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Original Research Article

Comparison of RIPASA and Alvarado scoring in the diagnosis of acute appendicitis and validation of RIPASA scoring

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ABSTRACT

Background: Acute appendicitis is one of the most common surgical emergencies. A delay in performing an appendicectomy in order to improve the diagnostic accuracy increases the risk of appendicular perforation and sepsis. We prospectively compared and validated RIPASA to Alvarado scoring system when applied to an Indian population.
Methods: This study included all the patients presented in General Surgery and The Emergency Department of Manipal Hospital, Bangalore diagnosed to have acute appendicitis from October 2014 to March 2016. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, predicted negative appendicectomy and receiver operating characteristic (ROC) curve of the RIPASA and Alvarado scoring system were derived using SPSS statistical software.
Results: 75 patients were included in the study. Using the RIPASA scoring system, 97.1% of patients who actually had acute appendicitis were correctly diagnosed, compared to only 52.85% when using the Alvarado scoring system. The sensitivity and the specificity of the RIPASA scoring system is 97.14% and 60% respectively. The diagnostic accuracy of RIPASA scoring system is 94.67% and that of Alvarado scoring system is 52%. The results indicate that the RIPASA scoring system is a better diagnostic tool for the diagnosis of acute appendicitis ($p<0.001$).
Conclusions: It is observed that the RIPASA scoring system has higher sensitivity and higher specificity compared to Alvarado scoring. It also has higher diagnostic accuracy and consequently, it has low negative appendicectomy rate. It can be concluded that the RIPASA scoring can be effectively conducted for the better evaluation of acute appendicitis.

Keywords: Acute appendicitis, Alvarado score, RIPASA Score

INTRODUCTION

One of the most common surgical emergencies worldwide is acute appendicitis, with a prevalence rate of 1 in 7 approximately.[1] The incidence is 1.5 and 1.9 per 1000 in the male and female population respectively.[2] A delay in performing an appendicectomy, in order to improve the diagnostic accuracy increases the risk of appendicular perforation and sepsis, which in turn increases morbidity and mortality.[3] The opposite is also true, where with reduced diagnostic accuracy, the negative or unnecessary appendicectomy rate is increased, and this is generally reported to be approximately 20%-40%.[4]

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a new diagnostic scoring system developed for the diagnosis of acute appendicitis and has been shown to have a significantly higher sensitivity, specificity and diagnostic accuracy compared to the Alvarado score, particularly when applied to Asian populations.[5] Although the RIPASA scoring system is

more extensive than the Alvarado scoring system, the latter did not contain certain parameters such as age, gender, duration of symptoms prior to presentation. These parameters are shown to affect the sensitivity and specificity of the Alvarado scoring system in the diagnosis of acute appendicitis.[6] An ultra-sonogram has comparatively less specificity and computerized tomography (CT) helps in confirming the diagnosis, however it is expensive and sometimes inaccessible.

The Alvarado score was assessed as to its accuracy in the preoperative diagnosis of acute appendicitis by Kalan, Talbot and Cunliffe in 1994.[4] A high score aids in early diagnosis of acute appendicitis in children and men whereas for women, the false positive rate of appendicitis was high. Chong et al in 2010 did a prospective study on patients presenting to the Accident and Emergency department or the surgical wards in RIPAS Hospital, the national hospital at Brunei Darussalam with right iliac fossa pain.[7] They concluded that the RIPASA scoring system is the more suitable appendicitis scoring system developed for local settings that is south-east Asia and has high sensitivity, specificity and diagnostic accuracy. The purpose of this study is to validate the scoring system in our set up.

METHODS

The study was conducted in the department of General Surgery & the department of Emergency medicine at Manipal Hospital, Bangalore. Clearance from the institution's ethical committee was obtained before the commencement of the study. A prospective observational study was conducted in all those a patients having acute right iliac fossa pain who underwent appendicectomy based on clinical judgment, USG correlation and in some cases with CT correlation during the period October 2014 to March 2016. We included those in the age group of 15 to 60 years. Those excluded were pregnant females, patients who presented with right iliac fossa mass, chronic recurrent right iliac fossa pain and previous history of pelvic inflammatory disease.

All 75 patients were scored on the basis of 18 parameters of RIPASA scoring system (Table 1) and 8 parameters of Alvarado scoring system (Table 2). Operative notes and histopathology reports will be reviewed and correlated with both scoring systems. The score taken for RIPASA was more than or equal to 7.5 and that of Alvarado score was more than 7. The data collected was then recorded in a study proforma, entered into an Excel worksheet and analysed using a Statistical software namely SPSS 23.0, MedCalc 9.0.1, Systat 12.0 and Microsoft office tools were used to generate graphs and tables. Descriptive and other statistical analysis were carried out in the present study. Results which are in continuous measurements are presented on Mean±SD (Standard Deviation) (Min-Max) and results on categorical measurements are presented in Number and its percentage (%). Significance of tests was assessed at 5% level of significance. Chi-square test was used to study the significance of parameters on a categorical scale between two or more groups.

Table 1: RIPASA scoring system.

1	Demography	Score
	Female	0.5
	Male	1
	Age <39.9 years	1
	Age >40 years	0.5
2	Symptoms	
	RIF pain	0.5
	Pain migration to RIF	0.5
	Anorexia	1
	Nausea & vomiting	1
	Duration of symptoms <48 hrs.	1
	Duration of symptoms >48 hrs.	0.5
3	Signs	
	RIF tenderness	1
	Guarding	2
	Rebound tenderness	1
	Rovsing sign	2
	Fever >37° C <39° C	1
4	Investigation	
	Raised WBC counts	1
	Negative urine analysis	1
5	Additional score	
	Non Asian	1
	Total score	17.5

RIF: Right Iliac Fossa; WBC: White Blood Cell.

Table 2: Alvarado scoring system.

	Score
Symptoms	
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/Vomiting	1
Signs	
Tenderness in right iliac fossa	2
Rebound tenderness in right iliac fossa	1
Elevated temperature	1
Laboratory findings	
Leucocytosis	2
Shift to Left (Neutrophilia)	1
Total	10

Sensitivity, specificity, PPV, NPV, accuracy were computed to find the diagnostic properties of Alvarado score, RIPASA score in relation to HPE findings. ROC curve analysis was performed to assess the role of Alvardo and RIPASA score to predict the appendicitis.

RESULTS

The mean age of our study population was 29.83±9.69 years. The gender distribution was 53 (70.7%) males and

22 (29.3%) females (Table 3). The percentage distribution of the patients with respect to age group (Table 4). The subjects were scored according to RIPASA system and were categorized into high probability group if the score was equal to or more than 7.5 and low probability group if the score was less than 7.5 (Table 5). Most of the patients (93.3%) scored equal to or more than 7.5. The subjects were also scored according to Alvarado system and were categorized into high probability group, if the score was equal to or more than 7 and low probability group if the score was less than 7 (Table 6). According to the Alvarado system only 53.3% of the study populations were categorized as having a high probability of acute appendicitis as against 93.3% according to RIPASA system. Patients classified as having low probability of acute appendicitis were 46.7% as against 6.7% according to RIPASA.

Table 3: The percentage distribution of patients with respect to age group.

Age in years	No. of patients	Percentage (%)
<20	11	14.7
21-30	31	41.3
31-40	25	33.3
41-50	4	5.3
51-60	4	5.3
Total	75	100

Table 4: The percentage distribution of the patients with respect to gender.

Gender	No. of patients	Percentage (%)
Male	53	70.7
Female	22	29.3
Total	75	100

Table 5: The percentage distribution of patients according to RIPASA score.

RIPASA	No. of patients	Percentage (%)
<7.5	5	6.7
≥7.5	70	93.3
Total	75	100

Table 6: Percentage distribution of patients as per Alvarado score.

Alvarado	No. of patients	Percentage (%)
<7.0	35	46.7
≥7.0	40	53.3
Total	75	100

The diagnoses of 75 patients were confirmed by HPE (Histopathological Examination). 70 patients (93.3%) were confirmed as acute appendicitis. 5 patients turned out to be negative for acute appendicitis in HPE resulting in a negative appendectomy rate of 6.7% in this study (Table 7).

Table 7: Percentage distribution of HPE report of patients.

HPE report	No. of patients	Percentage (%)
Positive	70	93.3
Negative	5	6.7
Total	75	100

Table 8: RIPASA scores in comparison to histopathology report.

RIPASA	HPE report		Total (%)
	Positive (%)	Negative (%)	
≥7.5	68 (97.1)	2 (40)	70 (93.3)
<7.5	2 (2.9)	3 (60)	5 (6.7)
Total	70 (100)	5 (100)	75 (100)

P<0.001**, Significant; Chi-square test; HPE – histopathology report.

Table 9: Alvarado score in relation to histopathological report.

Alvarado score	HPE report		Total (%)
	Positive (%)	Negative (%)	
≥7.0	37 (52.9)	3 (60)	40 (53.3)
<7.0	33 (47.1)	2 (40)	35 (46.7)
Total	70 (100)	5 (100)	75 (100)

P=0.001**, Significant, Chi-square test; HPE – histopathology report

At the optimal cutoff threshold of 7.5 for the RIPASA score, the calculated sensitivity and specificity were 94.1% and 60% respectively, for the diagnosis of acute appendicitis, taking histopathology report as reference. In this study, application of RIPASA score resulted in a negative appendectomy rate of 2.9% (Table 8). At the optimal cut-off threshold of 7.0, for the Alvarado score, the calculated sensitivity and specificity were 52.9% and 40% respectively, taking histopathology report as reference. In this study, application of Alvarado score resulted in a negative appendectomy rate of 7.5% (Table 9).

The RIPASA score correctly classified 68 patients with histopathology confirmed acute appendicitis to the high probability group (RIPASA score ≥7.5). 37 patients with the Alvarado score more than 7 had acute appendicitis according to histopathology report. PPV and NPV for RIPASA score were 97.1 and 60 respectively, compared with 92.5 and 5.7 for the Modified Alvarado score. NPV was significantly higher for the RIPASA score compared to Alvarado score (p<0.001). The diagnostic accuracy was 94.67% for the RIPASA score and 52% for the Alvarado score, showing a difference of 42.67%, which amounts to a total of 70 patients who were correctly diagnosed by the RIPASA scoring system over the Alvarado scoring system, with reference to HPE (Table 10).

Table 10: Correlation of RIPASA score, Alvarado score to the positive histopathology report.

Scoring	Observation				Correlation						
	TP	FP	FN	TN	Total	Se	Sp	PPV	NPV	Accuracy	P value
RIPASA	68	2	2	3	75	97.14	60	97.1	60	94.7	<0.001**
Alvarado	37	33	3	2	75	52.85	40	92.5	5.7	52	<0.001**

TP – true positive; FP – false positive; TN – true negative; FN – false negative; Se – sensitivity; Sp – specificity; PPV – positive predictive value; NPV – negative predictive value.

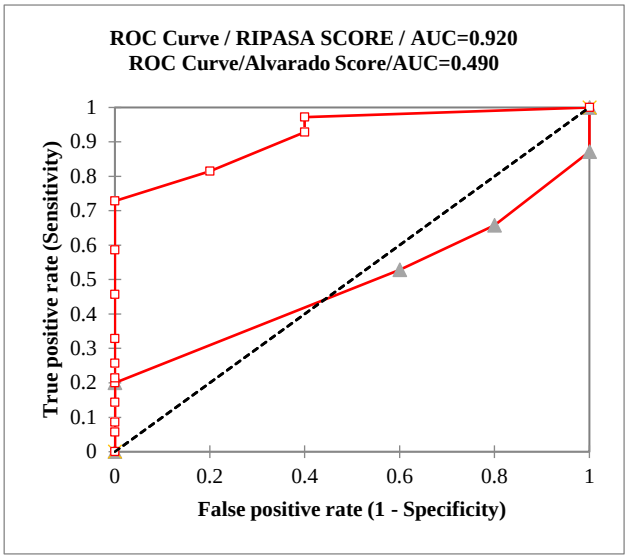

Figure 1: ROC curve analysis for RIPASA and Alvarado scoring systems.

A ROC (receiver operating characteristic) curve was plotted with true positive in x - axis and false positives in Y-axis for both RIPASA and Alvarado scoring systems. Using ROC curve, the area under the curve (AUC) for RIPASA was 0.920 which was more than that for Alvarado score, which was 0.490. The difference in the AUCs is 0.430 (Figure 1) which is strongly significant with a p<0.001.

DISCUSSION

Acute Appendicitis is one of the most common surgical emergencies, with a life time prevalence rate of approximately one in seven.[1] Despite being a common problem, acute appendicitis remains a difficult diagnosis to establish, particularly among the young, the elderly and females of reproductive age group, where a host of other genitourinary and gynecological inflammatory conditions can present with signs and symptoms that are similar to those of acute appendicitis.[8] The differential diagnosis of acute appendicitis being Crohn's disease, ulcerative colitis, renal colic, perforated peptic ulcer, pancreatitis, rectus sheath hematoma, diverticulitis, intestinal obstruction, colonic carcinoma, mesenteric ischemia in general and ectopic pregnancy, dysmenorrhea, pelvic inflammatory disease, endometriosis in females and testicular torsion in males specifically.

A delay in performing an appendectomy in order to improve its diagnostic accuracy increases the risk of appendicular perforation and sepsis, which in turn increases morbidity and mortality. The opposite is also true, where with reduced diagnostic accuracy, the negative or unnecessary appendectomy rate is increased, and this is generally reported to be approximately 20%-40%.[4] Several authors considered higher negative appendectomy rates acceptable in order to minimize the incidence of perforation.[9]

Diagnostic accuracy can be further improved through the use of USG or computed tomography imaging. Although ultrasonography has some limitations such as, it does not reveal any abnormalities despite the presence of appendicitis especially in early appendicitis before the appendix has become significantly distended and in adults where larger amounts of fat and bowel gas make visualization of appendix actually difficult.

Such routine practice of USG and CT may inflate the cost of health care substantially. A recent study has suggested that indiscriminate use of CT imaging may lead to early low-grade appendicitis and unnecessary appendectomies which would otherwise be resolved spontaneously by antibiotics therapy.[10]

Hence a host of scoring system were derived in order to diagnose acute appendicitis. Among them, the most popular being Alvarado scoring system. This scoring system had very good sensitivity and specificity when applied to a Western population. Subsequently, when this scoring system was applied to oriental populations, it showed relatively less specificity and sensitivity to diagnose acute appendicitis. So, a new scoring system was devised called the RIPASA scoring system which was more extensive yet a simple scoring system consisting of 18 fixed parameters and an additional parameter (NRIC) that is unique to Asian populations.

The study was a comparison of the Alvarado scoring system with the RIPASA scoring system. The RIPASA score is superior to Alvarado score in diagnosing acute appendicitis. Diagnostic accuracy was significantly higher in all age groups using the RIPASA scoring system when it was compared with the Alvarado scoring system.

Using the RIPASA scoring system, 97.1% of patients who actually had acute appendicitis were correctly

diagnosed and placed in the high probability group (RIPASA score > or = 7.5) compared to only 52.85% when using the Alvarado scoring system on the same population sample. Thus, the Alvarado scoring system failed to diagnose 47.15% of patients with acute appendicitis and wrongly classified them into the low probability group (Alvarado score <7.0), when compared to the RIPASA scoring system that failed to diagnose only 2.9% with acute appendicitis. Likewise, for patients who were classified in the low-probability group with the RIPASA score <7.5 and Alvarado score <7.0, the RIPASA scoring again outperformed the Alvarado scoring by correctly diagnosing 60% of patients who did not have acute appendicitis, comparing to the Alvarado score, which only able to correctly diagnose 40% ($p<0.001$). The sensitivity and the specificity of the RIPASA scoring system is 97.14% and 60% respectively. The sensitivity and the specificity of the Alvarado scoring system is 52.85% and 40%. The positive predictive value of the RIPASA scoring system is 97.14% and negative predictive value is 60%. The positive predictive value and negative predictive value of the Alvarado scoring system is 92.5% and 5.7% respectively. The diagnostic accuracy of RIPASA scoring system is 94.67% and that of Alvarado scoring system is 52%. The above results indicate that the RIPASA scoring system is a better diagnostic tool for the diagnosis of acute appendicitis than the Alvarado scoring system. Our study corroborates well with the study done by Chong et al in 2010.[5,7] They showed sensitivity of 97.5% and diagnostic accuracy of 91.8% of the RIPASA scoring system.

The difference in diagnostic accuracy was 42.67% between the RIPASA scoring system and the Alvarado scoring system was statistically significant ($p<0.001$), and also area under the curve difference was 0.430, indicating that the RIPASA scoring system is a much better diagnostic tool for the diagnosis of acute appendicitis in Indian continent. The RIPASA scoring system is a useful, rapid diagnostic tool for diagnosing acute appendicitis, as it requires only the patient's details (age, gender and nationality which are all available on registration), clinical history (RIF pain, migration to RIF, anorexia, nausea, vomiting and fever), clinical examination (RIF tenderness, localized guarding, rebound tenderness, Rovsing's sign) and two simple investigations (raised white cell count and negative urinalysis, which is defined as an absence of red and white blood cells, bacteria and nitrates). The RIPASA scoring system can also help us to reduce unnecessary and expensive radiological investigations such as routine CT imaging.

CONCLUSION

From the present study, it is observed that the RIPASA scoring system has higher sensitivity and higher specificity compared to Alvarado scoring. It also has higher diagnostic accuracy, high positive predictive value, high negative predictive value; consequently, it has low negative appendicectomy rate. Therefore, it can be concluded that the RIPASA scoring can be effectively conducted for the better evaluation of acute appendicitis which holds promise as an improved cost effective way of diagnosis.

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