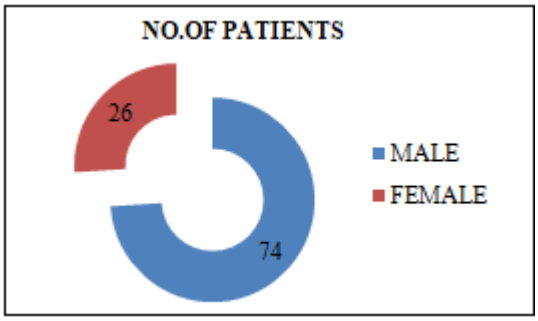


**Figure 2:** Pie chart of sex distribution of the study population

74% of patients in the study population were male, and 26% of patients were female.

**Table 4:** Descriptive analysis of imaging in the study population

| Imaging | No. of Patients | Percentage | Cummulative Percentage |
|---|---|---|---|
| CT-Acute Appendicitis | 23 | 23% | 23% |
| USG-Acute Appendicitis | 77 | 77% | 100% |

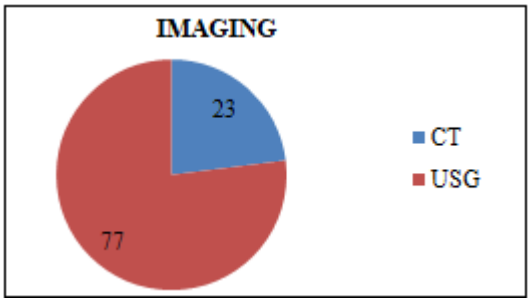


**Figure 3:** Pie chart of imaging in acute appendicitis

All patients underwent ultrasound imaging, and 23% of them needed CT scans to confirm the diagnosis of acute appendicitis.

**Table 5:** Descriptive analysis of USG in the study population

| USG | No of Patients | Percentage | Cumulative Percentage |
|---|---|---|---|
| Positive | 77 | 77% | 77% |
| Negative | 23 | 23% | 100% |
| Total | 100 | 100% | |

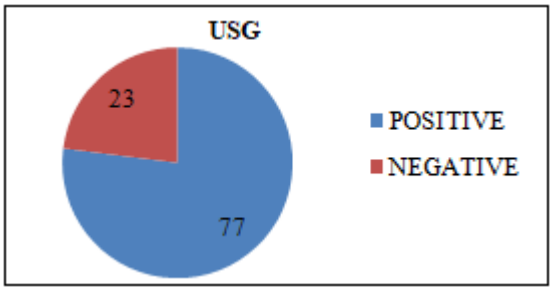


**Figure 4:** Pie chart of ultrasound abdomen in the study population

All 100 patients underwent ultrasound abdomen, and 77 cases (77%) were diagnosed with acute appendicitis.

Twenty-three patients (23%) had an equivocal or negative ultrasound report, and they had to undergo further imaging like CT.

**Table 6:** Descriptive analysis of RIPASA and USG in the study population

The cut-off score to diagnose acute appendicitis in RIPASA was fixed at 7.5.

| | | | USG | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| RIPASA | Positive | Count | 71 | 19 | 90 |
| | | % of the total count | 71% | 19% | 90% |
| | Negative | Count | 6 | 4 | 10 |
| | | % of the total count | 6% | 4% | 10% |
| Total | | Count | 77 | 23 | 100 |
| | | % of the total | 77% | 23% | 100% |

The correlation between RIPASA and ultrasound was studied, and although the sensitivity was high, the P-value was >0.05, and hence no relationship was inferred from this analysis.

P value is 0.18, which is insignificant. Chi-square=1.81

Sensitivity = 92.2%

Specificity=17.4%

Positive predictive valve=78.9%

Negative predictive valve=40%

**Table 7:** Descriptive analysis of Alvarado and USG in the study population

| | | | USG | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| ALVARADO | Positive | Count | 54 | 9 | 63 |
| | | % of the total count | 54% | 9% | 63% |
| | Negative | Count | 23 | 14 | 37 |
| | | % of the total count | 23% | 14% | 37% |
| Total | | Count | 77 | 23 | 100 |
| | | % of the total | 77% | 23% | 100% |

Sensitivity=70.1%

Specificity=60.9%

Positive predictive value=85.7%

Negative predictive value=37.8%

**Table 8:** Descriptive analysis of types of surgeries in the study population

| Appendectomy | No of Patients | Percent |
|---|---|---|
| Laparoscopic | 81 | 81% |
| Open | 19 | 19% |
| Total | 100 | 100% |

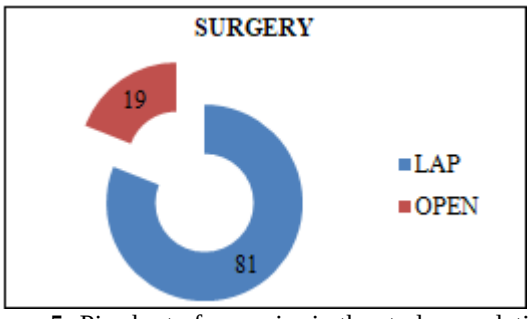


**Figure 5:** Pie chart of surgeries in the study population

Among 100 patients 81 underwent laparoscopic appendectomy and 19 patients underwent open appendectomy.

**Table 9:** Histopathological Analysis in the study population

| HPE | No. of Patients | Percentage | Cumulative Percentage |
|---|---|---|---|
| Positive | 92 | 92% | 92% |
| Negative | 08 | 08% | 100% |
| Total | 100 | 100% | |

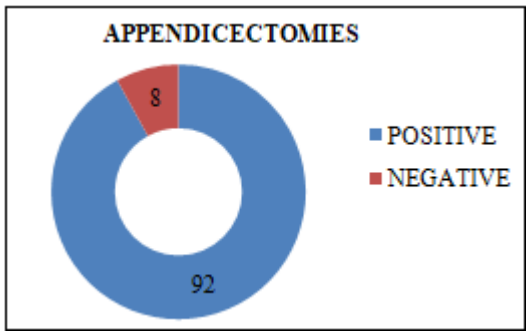


**Figure 6:** Pie chart of histopathological analysis in the study population

In a total of 100 patients, there were 92 patients with biopsy-proven appendicitis. 08 patients had negative appendectomies.

**Table 10:** Descriptive analysis of HPE distribution in the study population

| HPE | Frequency | Percent |
|---|---|---|
| Acute Appendicitis | 55 | 55% |
| Acute Appendicitis With Periappendicitis | 17 | 17% |
| Acute Suppurative Appendicitis | 18 | 18% |
| Gangrenous Appendicitis | 2 | 2% |
| Eosinophilic Appendicitis | 2 | 2% |
| Lymphoid Hyperplasia | 6 | 6% |
| Total | 100 | 100% |

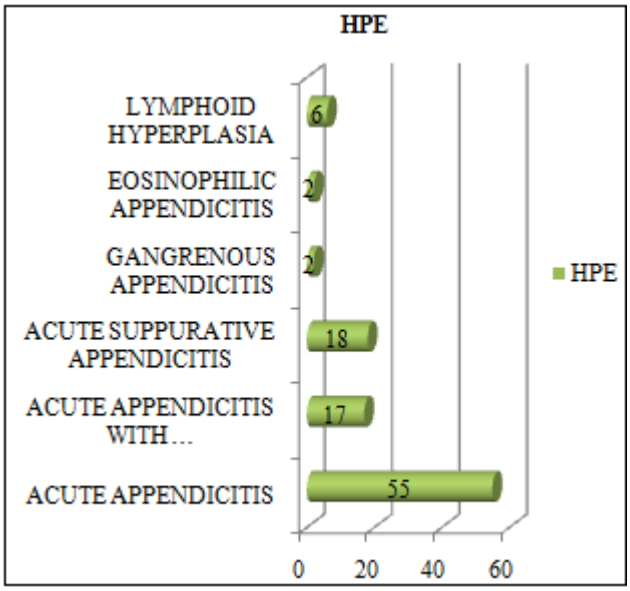


**Figure 7:** Bar chart of HPE distribution in the study population

Out of the 92 cases, 55 was reported as acute appendicitis, 17 as appendicitis with periappendicitis, 18 as acute suppurative and two as gangrenous appendicitis. Out of the 08 negative appendectomies, six were reported as reactive lymphoid hyperplasia, and two was reported as eosinophilic appendicitis.

**Table 11:** Descriptive analysis of RIPASA score in the study population

| RIPASA | No Of Patients | Percentage | Cumulative Percentage |
|---|---|---|---|
| Positive | 90 | 90% | 90% |
| Negative | 10 | 10% | 100% |
| Total | 100 | 100% | |

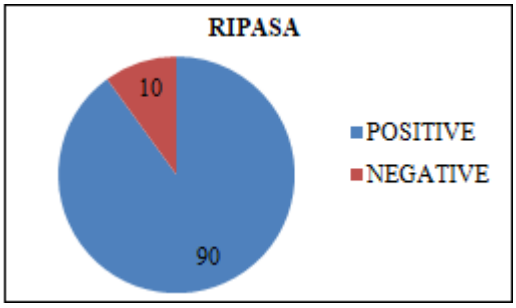


**Figure 8:** Pie chart of RIPASA score in the study population

The cut-off score to diagnose acute appendicitis in RIPASA was fixed at 7.5. The percentage of patients who had a score of above 7.5 in the RIPASA was 90% (90 patients). 10patients had a score below 7.5, which amounted to 10%.

**Table 12:** Descriptive analysis of Alvarado score in the study population

| ALVARADO | No Of Patients | Percentage | Cumulative Percentage |
|---|---|---|---|
| Positive | 63 | 63% | 63% |
| Negative | 37 | 37% | 100% |
| Total | 100 | 100% | |

The cut-off score to diagnose acute appendicitis in ALVARADO was fixed at 7.

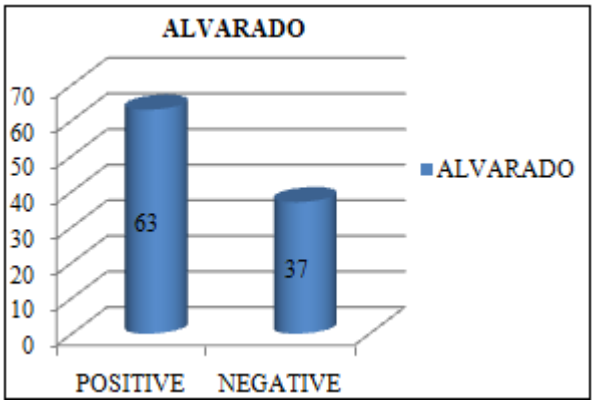


**Figure 9:** Bar chart of Alvarado score in the study population

The percentage of patients who had a score of above in Alvarado was 63% (63 patients). Thirty-seven patients had a score below 7, which amounted to 37% of the total cases.

**Table 13:** Evaluation of RIPASA score in the study population

| | | | HPE | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| RIPASA | Positive | Count | 86 | 4 | 90 |
| | | % of the total count | 86% | 4% | 90% |
| | Negative | Count | 6 | 4 | 10 |
| | | % of the total count | 6% | 4% | 10% |
| Total | | Count | 92 | 8 | 100 |
| | | % of the total | 92% | 8% | 100% |

P-value is 0.011, which is significant.
Sensitivity – 93.5%
Specificity – 50%
Positive predictive value – 95.6%
Negative predictive value – 40%

AUC (area under the curve) = 0.77
DA (diagnostic accuracy) = 90%
[if the p-value is less than 0.05 then the test diagnoses the disease state at a statistically significant level]

**Table 14:** Evaluation of Alvarado score in the study population

| | | | HPE | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| ALVARADO | Positive | Count | 60 | 3 | 63 |
| | | % of the total count | 60% | 3% | 63% |
| | Negative | Count | 32 | 5 | 37 |
| | | % of the total count | 32% | 5% | 37% |
| Total | | Count | 92 | 8 | 100 |
| | | % of the total | 92% | 8% | 100% |

P-value is 0.11, which is insignificant.
Sensitivity – 65.2%
Specificity – 62.5%
Positive predictive value – 95.2%
Negative predictive value – 13.5%
AUC(area under the curve) = 0.67
DA (diagnostic accuracy)=65%

**Table 15:** Distribution according to RIPASA and ALVARADO

| | Positive | Negative | Total |
|---|---|---|---|
| RIPASA | 90 | 10 | 100 |
| ALVARADO | 63 | 37 | 100 |
| Total | 153 | 47 | 200 |

CHI-SQUARE=20.3
P= 0.0000(highly significant)
[the difference between the two proportions is significant. Here we use chi-square test to compare proportions]

**Table 16:** The area under the curve

| Test Result Variable (s) | Area |
|---|---|
| RIPASA | 0.77 |
| ALVARADO | 0.67 |

The area under the ROC curve for RIPASA is significantly higher than Alvarado's area under the curve. This signifies that RIPASA has a higher statistical significance in predicting acute appendicitis.

## 4. Discussion

Acute appendicitis is one of the most common surgical emergencies, with a lifetime risk of approximately one in seven[47]. It essentially remains a clinical diagnosis. The earlier the diagnosis of acute appendicitis is made the risk of complications can be reduced. On the other hand, over diagnosis of acute appendicitis could also increase the rate of negative appendicectomies. Scoring systems are very useful, especially in equivocal cases that are encountered now and then. Widely used scores like Alvarado, which aid in the diagnosis of acute appendicitis, have been developed in and for a Caucasian population. A new scoring system for the Asian population was devised, which was evaluated in this study.

A new scoring system for the oriental population was devised and termed RIPASA, which has an additional parameter (NRIC) that is unique to the Asian population.

The RIPASA score was formulated in Raja Isteri Pengiran Anak Saleha Hospital, Brunei Darussalam and named after the hospital. The RIPASA score is simple and easy to use a quantitative scoring system, and most of these 14 clinical parameters are easily obtained from clinical history and examination. The RIPASA scoring system includes more parameters than Alvarado system, and the latter did not contain certain parameters such as age, gender, and duration of symptoms before the presentation. These parameters are shown to affect the sensitivity and specificity of the Alvarado scoring system in the diagnosis of acute appendicitis. This also includes a urinalysis, which can be easily performed on the spot. Hence a score can be obtained quickly and a rapid diagnosis made without having to wait for the full investigations to be available when a score of >7.5 is obtained. The additional parameter that is unique to our local population consists of foreign nationality. The RIPASA score has been shown to have significantly higher sensitivity, specificity and diagnostic accuracy compared to Alvarado Score, particularly when applied to the Asian population.[50]As previously explained, foreign nationals were included as an additional parameter as the probability of acute appendicitis among foreign nationals presenting with RIF pain.

Similar studies like Ravi et al. reported a sensitivity of 84.2% and a specificity of 100% for RIPASA.[51] Chong et al. reported sensitivity and specificity at 88.46% and 66.67% respectively.[47] Sarang et al. reported an 82.6% and a specificity of 88.89%.[52]Nanjundaiah et al. also reported sensitivity and specificity at 96.2% and 20.5% respectively.[53]Mahendraet al. reported a 93% accuracy, sensitivity 94.74% and specificity 60%.[54]

In our study, a total of 100 patients were included. Out of 100 patients, 60 were less 30 years. In which 29 patients were between 15-20years and 31 patients were between 21-30years. In the rest of 40 patients, 23 patients are between 31-40years. The mean age noted in this study was 29.84years.with youngest patient 15yrs old and oldest patient was 65yrs old. The highest incidence of acute appendicitis was between the age group of 15-30. A study on a South Indian population by Naveen et al. also quoted a similar incidence pattern. The incidence in various parts of the world like Poland, Turkey and the United States all remain high in this age group of patients.[62,65,66]

**Table 17:** Analysis of age distribution in the study population

| Age (Years) | Male | Female | Total |
|---|---|---|---|
| 15-30 | 45 | 15 | 60 |
| 31-40 | 17 | 06 | 23 |
| 41-65 | 12 | 05 | 17 |
| Total | 74 | 26 | 100 |

In this study, a male predominance was noted in the incidence of acute appendicitis. There was an incidence of 74% in males with 45% of them in age group 15-30years when compared to a 26% incidence in the female population. This increase in male incidence was noted in similar studies such as Chong et al., Cuscheri A et al. and in other published data.[47, 64]

From analysing the demographic data, the mean age was 29.84years. The youngest patient was 15 years old, and the oldest patient was 65 years old.

**Table 18:** Analysis of age in the study population

| Age | N | Minimum age | Maximum age | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Valid N | 100 | 15Years | 65Years | 29.84 | +/- 12.2 |

As part of the evaluation of acute right iliac fossa pain, all the patients included in the study underwent ultrasound examination of the abdomen. Out of 100 patients, 77 of them had features suggestive of acute appendicitis and rest of 23 patients had an equivocal or negative ultrasound and required CT for diagnosis. Out of 77% with positive ultrasound RIPASA was >7.5 in 71% and was negative in 6% of them. Out of 23% of patients with negative ultrasound, RIPASA was positive in 19%. When the correlation between RIPASA and ultrasound was studied, it was found that sensitivity was 92.2% and specificity was 17.4% with the positive predictive value of 78.9% and negative predictive value of 40% and P-value was 0.18. Although sensitivity was high, the P-value was >0.05, and no relationship was inferred from this analysis.

**Table 19:** Analysis of RIPASA and USG in the study population

| | | | Ultrasound | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| RIPASA | Positive | % of Total | 71% | 19% | 90% |
| | Negative | % of Total | 6% | 4% | 10% |
| Total | | | 77% | 23% | 100% |

On analysing Alvarado and ultrasound abdomen, both Alvarado and ultrasound were positive in 54%, and both were negative in 14%. In 23% of patients, ultrasound was positive, but Alvarado was <7. In about 9% of patients, Alvarado was >7, but the ultrasound was negative or equivocal for acute appendicitis. Correlation between Alvarado and ultrasound was studied and was found that sensitivity was 70.1% and specificity was 60.9%. CT was found to significantly increase the accuracy of diagnosing acute appendicitis, by Park JS et al.[63]

**Table 20:** Analysis of Alvarado and USG in the study population

| | | | Ultrasound | | Total |
|---|---|---|---|---|---|
| | | | Positive | Negative | |
| ALVARADO | Positive | % of Total | 54% | 9% | 63% |
| | Negative | % of Total | 23% | 14% | 37% |
| Total | | | 77% | 23% | 100% |

Out of the 100 patients, 81 (81%) underwent laparoscopic appendicectomy, while 19 patients (19%) had open appendicectomy.

While comparing the histopathology reports in a total of 100 patients, there were 92 patients with biopsy-proven appendicitis. 08 patients had negative appendicectomy.

Out of the 92 cases, 55 were reported as acute appendicitis, 17as appendicitis with peri-appendicitis, 18 as acute suppurative and 2 cases as gangrenous appendicitis. Out of the 08 negative appendectomies, six were reported as reactive lymphoid hyperplasia, and two were reported as eosinophilic appendicitis. There were increased eosinophils in the submucosa in eosinophilic appendicitis. However, the lamina propria did not contain an abundance of eosinophils, and their numbers were similar to that seen in normal appendices.[69]Hence they were not considered as the inflamed appendix and removal of them was termed as negative appendicectomy.

The rate of negative appendicectomy in our study was 8%. Park JS et al.reported a negative appendicectomy rate of 15%.[63]

The entire study population is scored with both Alvarado and RIPASA. The Alvarado score's cut off was set at a score of 7 and above for a diagnosis of acute appendicitis. Out of 100 patients, 63 patients had score >7, and 37 patients had score <7 that amounted for 73% and 37% respectively. This data was analysed in comparison with the histopathology reports. The sensitivity and specificity were calculated at 65.2% and 62.5% respectively. The positive predictive value was 95.2%, and the negative predictive value was 13.5%. The P-value calculated by the Chi-square tests gave a P value of 0.11, which was statistically insignificant.

**Table 21:** Analysis of Alvarado and HPE in the study population

| | | HPE | | Total |
|---|---|---|---|---|
| | | Positive | Negative | |
| ALVARADO | Positive | 60% | 3% | 63% |
| | Negative | 32% | 5% | 37% |
| Total | | 92% | 8% | 100% |

Reported sensitivity and specificity for both Alvarado and the Modified Alvarado scores range from 53 to 88% and 75 to 80% respectively. [42, 43] Nanjundaiah et al.and Hasan et al. reported similar sensitivities and specificities.[53,66] Dominik A et al. reported a 91% sensitivity and 81% specificity.[67] Ohle et al. reporte 82% sensitivity and 81% specificity.[68] The study b Nanjundaiah et al. and our study were done in an India population, whereas the other quoted studies were done in the Western population, which may be the reason why our sensitivities and specificities vary.

**Table 22:** Comparison of Alvarado in the current study with other studies

| Studies | Sensitivity | Specificity |
|---|---|---|
| This study | 65.2% | 62.5% |
| Nanjundaiah et al. | 58.9% | 85.7% |
| Hasan et al. | 82% | 75% |
| Domink A et al. | 91% | 81% |
| Ohle et al. | 82% | 81% |

**Table 23:** Analysis of RIPASA and HPE in the study population

| | | HPE | | Total |
|---|---|---|---|---|
| | | Positive | Negative | |
| RIPASA | Positive | 86% | 4% | 90% |
| | Negative | 6% | 4% | 10% |
| Total | | 92% | 8% | 100% |

The cut off for RIPASA score was set at a score of 7.5 and above. Out of 100 patients, 90 patients had a score >7.5, and

10 patients had a score <7.5 that amounted for 90% and 10% respectively.

The sensitivity and specificity were calculated and was 93.5% and 50% respectively. The positive predictive value was 95.6%, and the negative predictive value was 40%. The P-value calculated by the Chi-square tests gave a P value of less than 0.011, which was highly significant. Similar studies like Ravi et al. reported a sensitivity of 84.2% and a specificity of 100% for RIPASA.[51] Chong et al. reported sensitivity and specificity at 88.46% and 66.67% respectively. [47]Sarang et al. reported an 82.6% and a specificity of 88.89% .[52]Nanjundaiah et al. also reported sensitivity and specificity at 96.2% and 20.5% respectively.[53]Mahendraet al. reported a 93% accuracy, sensitivity 94.74% and specificity 60%.[54]

**Table 24:** Comparison of RIPASA score in the current study with other studies

| Studies | Sensitivity | Specificity |
|---|---|---|
| This study | 93.5% | 50% |
| Ravi et al. | 84.2% | 100% |
| Chong et al. | 88.46% | 66.67% |
| Sarang et al. | 82.6% | 88.89% |
| Nanjundaiah et al. | 96.2% | 20.5% |
| Mahendra et al. | 94.74% | 60% |

On comparing both the scores, the sensitivity was higher for the RIPASA score. The positive predictive value and the negative predictive value was higher for the RIPASA score. The P-value for RIPASA was highly significant (P = 0.000). This statistical significance is further backed up by the receiver operator curve (ROC)graph, which shows a larger area under the curve for RIPASA (0.77) when compared to Alvarado (0.67).

This study, along with various other quoted articles, suggests that the Alvarado score is not very sensitive in an Asian population as compared to a Western population. On the other hand, the RIPASA score seems more sensitive in the Asian population.

The authors who have devised the score suggest it uses many parameters important for the diagnosis of acute appendicitis, such as age, sex and duration of symptoms, which are not present in the Alvarado and Modified Alvarado scores.[47]The local inflammatory indicators such as Rovsing's sign and guarding were also included in the score. The original RIPASA score had scored residential foreigners as one since our study was based on an Indian population and no foreigners were included we decided to omit the score. This is based on the fact that the diet of the Western population is low in dietary fibre and high on saturated fatty foods. This puts this in a higher incidence of acute appendicitis. Thus the RIPASA was concluded to be a more applicable and useful score in an Indian population.

One of the limitations of this study is that it had a small study population. In this study, we did not use the RIPASA score in the surgical decision-making process. It was applied postoperatively in biopsy-proven appendicitis to calculate the sensitivity and specificity. In the future, we plan to prospectively apply RIPASA in the surgical decision-making process in patients with acute right iliac fossa pain. In a larger randomised control trial, the score's validity can then be established.

## 5. Conclusion

- Acute appendicitis was a common surgical illness occurring predominantly in the 18-30 age group.
- The male: female ratio was 2.6:1.
- 77% of patients had ultrasound features suggestive of acute appendicitis.23% of patients required CT to confirm the diagnosis of acute appendicitis.
- The negative appendectomy rate was 8% in our study.
- 81% of patients underwent laparoscopic appendectomy, and 19% of patients underwent an open appendectomy
- The sensitivity and specificity were calculated at 65.2% and 62.5% respectively for Alvarado. The positive predictive value was 95.2%, and the negative predictive value was 13.5%. The P-value was 0.11.
- RIPASA score's sensitivity and specificity were calculated at 93.5% and 50% respectively. The positive predictive value was 95.6%, and the negative predictive value was 40%. The P-value was 0.011.
- The difference in diagnostic accuracy between RIPASA and Alvarado was statistically significant (P-value < 0.000).

The RIPASA shows promising results in a South Indian population. The various parameters required in the score can easily be obtained from a simple history and physical examination. In a resource-limited setup, this score can help us to stratify patients based on the need for further evaluation, thereby reducing unnecessary admissions. Since the incidence is higher in a younger population, this score can also help reduce the need for CT imaging, reducing radiation exposure. It is a simple and easy scoring system, which can be applied to an Asian population, with higher sensitivity and specificity.

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