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A Comparison of ALVARADO and RIPASA score for the diagnosis of acute appendicitis.

Sumit Kumar[1], Murali Krishna Reddy CT[2,] Apurva Agarwal[3,] Arvind Kumar[4]
[1](1(Senior Resident, Department of General Surgery, Nalanda Medical College and Hospital, Patna India)
[2](Senior Resident, Department of General surgery, DM-WIMS, Wayanad, Kerala, India)
[3](Department of General surgery, NMCH, Patna, India))
[4](Department of Anesthesia, IGIMS, Patna, India))
**Corresponding Author: Dr Sumit Kumar*

Abstract: ***Background & Objective***: *Acute appendicitis is one of the most common surgical emergencies in clinical practice. A quick diagnosis and treatment of acute appendicitis results in marked decrease in morbidity and mortality. Diagnosis of acute appendicitis is essentially made on a patient history and examination, but a clinical suspicion alone can lead to removal of a normal appendix in 15-30% of cases. Ultrasound is operator dependent and often misses or over-diagnoses the condition. Contrast enhanced computed tomography (CECT) scan is the investigation of choice with high sensitivity and specificity for the diagnosis but is expensive and not available at all centers in odd hours, particularly in developing countries like India. A number of scoring systems have been used for aiding in early diagnosis of acute appendicitis and its prompt management of which Alvarado score is the most popular. The accuracy of Alvarado score in the diagnosis of acute appendicitis is disappointingly low in Asian population and RIPASA scoring has been designed for the diagnosis of acute appendicitis in the Asian population. So, we prospectively applied and compare Alvarado and RIPASA score in the diagnosis of acute appendicitis in Indian population.*

Materials and Methods: *We compared prospectively RIPASA and Alvarado scoring system by applying them to 100 patients. Both scores were calculated for patients who presented with right iliac fossa pain during the study period. Depending on clinical judgment appendicectomy was done. Post-operative histopathology report was correlated with the scores. A score of 7.5 is the optimal cut off threshold for RIPASA and 7 for Alvarado scoring system. Sensitivity, specificity, positive predictive value (PPV) and negative predictive (NPV) for RIPASA & Alvarado system was done*

Results*: The sensitivity and specificity of RIPASA score were 97.73% and 75.00 % respectively. The sensitivity and specificity of Alvarado score were 59.09% and 91.67% respectively. RIPASA score correctly classified 97.73 percent of all patients confirmed with histological acute appendicitis to the high probability group (RIPASA score greater than 7.5) compared with 59.09% with Alvarado score (Alvarado score greater than 7.0; p-value less than 0.001).*

Conclusion: *The RIPASA score is a better tool in evaluation of suspected appendicitis based on the more sensitivity, more negative predictive value and more accurate as compared to Alvarado scoring system for Indian population.*

Key Word*: Alvarado, Acute appendicitis, RIPASA, Indian Population*

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I. Introduction

Acute appendicitis is one of the most common surgical emergencies in clinical practice, with estimated life time prevalence approximately 1in7 [1]. It is a common cause of abdominal pain for which a prompt diagnosis and treatment is rewarded by a marked decrease in morbidity and mortality. Diagnosis of acute appendicitis is essentially clinical; patient history and examination both remain the most effective and practical diagnostic modalities (1). Acute appendicitis is associated with raised TLC. It is raised in other inflammatory conditions also, making its role only supportive in the diagnosis of acute appendicitis. (2) however, a decision to operate based on clinical suspicion alone can lead to removal of a normal appendix in 15-30% of cases [2].

There is limited role of X rays in the diagnosis of acute appendicitis. It may rule out other causes of acute abdomen such as bowel perforation. Ultrasound is operator dependent and often misses or over-diagnoses the condition (3). CECT scan is the investigation of choice with high sensitivity and specificity for the diagnosis but is expensive and not available at all centers particularly in developing countries, like India (4,5). Recent reports suggest that the indiscriminate use of CT scans may lead to the detection of low-grade appendicitis that would otherwise have resolved spontaneously (6,7,8).

Several scoring systems have been developed to aid in the decision-making process to reach a diagnosis of acute appendicitis in the fastest and easiest way. The 'Alvarado score' and the 'Modified Alvarado score' are the two most commonly used scoring systems available. Reported sensitivity and specificity for both Alvarado and the Modified Alvarado scores ranges from 53 to 88% and 75 to 80% respectively [3 ,4]. However, these scoring systems were developed in western countries and several studies have reported very low sensitivity and specificity when applied to a population with a completely different ethnic origin and diet [5, 6, 7].

In a recent study conducted in the Accident and Emergency department (AED) of Raja *Isteri Pengiran Anak Saleha* (RIPAS) Hospital, Brunei Darussalam, from November 2008 to April 2009, hypothesized a new clinical scoring system named as *Raja Isteri Pengiran Anak Saleha Appendicitis* (RIPASA) scoring. The study demanded that this scoring system is having much more sensitivity, specificity, positive and negative predictive value than Alvarado scoring system [8].

In this study an attempt is made to compare the diagnostic accuracy between these two scoring systems and to draw a conclusion that which scores is more accurate and cost effective in respect to our socio-economic condition and also to minimize the negative appendectomy as much as possible utilizing them and also to reduce the morbidity, mortality and economic burden related to negative appendectomy.

II. Material and Methods

The study was a prospective study and conducted in the Department of General Surgery, Tata Motors Hospital, Jamshedpur between October 2012 to September 2014.

Study Population:

All patients undergoing Emergency Appendectomy for the provisional diagnosis of acute appendicitis.

Study Period:

Two year from October 2012 to September 2014.

Sample Size:

100 patients.

Sample Design:

The incidence of acute appendicitis who undergo appendectomy on an average about five cases in our hospital per month. So total population in this study period of 2 year is 120. Keeping this population in mind with confidence limit of 95% and confidence interval of 5%, minimum sample size calculated is 92.

Inclusion criteria:

Patients presenting with acute pain in right iliac fossa suggestive of acute appendicitis and undergoing appendectomy.

Exclusion criteria:

Duration of pain > 72 hrs.

Other causes of acute RIF pain like ruptured ectopic pregnancy, twisted/ruptured ovarian cyst, pelvic inflammatory disease, ureteric colic, Meckel's diverticulitis, pyelonephritis diagnosed pre or per-operatively.

Recurrent RIF pain.

Known cases of IBS/IBD/Renal colic/malignancy.

Age < 5 yrs.

Pregnant females.

Study Design:

Observational, cross-sectional, institution based Prospective comparative study.

Parameters to Be Studied:

Score according to the ALVARADO System.

Score according to the RIPASA System

Histopathological reports.

Study Tools:

A) ALVARADO Score chart.

B) RIPASA Score chart.

C) Equipment's required for laboratory investigations (complete hemogram and urinalysis), Imaging study (USG) & histopathology.

Work -Up:

Written informed consent was obtained from all patients.

The scoring will be done for all patients fulfilling inclusion criteria, immediately upon admission, by the surgeon on call.

Routine blood investigations including complete hemogram and urine microscopy
Histo-pathological examination will be done of all appendicular specimens for diagnostic confirmation of all cases who underwent surgery.
STATISTICAL ANALYSIS:
Data after collection will be analyzed using McNemar Chi-square test for discrete data and t-test for continuous data. P value < 0.05 will be considered significant to draw inference. Analysis will be done with SPSS version 16 for windows

III. Result

Demographic Parameters

Table no.:- 01
Sex distribution among the patients

Total population	Male		Female	
	Total	Percentage	Total	Percentage
100	43	43%	57	57%

For Test of Significance, here we use
"Test of Significance for Difference of Proportion"
"Chi – square Distribution { χ^2 – Test } "
χ^2_{cal} = 3.380 { at 95% confidence limit, with degree of freedom
$(n_1 - 1).(n_2 - 1) = 1$, χ^2_{tab} = 3.841 }
$\chi^2_{cal} < \chi^2_{tab}$ { 3.380 < 3.841 } at 5% level of significance
There was Statistically no significance difference between the gender,
With p – value = 0.660

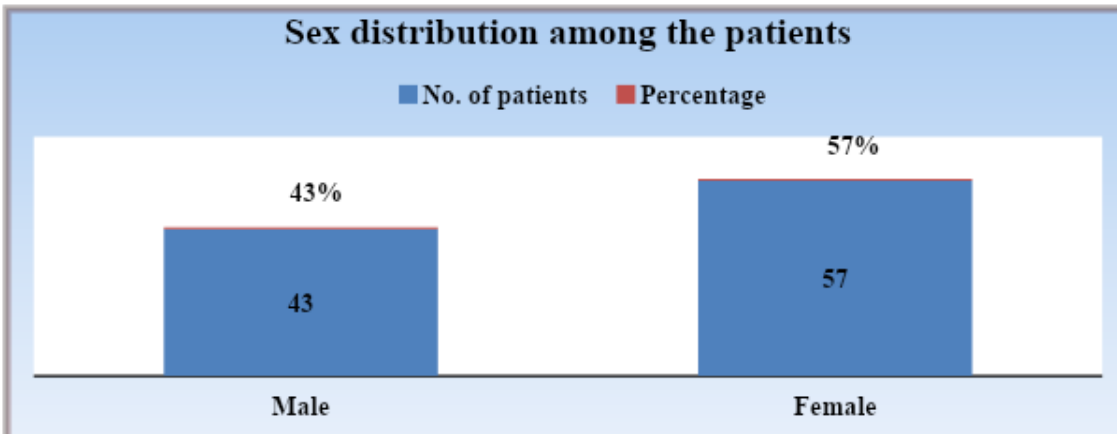


Table no. :- 02
Age distribution among the patients

Age (in year)	Total no. of patients	Percentage
≤ 10 year	3	3%
11 - 20 year	33	33%
21 - 30 year	32	32%
31 – 40 year	23	23%
41 – 50 year	8	8%
51 – 60 year	1	1%

Overall Mean ± standard deviation among the patients are ($\mu \pm \delta$) = 26.46 ± 10.53

Minimum Age	9 year
Maximum Age	60 year
Mean Age	26.46 ± 10.53 Yrs.

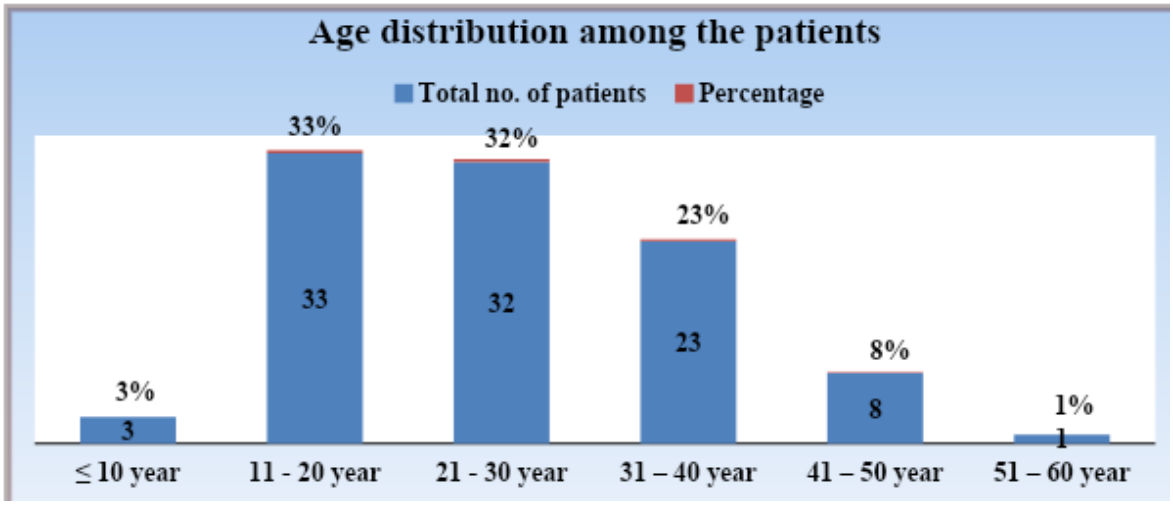
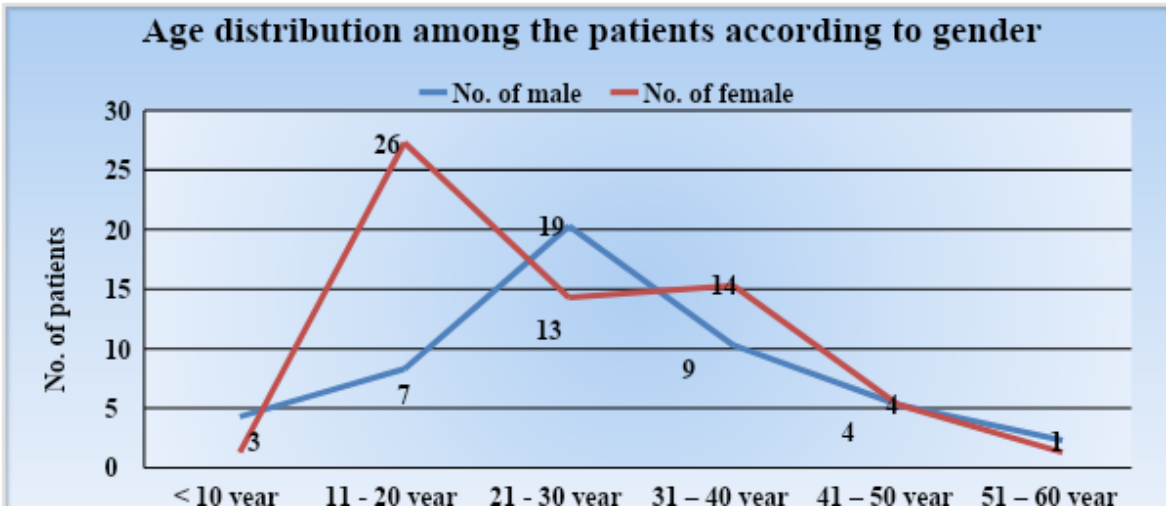
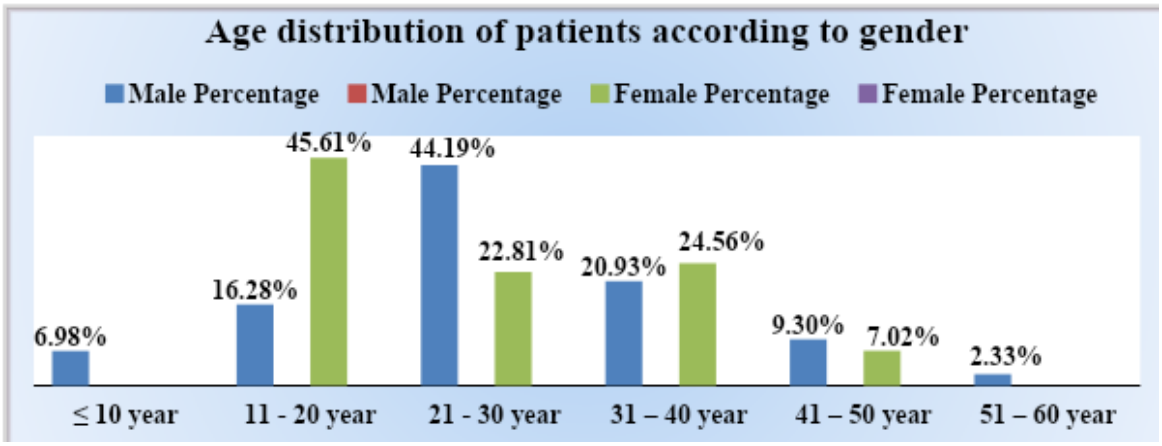


Table no. :- 03
Age distribution among the patients according to their sex

Age (in year)	Male		Female	
	Total	Percentage	Total	Percentage
≤ 10 year	3	6.98%	0	0%
11 - 20 year	7	16.28%	26	45.61%
21 - 30 year	19	44.19%	13	22.81%
31 – 40 year	9	20.93%	14	24.56%
41 – 50 year	4	9.30%	4	7.02%
51 – 60 year	1	2.33%	0	0%

For Test of Significance, here we use
"Test of Significance for Difference of two means"
Mean ± standard deviation of male ($\mu \pm \delta$) = 27.98 ± 11.13
Mean ± standard deviation of female ($\mu \pm \delta$) = 25.32 ± 9.99
$|t|_{cal}$= 1.255 { at 95% confidence limit , $|t|_{tab}$= 1.96 }
$|t|_{cal} < |t|_{tab}$ { 1.255 < 1.96 } at 5% level of significance , at degree of freedom 98.
Hence, there were Statistically not significant difference between the gender, With p - value = 0.2125 { p > 0.05 }
Although, the age of male was (higher) than the age of female.





After analyzing table (1,2,3) it is documented that acute appendicitis is a predominant disease of younger age group. The incidence is more in second decade in females and third decade in males. 68% of total appendicitis patients are in the age group of 10 – 30 yrs. From the graph it is seen that there is a steep rise of incidence of acute appendicitis in second and third decade. The lowest age in our study is 9 yrs. and highest age is 60Yrs.

Regarding the male female distribution of cases in our study the ratio between female and male is 1.3:1, but both genders show almost same pattern of distribution according to their age.

Table no. :- 04
Appendicular pathology in various age groups

Histopathology	No. of patients (n = 100)					
	≤ 10 y	11 – 20 y	21 – 30 y	31 – 40 y	41 – 50 y	51 – 60 y
Acute Appendicitis	2	22	24	15	6	1
Gangrenous Appendicitis	1	4	5	2	1	0
Perforated Appendicitis	0	0	2	2	0	0
Appendicular Abscess	0	1	0	0	0	0
Normal Appendicitis	0	6	1	4	1	0

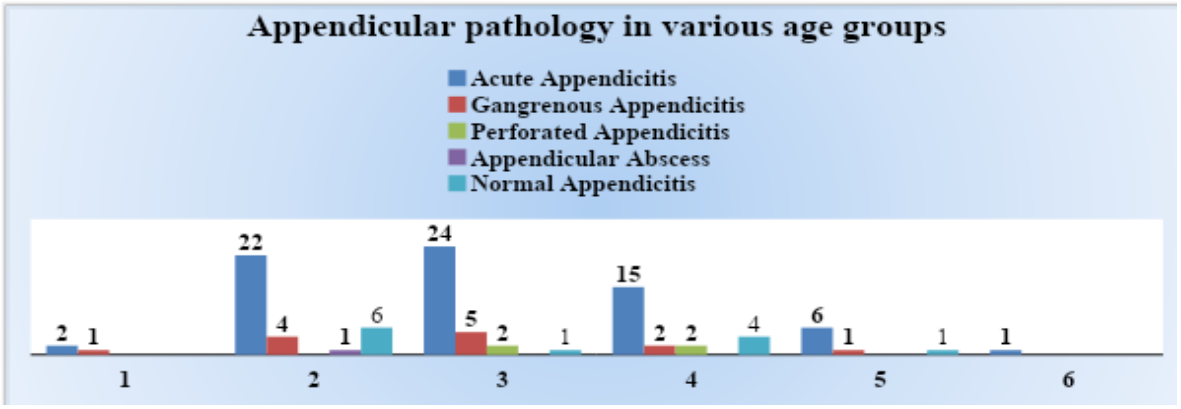
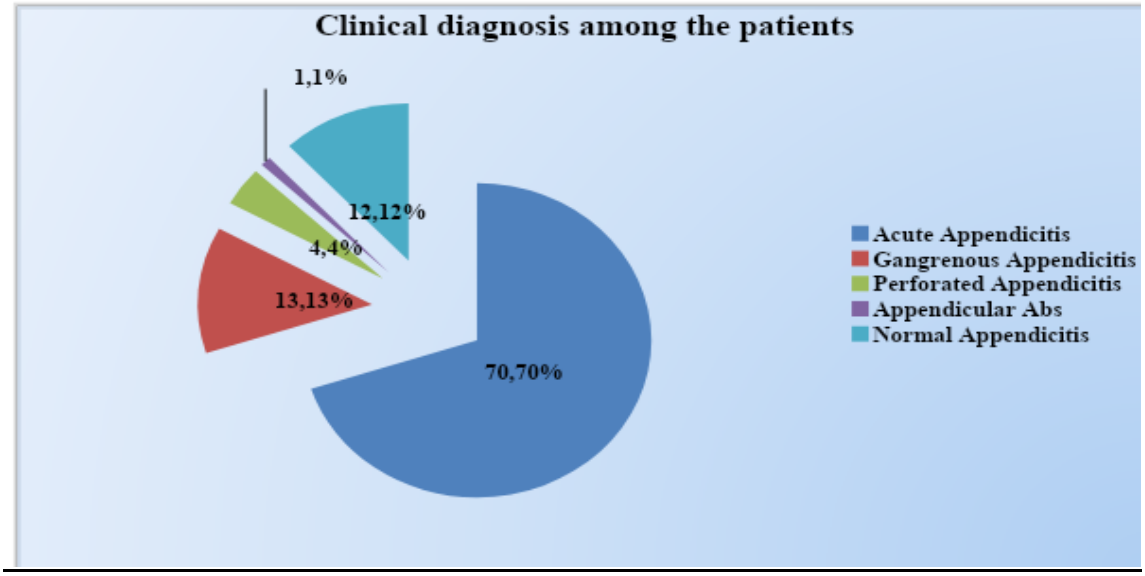


Table no.: - 05
Clinical Diagnosis among the patients (n = 100)

Clinical Diagnosis	No. of patients	Percentage
Acute Appendicitis	70	70%
Gangrenous Appendicitis	13	13%
Perforated Appendicitis	4	4%
Appendicular Abs	1	1%
Normal Appendicitis	12	12%



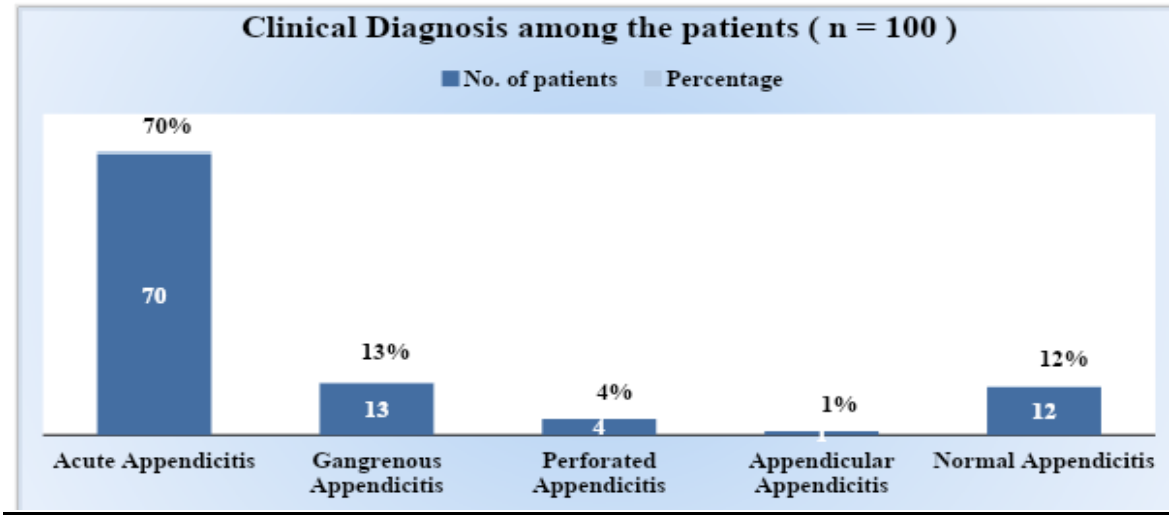


Table (4,5) shows that acute appendicitis and Gangrenous appendix is more prevalent in second and third decade. Perforated appendix is more common in third and fourth decade.

The demographics of these 100 patients are shown in Table (1,2,3) . The mean age of the patients (43 males, 57 female) was 26.46 ± 10.53 years. 100 patients underwent emergency appendectomy based on the surgeons' clinical judgement. Out of these, only 88 cases were confirmed histologically for acute appendicitis among them 70 (70%) cases are simple acute appendicitis, 4 (4%) cases had perforated appendicitis, 13 (13%) cases had gangrenous appendicitis and 1 (1%) had appendicular abscess. 12 cases were negative for acute appendicitis and histology specimens showed normal appendix**.**

Table no.: - 6

Accuracy of Score in the diagnosis (for diseased group)

RIPASA → / Alvarado Score ↓	≥ 7.5	< 7.5
≥ 7	53	0
< 7	36	11

"McNemar test - Chi – square Distribution $\{\chi^2 - \text{Test}\}$"

$\chi^2_{cal} = 34.028$ { at 95% confidence limit ,with degree of freedom

$(n_1 - 1).(n_2 - 1) = 1$, $\chi^2_{tab} = 3.841$ }

$\chi^2_{cal} > \chi^2_{tab}$ { 34.028 > 3.841 } at 5% level of significance

The results show that there is Statistically significance difference in the diseased group,

with $p < 0.05$.
So, in this case there are significant difference in the RIPASA Score as it has more true positive case in comparison to ALVARADO Score.

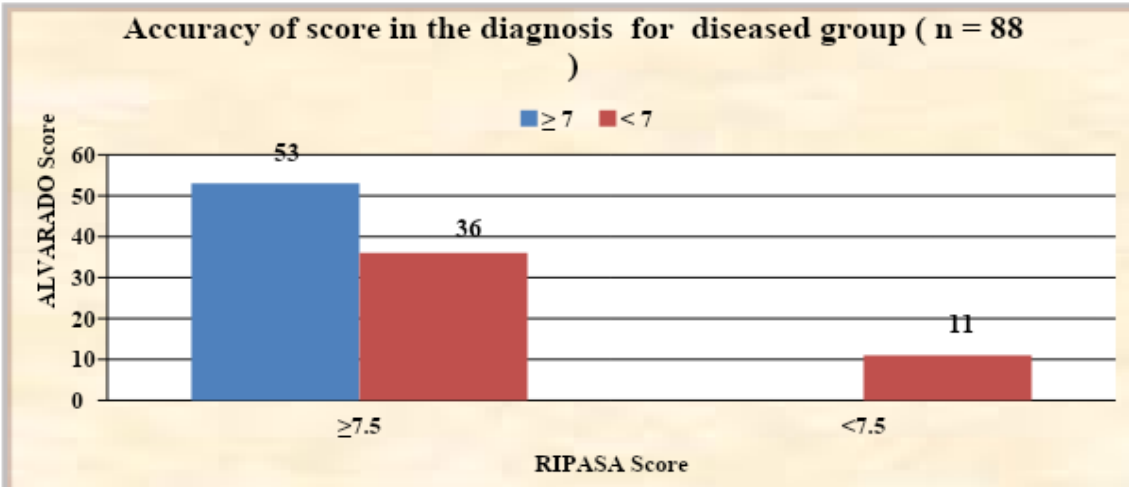


Table no. :- 7
Accuracy of Score in the diagnosis (for non-diseased group)

RIPASA → / Alvarado Score ↓	≥ 7.5	< 7.5
≥ 7	1	0
< 7	2	9

"Test of significance for difference of proportions { |Z| – Test } "
$|Z|_{cal} = 1.366$ { at 95% confidence limit ,with degree of freedom
$(n_1 - 1).(n_2 - 1) = 1$, $|Z|_{tab} = 1.96$ }
$\chi^2_{cal} < \chi^2_{tab}$ {1.366 < 1.96} at 5% level of significance
There were Statistically no significance difference between the two groups,
With p – value = 0.1718

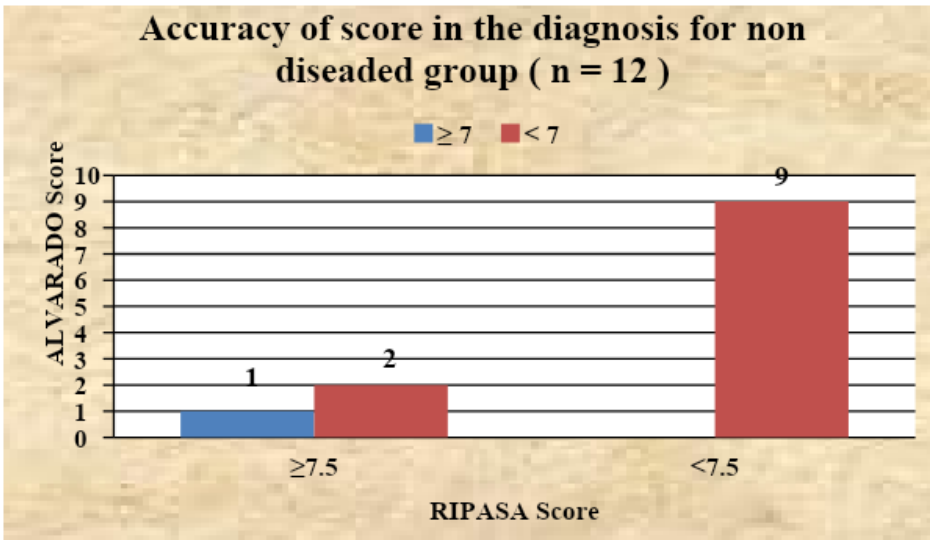


Table (6,7) shows Mc Nemar chi-square test. The result shows that there is statistically significant difference in the diseased group but statistically non-significant difference differences in the non-diseased group.

So, in this case there are significant differences in the RIPASA Score as it has more true positive cases (86) in comparison to Alvarado Score (52).

Table no. :- 8

Distribution of patients according to RIPASA and ALVARADO Scores

Parameter	T.P.		F.P.		T.N.		F.N.	
	R ≥ 7.5	A ≥ 7	R ≥ 7.5	A ≥ 7	R < 7.5	A < 7	R < 7.5	A < 7
Sample size	86	52	3	1	9	11	2	36
Male : Female	41:45	26:26	0:3	0:1	1:8	1:10	1:1	16:20
Age (μ ± δ)	26.03±10.09	26.35±11.08	30.33±12.66	16	25.78±12.80	27.91±12.44	42±11.31	26.47±9.30
Total score (μ ± δ)	9.54±1.49	8.08±0.78	8.33±0.29	7	6.72±0.51	4.18±0.75	5.75±1.06	4.89±1.01

For Test of Significance in T.P. for age, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 0.174$ {at 95% confidence limit, $|t|_{tab} = 1.96$}
$|t|_{cal} < |t|_{tab}$ { 0.174 < 1.96 } at 5% level of significance , at degree of freedom 136
Hence, there were Statistically not significant difference between the two groups,
with p - value = 0.8622 {p > 0.05}

For Test of Significance in T.N. for age, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 0.376$ {at 95% confidence limit, $|t|_{tab} = 1.96$}
$|t|_{cal} < |t|_{tab}$ { 0.376 < 1.96 } at 5% level of significance , at degree of freedom 18
Hence, there were Statistically not significant difference between the two groups,
with p - value = 0.7110 { p > 0.05 }
For Test of Significance in F.N. for age, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 2.283$ {at 95% confidence limit, $|t|_{tab} = 1.96$}
$|t|_{cal} < |t|_{tab}$ { 2.283 < 1.96 } at 5% level of significance , at degree of freedom 36
Hence, there were Statistically not significant difference between the two groups,
with p - value = 0.0284 { p > 0.05 }
Statistical tests are not applicable in F.P.
For Test of Significance in T.P. for TOTAL SCORE, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 6.539$ { at 95% confidence limit , $|t|_{tab} = 1.96$ }
$|t|_{cal} > |t|_{tab}$ { 6.539 > 1.96 } at 5% level of significance , at degree of freedom 136
Hence, there were Statistically significant difference between the two groups,
with P< 0.05 (p <0.0001)
For Test of Significance in T.N. for TOTAL SCORE, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 8.637$ { at 95% confidence limit , $|t|_{tab} = 1.96$ }
$|t|_{cal} > |t|_{tab}$ { 8.637 > 1.96 } at 5% level of significance , at degree of freedom 18
Hence, there were Statistically significant difference between the two groups,
with p < 0.05 (P < 0.0001)

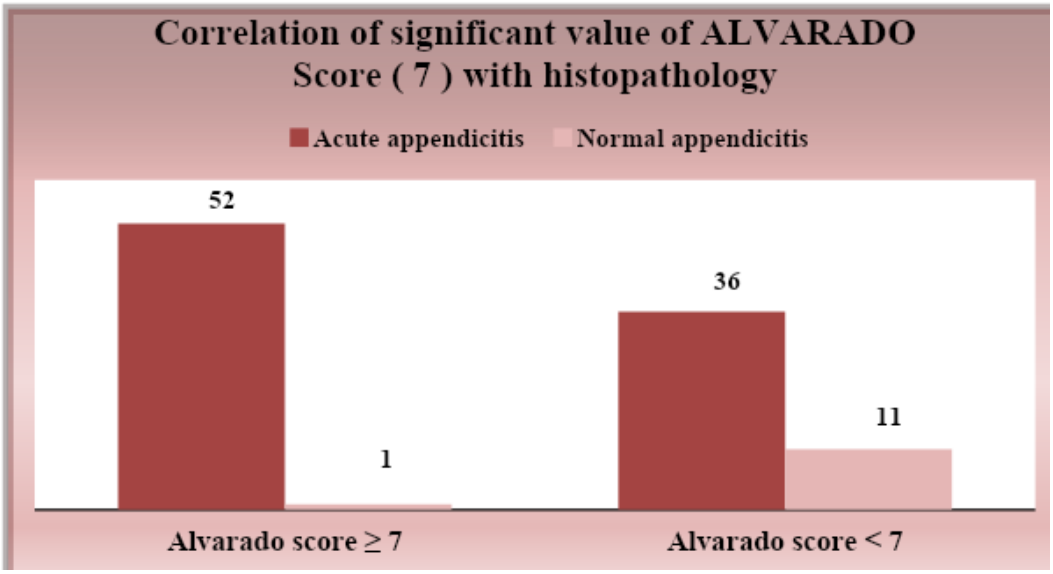
For Test of Significance in F.N. for TOTAL SCORE, here we use
"Test of Significance for Difference of two means"
$|t|_{cal} = 1.170$ { at 95% confidence limit , $|t|_{tab} = 1.96$ }
$|t|_{cal} < |t|_{tab}$ { 1.170 < 1.96 } at 5% level of significance , at degree of freedom 36
Hence, there were Statistically not significant difference between the two groups,
with p = 0.2495

Table no. :- 9

Correlation of significant value of ALVARADO Score (7) with histopathology

Histopathology	Alvarado score ≥ 7	Alvarado score < 7	Total
Acute appendicitis	52	36	88
Normal appendicitis	1	11	12
Total	53	47	100

Sensitivity = 59.09%
Specificity = 91.67%
Positive predictive value = 98.11%
Negative predictive value = 23.40%
Diagnostic accuracy = 64.08%
Negative appendectomy rate =1.88
Disease Prevalence = 88%
"McNemar test - Chi – square test { χ^2 – Test } "
χ^2_{cal} = 8.979 { at 95% confidence limit ,with degree of freedom
$(n_1 - 1).(n_2 - 1) = 1$, $\chi^2_{tab} = 3.841$ }
$\chi^2_{cal} > \chi^2_{tab}$ { 8.979 > 3.841 } at 5% level of significance
There were Statistically significance difference among the patients according to ALVARADO Score (7) with histopathology , with (p = 0.0027) p< 0.05



Diagnostic Accuracy of Alvarado Score (taking 7 as gold standard):
True Positive (TP) = 52
True Negative (TN) = 11
False Positive (FP) = 1
False Negative (FN) = 36

$$\text{Sensitivity} = \frac{TP}{TP + FN} \times 100 = \frac{52}{52 + 36} \times 100 = \frac{52}{88} \times 100 = 59.09\ \%$$

$$\text{Specificity} = \frac{TN}{TN + FP} \times 100 = \frac{11}{11 + 1} \times = \frac{11}{12} \times 100 = 91.67\%$$

$$\text{Positive Predictive Value (PPV)} = \frac{TP}{TP + FP} \times 100 = \frac{52}{52 + 1} \times 100 = \frac{52}{53} \times 100 = 98.11\%$$

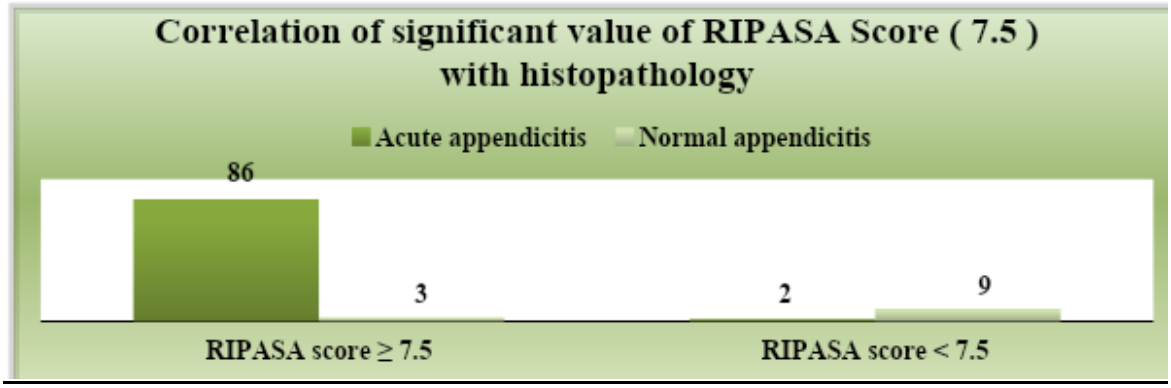
$$\text{Negative Predictive value (NPV)} = \frac{TN}{TN + FN} \times 100 = \frac{11}{11 + 36} \times 100 = \frac{11}{} \times 100 = 23.40\ \%$$

Table no.: - 10
Correlation of significant value of RIPASA Score (7.5) with histopathology

Histopathology	RIPASA score ≥ 7.5	RIPASA score < 7.5	Total
Acute appendicitis	86	2	88
Normal appendicitis	3	9	12
Total	89	11	100

Sensitivity = 97.73%
Specificity = 75%
Positive predictive value = 96.63%
Negative predictive value = 81.82%
Diagnostic accuracy = 95.15%
Negative appendectomy rate =3.37
Disease Prevalence = 88%

"McNemar test - Chi – square test { χ^2 – Test } "
χ^2_{cal} = 49.866 { at 95% confidence limit ,with degree of freedom
$(n_1 - 1).(n_2 - 1) = 1$, $\chi^2_{tab} = 3.841$ }
$\chi^2_{cal} > \chi^2_{tab}$ { 49.866 > 3.841 } at 5% level of significance
There were Statistically highly significance difference among the patients according to RIPASA Score (7.) with histopathology , with < 0.05



Diagnostic Accuracy of RIPASA Score (taking 7.5 as gold standard):
True Positive (TP) = 86
True Negative (TN) = 9
False Positive (FP) = 3
False Negative (FN) = 2

$$\text{Sensitivity} = \frac{TP}{TP + FN} \times 100 = \frac{86}{86 + 2} \times 100 = \frac{86}{88} \times 100 = 97.73\ \%$$

$$\text{Specificity} = \frac{TN}{TN + FP} \times 100 = \frac{9}{9 + 3} \times 100 = \frac{9}{12} \times 100 = 75.00\ \%$$

$$\text{Positive Predictive Value (PPV)} = \frac{TP}{TP + FP} \times 100 = \frac{86}{86 + 3} \times 100 = \frac{86}{89} \times 100 = 96.63\%$$

$$\text{Negative Predictive value (NPV)} = \frac{TN}{TN + FN} \times 100 = \frac{9}{9 + 2} \times 100 = \frac{9}{11} \times 100 = 81.82\ \%$$

Table no. :- 11
Comparative study of diagnostic accuracy between ALVARADO and RIPASA Score

Parameter	Alvarado score (N =100)	Ripasa score(N= 100)	X^2_{cal}	p-value
Sensitivity	59.09%	97.73%	41.845	P<0.001 #
Specificity	91.67%	75%	8.840	0.0029
PPV	98.11%	96.63%	0.045	0.8320
NPV	23.40%	81.82%	66.121	P<0.001 #
DA	63.00%	95.00%	27.857	P<0.001 #
NAR	1.88	3.37	0.0470	0.8284

Here we use "proportion test"
# indicates significant (RIPASA SCORE is more significant than ALVARADO SCORE) in view of sensitivity, NPV and diagnostic accuracy.

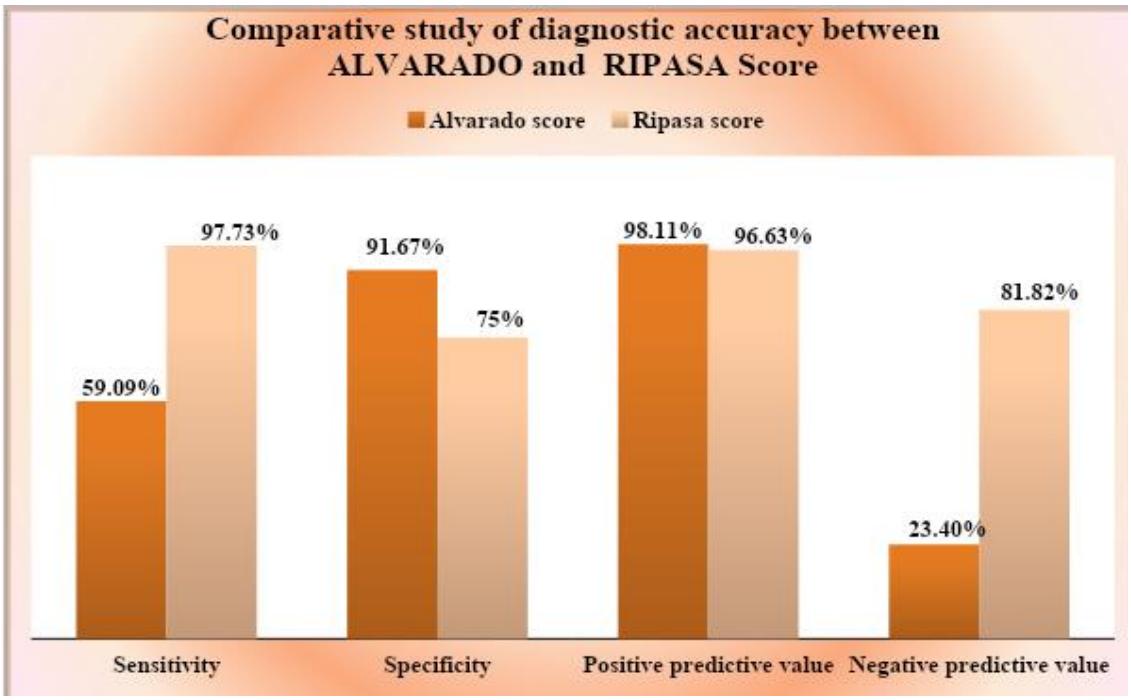


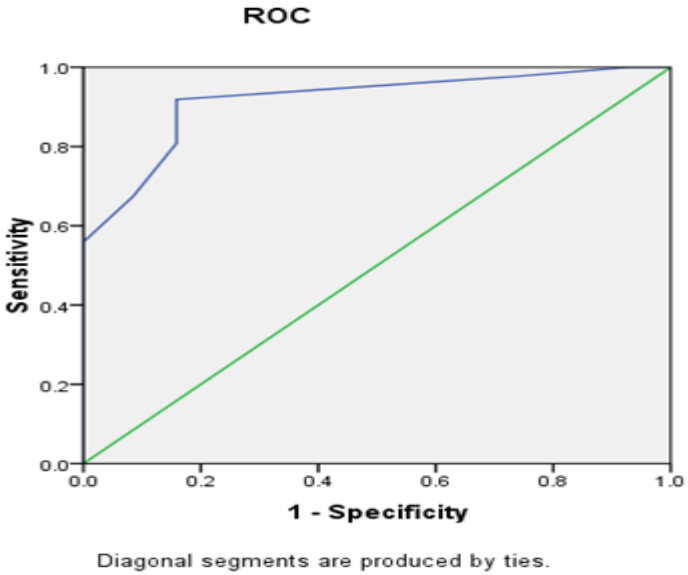
Table 8 shows the distribution of the 100 patients in four groups according to the RIPASA score at a cut-off threshold score of 7.5 and the Alvarado score at a cut-off threshold of 7.0. The RIPASA score correctly classified 86 (97.7%) patients confirmed with histological acute appendicitis to the high-probability group (RIPASA score ≥ 7.5) compared with 52 (59.0%) patients with Alvarado score ≥ 7.0 (Table 11, $p < 0.001$). The 36 patients who were missed by the Alvarado score were classified wrongly into the false negative group with Alvarado score < 7.0. This number was significantly higher than those wrongly classified as false negative by the RIPASA score (Table 11, $p < 0.001$).

Both the RIPASA and Alvarado scores correctly classified 9 (75.0%) and 11 (91.6%) patients without acute appendicitis into the true negative group with scores < 7.5 and < 7.0, respectively. There was no statistical significance between the true negative groups (p=0.002). The mean total RIPASA scores for each group are shown in Table 8. True positive cases achieved mean total RIPASA scores of 9.54 ± 1.49. while true negative cases had mean scores of 6.72 ± 0.51**.**

At the optimal cut-off threshold score of 7.5 for the RIPASA score, the calculated sensitivity and specificity were 97.73% (95% confidence interval [CI] and 75.00% (95% CI), respectively compared with 59.09% (95% CI) and 91.67% (95% CI), respectively for Alvarado score at an optimal cut-off threshold of 7.0 (Table 11). The PPV and NPV for the RIPASA score were 96.63% (95% CI) and 81.82% (95% CI), respectively compared with 98.11% (95% CI) and 23.40% (95% CI), respectively for the Alvarado score (Table 11). The NPV was significantly higher for the RIPASA score compared to that for the Alvarado score ($p < 0.001$).

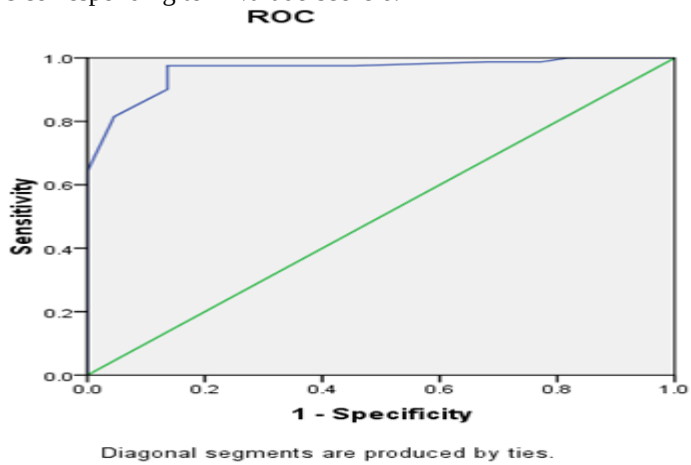
The diagnostic accuracy was 95.00% (95% CI), for the RIPASA score and 63.00% (95% CI) for the Alvarado score, showing a difference of 32.00% ($p < 0.001$), which was statistically significant. This difference of 32.00% equates to a total of 34 patients with confirmed histological acute appendicitis who were missed from being diagnosed by Alvarado score. The predicted negative appendectomy rates for both the RIPASA and

Alvarado scores were 3.37% and 1.88% respectively, which was not statistically significant (p= .828) (Table-11).



ROC (Receiver operating curve) of Alvarado Score: Area under curve: 0.916, p value : <0.001; 95% Confidence interval (CI) of area under curve =0.888-0.944.

The extreme point of left upper quadrant coincides with the highest sensitivity (80.80%) and specificity (84.00%), and here it is corresponding to Alvarado score 6.



ROC (Receiver operating curve) of RIPASA Score; The area under curve is 0.961; p value = <0.001; 95% Confidence interval of area under curve = 0.924 – 0.998.
The extreme point of left upper quadrant coincides with the highest sensitivity (97.50%) and specificity (86.40%) and here it is corresponding to RIPASA score 7.5.

IV. Discussion

Acute appendicitis is one of the most common surgical emergencies encountered by the surgeons with emergency appendectomy making up one in ten of all emergency abdominal surgeries [9,10]. A quick and correct diagnosis of acute appendicitis leading to early appendectomy and avoidance of complications arising from perforation can be difficult at times.

Radiological modalities such as computed tomography (CT) imaging further aid in making a definite diagnosis and have been reported to have high sensitivity (94%) and specificity (95%) for diagnosing acute appendicitis [11] 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(4,5). In most large hospitals, it is routine to request for CT imaging in all patients suspected of acute appendicitis [12]. However, such routine practice will inflate the cost of healthcare substantially. Furthermore, the process of arranging for CT imaging may cause further

delay for emergency appendectomy. A recent study has suggested that such indiscriminate use of CT imaging may lead to the detection of early low-grade appendicitis and unnecessary appendectomies in a condition that would otherwise have resolved spontaneously with antibiotics therapy [87].

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 (13). Another scoring system RIPASA score has been developed, claimed to have better outcomes in Asian settings (14).

This study is an attempt to compare both the scoring system in the diagnosis of acute appendicitis and to see whether there is correlation between the scores with intraoperative and histopathological findings.

Present study included clinically suspected 100 cases, with 91% patient in ≤40 years age group and 9% patients in >40 years. Mean age of the patient was 26.46 years. There were 43 males and 57 females in the study. A cross-sectional study conducted at Bugando Medical Centre, Mwanza Tanzania, between November 2008 and April 2009 was reported almost similar demographic pattern of 37 (29.1%) male and 90 (70.9%) female out of 127 patients with mean age of 29.64.

All the patients clinically suspected to be acute appendicitis were scored according to both the scoring systems and were taken up for surgery. Histopathology was the gold standard for confirmation of the diagnosis. Histopathologically 88 patients were in appendicitis group and 12 patients were in no appendicitis or normal appendix group.

Symptoms such as RIF pain was present in all the cases of acute appendicitis. On evaluation of symptoms and all clinical signs there was no value which was statistically significance.

Alvarado score when applied in all the clinically suspected patients, had 53 cases with score ≥ 7 and 47 cases with score <7. When analyzed with respect to histopathology the sensitivity of scoring system in the present study came out to be 59.09%, specificity was 91.67%, positive and negative predictive values were 98.11% and 23.40% respectively. Accuracy was 64.08%. Negative appendectomy rate was 1.88%.

Using the RIPASA score, 89 cases with score ≥ 7.5 and 11 cases with score <7.5. When analyzed with respect to histopathology the sensitivity of scoring system in the present study came out to be 97.73%, specificity was 75.00%, positive and negative predictive values were 96.63% and 81.82% respectively. Accuracy was 95.15%. Negative appendectomy rate was 3.37%

97.73 of patients who actually had acute appendicitis (true positive) were correctly diagnosed and placed in the high-probability group (RIPASA score ≥ 7.5) and managed appropriately, compared to only 59.09% when using the Alvarado score on the same population sample. Thus, the Alvarado score failed to diagnose 34 patients with acute appendicitis and wrongly classified them in the low-probability group (Alvarado score < 7.0). The difference in diagnostic accuracy of 32.00% between the RIPASA score and Alvarado score was statistically significant ($p < 0.001$), indicating that the RIPASA score is a much better diagnostic tool for the diagnosis of acute appendicitis in our patient population, which is representative of an Indian population group. Similarly, for patients who were classified in the low-probability group, i.e. true negative group with RIPASA score < 7.5 and Alvarado score < 7.0, the RIPASA score again outperformed the Alvarado score by correctly diagnosing 81.82% of patients who did not have acute appendicitis, compared with the Alvarado score, which only managed to correctly diagnose 23.40% ($p < 0.001$). In a study by Chong et al, a prospective study, the sensitivity, specificity, PPV, NPV and diagnostic accuracy of the RIPASA score were 97.05%, 81.80%, 86.5%, 96.4% and 91.8% respectively. The predicted negative appendectomy rate was 13.5%. 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. There is paucity of published studies, by other authors, comparing these scoring systems.

Receptor operative curve (ROC) analysis was done in the present study to look for the cut off scores for both scoring systems, with good sensitivity and specificity. Alvarado score cut off came out to be 6 (not 7) was more consistent with the operative and histopathological findings. This translates into a significant patient population receiving conservative treatment in case a score of 7 is taken as the cutoff point.

The RIPASA score specifies a cut off score of 7.5 for accepting an operative approach. Analysis of the collected data shows consistency with this cut off point ($p=<0.001$). This possibility means that the RIPASA score of 7.5 as the cutoff point is more suitable for the decision-making algorithm when applied to the Asian population.

Thus, in an emergency setting, the on duty Medical Officer can make a quick decision upon seeing patients with RIF pain, by referring those with a RIPASA score ≥ 7.5 to the on-call surgical team for admission, while patients with a RIPASA score < 7.0 can either be observed in the ward or sending home with advice to patient party for observation.

The use of a numerical score also improves the working relationships between the on-duty emergency medical officer and the on-call surgeon, since any patient with a RIPASA score ≥ 7.5 needs to be admitted. With its high sensitivity (97.73%) and NPV (81.82%), the RIPASA score can also help to reduce unnecessary and

expensive radiological investigations such as routine CT imaging, thus further helping to reduce annual healthcare expenditure.

The 14 fixed parameters can be easily and rapidly obtained in any population settings. The option of having additional parameters (FNIC) makes the RIPASA score more flexible and adaptable to different geographical regions. In terms of healthcare cost savings, the use of RIPASA score may help to reduce unnecessary inpatient admissions and expensive radiological investigations.

In this study the RIPASA score considerably better than the Alvarado score in terms of correctly diagnosing the acute appendicitis (sensitivity and diagnostic accuracy) as well was found to be as those who were negative for acute appendicitis (NPV).

V. Conclusion

- RIPASA score at a cut off threshold total score of 7.5 is a better diagnostic scoring system than Alvarado score.
- The RIPASA score is a better tool in evaluation of suspected appendicitis based on the more sensitivity, more negative predictive value and more accurate as compared to Alvarado scoring system.
- Alvarado scoring system is more specific as compared to RIPASA scoring system.
- Negative appendectomy rate with Alvarado scoring system is 1.88% as compared to 3.37% with RIPASA scoring system.
- ROC analysis depicts cut off point for Alvarado score to be 6, not consistent with the original cut off 7, was more accurate with the operative and histopathological findings, while RIPASA scoring cut off point comes to be 7.5, similar to the original cut off.
- Traditional scoring system in Alvarado is old and may not be accurate for south Asian countries, hence requires modifications.

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