Omkant Sharma
Assistant Professor, Department of Surgery, American International Institute of Medical Sciences, Udaipur, Rajasthan, India

Quresh Bambora
Assistant Professor, Department of Surgery, American International Institute of Medical Sciences, Udaipur, Rajasthan, India

Bhanwar Lal Barkesiya
Assistant Professor, Department of Surgery, American International Institute of Medical Sciences, Udaipur, Rajasthan, India

Acute appendicitis: Diagnostic accuracy of Alvarado and RIPASA scoring system

Omkant Sharma, Quresh Bambora and Bhanwar Lal Barkesiya

Abstract
Introduction: One of the commonest clinical presentation that requires emergency surgery is acute appendicitis. Much efforts have been directed towards early diagnosis and intervention. Delay in diagnosis leads to increase morbidity and costs. In present study, we aimed to compared two scores i.e. RIPASA and Alvarado scoring system in the diagnosis of acute appendicitis.
Materials and methods: Present hospital based screening included 100 patients presenting with Right iliac fossa pain and clinically diagnosed as acute appendicitis. The diagnosis of acute appendicitis was confirmed by operative findings and histopathological assessment of the appendicectomy specimen. A score of 7 or above is taken as high probability of acute appendicitis for Alvarado scoring system while a score of 7.5 or above was taken as high probability of acute appendicitis for RIPASA scoring system.
Results: Sensitivity and specificity of modified Alvarado score in diagnosing Appendicitis was 58.7% and 88% while PPV and NPV was 93.6% and 41.5%. Sensitivity and specificity of RIPASA score in diagnosing Appendicitis was 89.3% and 84% while PPV and NPV was 94.4% and 72.4%. Overall diagnostic accuracy was 88% and 66% for RIPASA and modified Alvarado Score. Both scores showed good efficacy in screening the cases appendicitis on ROC analysis. However, overall screening efficacy of RIPASA score was better than Modified Alvarado Score (AUC – 0.891 vs 0.702).
Conclusion: RIPASA score is currently a much better diagnostic scoring system for acute appendicitis compared to the Alvarado score. RIPASA had significantly higher sensitivity, NPV and diagnostic accuracy in our study group. The 14 fixed parameters can be easily and rapidly obtained in any population setting by taking a complete history and conducting a clinical examination and two simple investigations. In remote settings or emergency, a quick decision can be made with regards to referral to an operating surgeon or observation. The use of RIPASA scoring would help in decreasing the unwarranted patient admissions and also expensive radiological investigations.

Keywords: Acute appendicitis, Alvarado score, diagnostic accuracy, RIPASA score

Introduction
One of the commonest clinical presentation that requires emergency surgery is acute appendicitis [1]. It is rare in infancy and amongst the elderly, but is common in children, teenagers and young adults [2]. Approximately 6% of the population will suffer from acute appendicitis during their lifetime; therefore much effort has been directed toward early diagnosis and intervention. This effort has successfully lowered the mortality rate to less than 0.1% for non-complicated appendicitis, 0.6% where there is gangrene, and 5% for perforated cases [3].
Much efforts have been directed towards early diagnosis and intervention. Delay in diagnosis leads to increase morbidity and costs. Despite attempts to increase the diagnostic accuracy in cases of acute appendicitis, the rate of misdiagnosis in developed countries has remained constant at 15.3% [4].
The classical signs of symptoms of acute appendicitis were first reported by Fitz in 1886. Since then it has remained the most common diagnosis for hospital admission requiring laparotomy [5, 6].
Simple appendicitis can progress to perforation, which is associated with a much higher morbidity and mortality, and surgeons have therefore been inclined to operate when the diagnosis is probable rather than wait until it is certain. As a result of their concern about this, surgeons create for themselves 'a surgical security zone which allows them to accept a 15-30% negative laparotomy rate with impunity [7].
Despite more than 100 years' experience, accurate diagnosis still evades the surgeon. Simple appendicitis can progress to perforation, which is associated with a much higher morbidity and

Corresponding Author:
Bhanwar Lal Barkesiya
Assistant Professor, Department of Surgery, American International Institute of Medical Sciences, Udaipur, Rajasthan, India

mortality, and surgeons have therefore been inclined to operate when the diagnosis is probable rather than wait until it is certain [7].

But the surgical principle about acute appendicitis, "when in doubt, take it out", does not hold true in view of the number of major and minor complications following appendectomy. The diagnosis of appendicitis can be difficult, occasionally challenging the diagnostic skills of even the most experienced surgeon. Attempts to increase the diagnostic accuracy of acute appendicitis have included computer aided diagnosis, imaging by ultrasonography, laparoscopy and even radioactive isotope imaging [8-11].

Owing to its myriad presentations, acute appendicitis is a common but difficult diagnostic problem. The accuracy of the clinical diagnosis has been reported to range from 76% to 92% and varies greatly depending on the experience of the examiner [12].

A number of scoring systems have been used for aiding in early diagnosis of acute appendicitis and its prompt management. These scores make use of clinical history, physical examination and laboratory findings. The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Alvarado score are new diagnostic scoring systems developed for the diagnosis of Acute Appendicitis and has been shown to have significantly higher sensitivity, specificity and diagnostic accuracy. The RIPASA scoring system includes more parameters than Alvarado system and 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 Alvarado scoring system in the diagnosis of acute appendicitis [13].

The RIPASA Score is a new diagnostic scoring system developed for the diagnosis of Acute Appendicitis and has been shown to have significantly higher sensitivity, specificity and diagnostic accuracy compared to Alvarado Score, particularly when applied to Asian population [14-19].

Not many studies in India have been conducted to compare RIPASA and Alvarado scoring system in the diagnosis of acute appendicitis. Hence, we prospectively compared Alvarado and RIPASA score by applying them to the patients attending our hospital with right iliac fossa pain that could probably be acute appendicitis.

Materials and Methods
A hospital based screening study was conducted at Department of Surgery of a tertiary care hospital. Study included 100 patients presenting with Right iliac fossa (RIF) pain and clinically diagnosed as acute appendicitis.
The detailed history, clinical examination, laboratory investigations was done, which include routine haematological investigations, urine routine, x-ray KUB and USG abdomen and pelvis in some equivocal cases. Two specially-designed proforma were filled in for each patient. These proforma had general information about the patient plus eight variables based on the Alvarado scoring system [20] and another proforma had similar patient details and the fourteen variables based on RIPASA scoring system [21].

The decision to operate on the patient (vs. conservative line of management) was based solely on the clinical suspicion of an experienced surgeon who was not a part of/ involved in the study.

The diagnosis of acute appendicitis was confirmed by operative findings and histopathological assessment of the appendicectomy specimen with the ultimate criterion for the final diagnosis of acute appendicitis being the histological demonstration of polymorphonuclear leucocytes throughout the thickness of the appendix wall. Those patients who were treated conservatively and subsequently discharged were reviewed in the surgical outpatient within a week.

A score of 7 or above is taken as high probability of acute appendicitis for Alvarado scoring system while a score of 7.5 or above was taken as high probability of acute appendicitis for RIPASA scoring system.

Statistical analysis
All the data was noted down in a pre-designed study proforma. Qualitative data was represented in the form of frequency and percentage. Quantitative data was represented using Mean ± SD and Median & IQR (Interquartile range). Diagnostic accuracy was evaluated by calculating sensitivity, specificity, PPV and NPV using standard formulae. A p-value < 0.05 was taken as level of significance. Results were graphically represented where deemed necessary. SPSS Version 21 was used for most analysis and Microsoft Excel 2010 for graphical representation.

Results
Mean age of the study cases was 27.32 years with maximum number of cases between 21-40 years of age (67%). Out of 100 patients enrolled in the study 64 were males (64%) and 36 were females (36%). Diagnosis of acute appendicitis as per modified Alvarado Score was made in 47% cases. Diagnosis of acute appendicitis as per modified RIPASA Score was made in 71% cases. Diagnosis of acute appendicitis was confirmed on histopathology by 75% cases. Sensitivity and specificity of modified Alvarado score in diagnosing Appendicitis was 58.7% and 88% while PPV and NPV was 93.6% and 41.5%. Sensitivity and specificity of RIPASA score in diagnosing Appendicitis was 89.3% and 84% while PPV and NPV was 94.4% and 72.4%. Overall diagnostic accuracy was 88% and 66% for RIPASA and modified Alvarado Score (Table 1 & 2).

ROC curve analysis was done to evaluate for screening efficacy of Modified Alvarado & RIPASA Score. Both scores showed good efficacy in screening the cases appendicitis. However, overall screening efficacy of RIPASA score was better than Modified Alvarado Score (AUC – 0.891 vs 0.702) (Graph 1, Table 3).

Table 1: Screening Efficacy of Modified Alvarado Score

Modified Alvarado Score	Appendicitis (Histopathology)		Total
	No	Yes	
<7	22	31	53
>/= 7	3	44	47
Total	25	75	100

Parameters	%
Sensitivity	58.7%
Specificity	88.0%
PPV	93.6%
NPV	41.5%
Accuracy	66.0%

Table 2: Screening Efficacy of RIPASA Score

RIPASA Score	Appendicitis (Histopathology)		Total
	No	Yes	
< 7.5	21	8	29
>/= 7.5	4	67	71
Total	25	75	100

Parameters	%
Sensitivity	89.3%
Specificity	84.0%
PPV	94.4%
NPV	72.4%
Accuracy	88.0%

Table 3: Receiver's operative characteristics curve parameters of Modified Alvarado & RIPASA Score

Area Under the Curve					
Test Result Variable(s)	Area	SE	p- value	Asymptotic 95% CI	
				Lower Bound	Upper Bound
Modified Alvarado Score	0.702	0.104	<0.01	0.498	0.907
RIPASA Score	0.891	0.095	<0.01	0.651	0.972
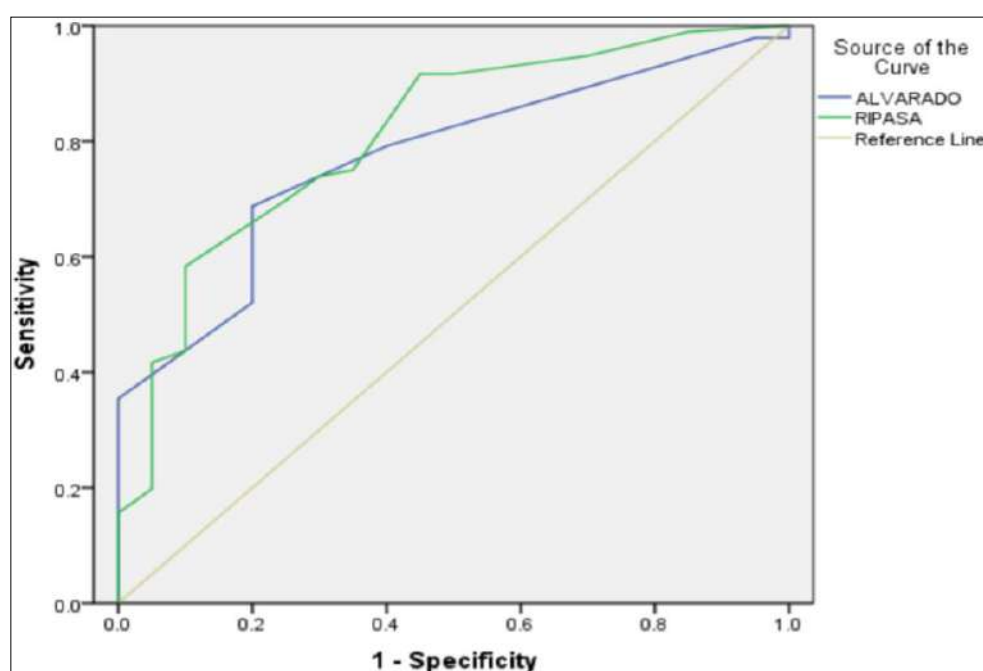
Graph 1: Receiver's operative characteristics curve for screening efficacy of Modified Alvarado & RIPASA Score

Discussion

Acute appendicitis is one of the most common conditions seen in surgical emergency. It can be easily treated if accurate diagnosis is made in time, otherwise delay in diagnosis and treatment can lead to gangrene, perforation and diffuse peritonitis.

Acute appendicitis has a lifetime occurrence of approximately 7% and perforation rates of 17-20% [1]. The decision to operate is based on disease history and physical findings. Often patients with acute appendicitis are not diagnosed until the occurrence of severe complications while waiting for more evidence to the diagnosis. These patients have a higher mortality and morbidity than patients who are diagnosed in time [13]. Thus, a timely therapeutic intervention of acute appendicitis is important for decreasing the morbidity and mortality by timely accurate diagnosis.

By and large throughout History main emphasis was on clinical judgment but prone to interobserver variation in diagnosing and decision making for surgery. Despite attempts to increase the diagnostic accuracy in cases of acute appendicitis, the rate of misdiagnosis in developed countries has remained constant at 15.3%. Despite more than 100 years' experience, accurate diagnosis still evades the surgeon. Simple appendicitis can progress to perforation, which is associated with a much higher morbidity and mortality, and surgeons have therefore been inclined to operate when the diagnosis is probable rather than wait until it is certain [4].

But the surgical principle about acute appendicitis, "when in doubt, take it out", does not hold true in view of the number of major and minor complications following appendectomy.

Many scoring systems have been proposed in the past as an objective to ensue a clinically accurate uniform diagnostic tool which can be put into practice for early and timely diagnosis of acute appendicitis without wasting time waiting for other means of diagnosis like imaging modalities. The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and Alvarado score are the two diagnostic scoring systems developed for the diagnosis of Acute Appendicitis and has been shown to have significantly higher sensitivity, specificity and diagnostic accuracy. Not many studies in India have been conducted to compare RIPASA and

Alvarado scoring system in the diagnosis of acute appendicitis. Hence, we prospectively compared Alvarado and RIPASA score by applying them to the patients attending our hospital with right iliac fossa pain that could probably be acute appendicitis.

In present study, a score of 7 or above is taken as high probability of acute appendicitis for Alvarado scoring system while a score of 7.5 or above was taken as high probability of acute appendicitis for RIPASA scoring system.

At the respective cut-offs, diagnosis of acute appendicitis as per modified Alvarado and RIPASA Score was made in 47% and 71% cases respectively. Sensitivity and specificity of modified Alvarado score in diagnosing Appendicitis was 58.7% and 88% while PPV and NPV was 93.6% and 41.5%. Overall diagnostic accuracy was 66%. Sensitivity and specificity of RIPASA score in diagnosing Appendicitis was 89.3% and 84% while PPV and NPV was 94.4% and 72.4%. Overall diagnostic accuracy was 88%.

In a study done by Nanjundaiah et al. [18] at optimal cutoff threshold of >7 the sensitivity and specificity of the Alvarado scoring system were 58.9% and 85.7% respectively which is very much comparable with present study. The positive predictive value and negative predictive value of Alvarado score is 97.3% and 19.1% respectively. In a study done by Chong CF et al. [19] the cut-off threshold score of 7.0 for the Alvarado score, the sensitivity, specificity, PPV, NPV and diagnostic accuracy were 68.3 percent, 87.9 percent, 86.3 percent, 71.4 percent and 86.5 percent, respectively.

In a study done by Nanjundaiah et al. [18] using the RIPASA score, 96.2% of patients who actually had acute appendicitis were correctly diagnosed and placed in the high probability group (RIPASA score >7.5), compared to only 58.9% when using the Alvarado score on the same population sample.

In a study done by Chong CF et al. [19] the RIPASA score correctly classified 98 percent of all patients confirmed with histological acute appendicitis to the highprobability group (RIPASA score greater than 7.5) compared with 68.3 percent with the Alvarado score (Alvarado score greater than 7.0; p-value less than 0.0001).

The comparison of diagnostic accuracy of modified Alvarado and RIPASA Score across various studies is being tabulated below (Table 4 & 5).

Table 4: The comparison of diagnostic accuracy of modified Alvarado

Modified Alvarado Score	Present Study	Pasumarthi V [15]	Subramani B [22]	Díaz B [23]
Sensitivity	58.7%	52.1%	68.0%	75.0%
Specificity	88.0%	80.0%	86.9%	41.6%
PPV	93.6%	92.6%	85.0%	93.7%
NPV	41.5%	25.8%	71.4%	12.5%
Accuracy	66.0%	56.9%	77.1%	55.7%

Table 5: RIPASA Score across various studies is being tabulated below

RIPASA Score	Present Study	Pasumarthi V [15]	Subramani B [22]	Díaz B [23]
Sensitivity	89.3%	75.0%	98.0%	93.3%
Specificity	84.0%	65.0%	80.4%	08.3%
PPV	94.4%	91.4%	84.4%	91.8%
NPV	72.4%	35.0%	97.4%	10.1%
Accuracy	88.0%	73.3%	89.6%	50.9%

ROC curve analysis was done to evaluate for screening efficacy of Modified Alvarado & RIPASA Score. Both scores showed good efficacy in screening the cases appendicitis. However, overall screening efficacy of RIPASA score was better than Modified Alvarado Score (AUC – 0.891 vs 0.702).

In a similar study by Pasumarthi V [15], both scores showed good efficacy in screening the cases appendicitis with overall screening efficacy of RIPASA score was better (AUC – 0.810 vs 0.77). In a study done by Chong CF et al. [19], area under curve for the RIPASA score is 0.9183 which is greater than that for the Alvarado score, which is 0.8651. Similar results were also observed by the study of Nanjundaiah et al. [17].

Thus to conclude, the RIPASA score is a useful, rapid diagnostic tool for acute appendicitis, especially in the settings of the emergency as it requires only the patient's demographics (age, gender), a good clinical history (RIF pain, migration to RIF, anorexia, nausea and vomiting), clinical examination (RIF tenderness, localised guarding, rebound tenderness, Rovsing's sign and fever) and two simple investigations (raised white cell count and negative urinalysis performed at triage, which is defined as an absence of red and white blood cells, bacteria and nitrates). Thus, in the emergency setting, a quick decision can be made upon seeing patients with RIF pain. Those with a RIPASA score >7.5 need admission and further management, while patients with a RIPASA score <7.0 can either be observed. With its high sensitivity (89.3%) and NPV (72.4%), the RIPASA score can also help to reduce unnecessary and expensive radiological investigations such as routine CT imaging.

Conclusion

RIPASA score is currently a much better diagnostic scoring system for acute appendicitis compared to the Alvarado score. RIPASA had significantly higher sensitivity, NPV and diagnostic accuracy in our study group. The 14 fixed parameters can be easily and rapidly obtained in any population setting by taking a complete history and conducting a clinical examination and two simple investigations. In remote settings or emergency, a quick decision can be made with regards to referral to an operating surgeon or observation. The use of RIPASA scoring would help in decreasing the unwarranted patient admissions and also expensive radiological investigations.

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