

## Evaluation of Alvarado Score and RIPASA Score in the Diagnosis of Acute Appendicitis

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### Abstract

### Original Research Article

**Background:** Acute appendicitis despite being a common problem, remains a difficult diagnosis to establish. A delay to diagnose this condition as well as negative appendicectomies should be prevented. The above problems can be avoided by using scoring systems. This study aims to compare the efficacy of Alvarado score and Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score in the diagnosis of acute appendicitis. **Methods:** This is a prospective observational study attempted to compare the efficiency of Alvarado and RIPASA score, in pre-operative diagnosis of acute appendicitis and to correlate these scores with histo-pathological diagnosis. 100 cases satisfying inclusion and exclusion criteria were selected for study. Based on detailed history and thorough clinical examination, diagnosis of acute appendicitis was made. **Results:** The sensitivity and specificity of RIPASA score were 97.4% and 56.52% respectively and Alvarado score were 70.12% and 78.26% respectively. The accuracy for diagnosing the acute appendicitis showed high probability with RIPASA score (88%) when compared to Alvarado score (72%). **Conclusion:** The RIPASA scoring system had a higher sensitivity, Negative Predictive Value and accuracy, than the Alvarado score in the diagnosis of Acute Appendicitis. Hence, the new appendicitis scoring system 'RIPASA' score is simple, promising and has good diagnostic accuracy.

**Keywords:** Acute Appendicitis, Alvarado, RIPASA, Clinical Scores, Diagnosis.

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## INTRODUCTION

Appendectomy remains the most frequently performed emergency abdominal surgical procedure [1]. The lifetime risk of acute appendicitis for men and women is 8.6% and 6.7%, respectively. However, the lifetime risk of having an appendectomy is 12% for men and 25% for women [2, 3]. The incidence is highest in adolescents and young adults, but the incidence of complicated appendicitis shows little variance between different age groups [4].

The clinical diagnosis of acute appendicitis relies upon a detailed history and thorough physical examination. The principal presenting complaint of patients with acute appendicitis is abdominal pain. Murphy was the first to describe the sequence of colicky central abdominal pain followed by vomiting and migration of the pain to the right iliac fossa. This classical presentation is only seen in approximately 50% of patients. The history of pain is usually 24 h of colicky peri-umbilical pain followed by migration of the pain to the right iliac fossa with a progression to a more constant severe pain. This progression results

from the initial pain being referred from the visceral innervation of the midgut followed by more defined localization of the pain when the parietal peritoneum is involved by the inflammatory process [5].

Associated symptoms include loss of appetite and nausea but profuse vomiting is rarely a feature of simple appendicitis and may well represent the development of diffuse peritonitis following perforation. Patients will often have a low grade fever. It is common for patients to report no change in bowel habit but a range of bowel habit disturbances may be associated with the onset of pain. Cope reported that patients may feel constipated and anticipate relief of pain with defecation but this does not occur [6].

Those at the extremes of age often present a significant diagnostic challenge as they may present with atypical signs and symptoms [7]. Infants may appear listless whilst the elderly may present with confusion. A high index of suspicion is therefore required to make the diagnosis in such cases [5].

Studies reporting the mortality associated with appendicitis have demonstrated a significant increase in mortality associated with perforation [8]. The rate of perforation is reported to increase by 5% per 12 h period, 36 h after the onset of symptoms, therefore, expedient diagnosis and treatment are required [9].

Furthermore, high rates of negative appendectomy (operation without histological confirmation of appendicitis) have been reported with some groups such as females of reproductive age having rates of up to 26% [10].

Hence, delayed or incorrect diagnosis therefore has both clinical and economic consequences and this has resulted in considerable research to identify clinical, laboratory and radiological findings that are diagnostic of appendicitis and the development of clinical scoring systems (some computer aided) to guide the clinician in making the correct diagnosis [5].

Several scoring systems have been devised to aid decision making in doubtful cases, including the Ohmann, Alvarado, Eskelinen, Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) and several others [11-15]. These scoring systems utilize routine clinical and laboratory assessments and are simple to use in a variety of clinical settings. However, differences in sensitivities and specificities were observed if the scores were applied to various populations and clinical settings, usually with worse performance when applied outside the population in which they were originally created [11, 12, 15]. Additionally, geographic variation of the incidence and clinical pattern of the differential diagnosis of acute abdominal pain may impair their applicability [16].

The RIPASA is the new diagnostic scoring system developed for the diagnosis of Acute Appendicitis [17]. The RIPASA scoring system includes various parameters including clinical features as well as other variables such as age, gender, duration of symptoms prior to presentation [18]. However, being the new scoring system not many studies have been done to evaluate the accuracy of RIPASA in the diagnosis of acute appendicitis.

Hence, the present study was undertaken to evaluate accuracy of RIPASA scoring system in the diagnosis of acute appendicitis so as to reduce the delay in diagnosis.

## MATERIALS AND METHODS

The study was conducted in Kamineni Institute of Medical Sciences and Hospital, Narketpally, Telangana, India. Institutional ethical clearance was obtained prior to the commencement of this study. Informed consent was obtained from all patients. The

study population included all the patients attending Kamineni Institute of Medical Sciences and Hospital with right iliac fossa pain during the period October 2017 to September 2019. Pregnant women, patients presenting with non-RIF pain and those who have been admitted by other specialties for other complains but who subsequently developed RIF pain were excluded from the study.

On these 100 patients of Right iliac fossa pain and with the clinical features suggestive of acute appendicitis, both the RIPASA scoring system and the Alvarado scoring system were applied. The data collected included the patients' demographics (national registration identity card [NRIC] number, age and gender), the presenting symptoms (RIF pain, the migration of pain to the RIF, nausea and vomiting, anorexia and the duration of symptoms), clinical signs (RIF tenderness, guarding, rebound tenderness, Rovsing's sign and fever) and laboratory investigations (elevated white cell count and negative urinalysis).

The RIPASA score and the Alvarado scores were applied but the decision for radiological investigations or emergency appendectomy was made based on clinical judgement. Before resection the appendix was assessed intra operatively. The resected specimen was sent for histopathological examination and reports analyzed. Final diagnosis is obtained by comparing with histopathological diagnosis.

Receiver operating curve (ROC) [19] at the optimal cut-off threshold score for the RIPASA and Alvarado score was derived using StatsDirect statistical software version 2.7.2 (StatsDirect Ltd, Cheshire, UK 2008). The optimal cut off threshold score derived from the ROC analysis was 7.5 for RIPASA scoring system and 7 for the Alvarado scoring system, based on this optimal cut off threshold scores. Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) of the RIPASA and the ALVARADO scoring systems are calculated and compared by using an appropriate statistical analysis.

## RESULTS

Table-1 indicates the distribution of males and females according to Alvarado and RIPASA scores (n=100). According to Alvarado scores, out of the 59, (group  $\geq 7$ : probability of acute appendicitis is high) 36 (61.02%) were males and 23 (38.98%) were females and out of 41, (group  $< 7$ : probability of acute appendicitis is low) 23(51.5%) were males and 18(48.5%) were females. According to RIPASA score, out of the 85, (group  $\geq 7.5$ : probability of acute appendicitis is high) 51 (60%) were males and 34 (40%) were females and out of 15, (group  $< 7.5$ : probability of acute appendicitis is low) 8(53.3%) were males and 7(46.7%) were females.

**Table-1: Distribution of males and females according to Alvarado and RIPASA scores (n=100)**

	Alvarado Score			RIPASA Score		
	<7	>=7	Total	<7.5	>=7.5	Total
No. of patients	41	59	100	15	85	100
Males	23(51.5%)	36(61.02%)	59	8(53.3%)	51(60%)	59
females	18(48.5%)	23(38.98%)	41	7(46.7%)	34(40%)	41

Table-2 indicates the distribution of patients with Alvarado scores (group <7, n=41 and group >=7, n=59) according to Histopathological findings (HPE).

Out of 41 subjects, 23(56.1%) in the group score <7 showed appendicitis in HPE and out of 59, 54 (91.5%) in the group score >=7 showed appendicitis in HPE.

**Table-2: Distribution of patients with Alvarado scores (group <7, n=41 and group >=7, n=59) according to Histopathological findings (HPE)**

	Group score <7			Group score >=7		
	No. of patients	HPE showing Appendicitis	HPE not showing Appendicitis	No. of patients	HPE showing Appendicitis	HPE not showing Appendicitis
Males	23	14(60.8%)	9(39.2%)	36	34(94.45%)	2(5.55%)
Females	18	9(50%)	9(50%)	23	20(86.95%)	3(13.05%)
Total	41	23(56.1%)	18(43.9%)	59	54(91.5%)	5(8.5%)

Table-3 indicates the distribution of patients with RIPASA scores (group <7.5, n=15 and group >=7.5, n=85) according to Histopathological findings (HPE). Out of 15 subjects, 2(13.3%) in the group score

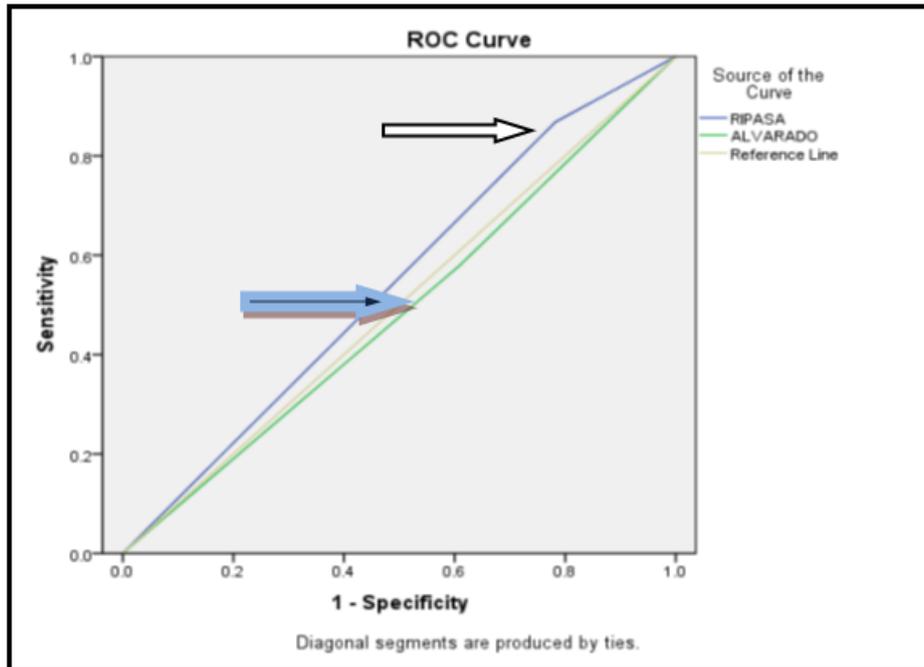
<7.5 showed appendicitis in HPE and out of 85, 75 (88.2%) in the group score >=7.5 showed appendicitis in HPE.

**Table-3: Distribution of patients with RIPASA scores (group <7.5, n=15 and group >=7.5, n=85) according to Histopathological findings (HPE)**

	Group score <7.5			Group score >=7.5		
	No. of patients	HPE showing Appendicitis	HPE showing Normal Appendix	No. of patients	HPE showing Appendicitis	HPE showing Normal Appendix
Males	8	1(12.5%)	7(87.5%)	52	48(92.3%)	4(8.7%)
Females	7	1(14.3%)	6(85.7%)	33	27(81.8%)	6(19.2%)
Total	15	2(13.3%)	13(86.7%)	85	75(88.2%)	10(11.8%)

Figure-1 indicates the Receiver Operating Curve (ROC) of Alvarado and RIPASA Scores. The sensitivity, specificity, positive and negative predictive value of Alvarado scoring system were 70.12%, 78.26%, 91.52% and 43.90% respectively. The sensitivity, specificity, positive and negative predictive value of RIPASA scoring system were 97.40%,

56.52%, 88.23% and 86.67% respectively. The percentages of false negatives and false positives of Alvarado score were 2.59% and 43.47% respectively. The percentages of false negatives and false positives of RIPASA score were 29.87% and 21.73% respectively. The accuracy of Alvarado and RIPASA scores were 72% and 88% respectively



**Fig-1: Receiver Operating Curve (ROC) of Alvarado and RIPASA Scores**

- Arrow indicating optimal cut off threshold for RIPASA score=7.5
- Arrow indicating optimal cut off threshold for Alvarado score=7

## DISCUSSION

Acute appendicitis is one of the most commonly encountered surgical emergencies, with emergency appendicectomy making up 10% of all emergency abdominal surgeries [20]. A quick and correct diagnosis of acute appendicitis leading to early appendicectomy and avoidance of complications arising from perforation can be difficult at times.

Radiological modalities such as ultrasonography [1] and 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 [21]. Thus, in most large hospitals, it is routine to request for CT imaging in all patients suspected of acute appendicitis. 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 appendicectomy.

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

So several scoring systems evolved, such as the Alvarado, which was introduced in 1986 to help with the clinical decision-making process in achieving an accurate diagnosis of acute appendicitis in the fastest and cheapest way.

Despite good sensitivity and specificity when applied to a western population, both the Alvarado and the Modified Alvarado scores have been shown to achieve low sensitivity and specificity, ranging from 50 to 59% and 23 to 94% respectively, when applied to Middle Eastern, Asian or Oriental populations. Because of the poor sensitivity and specificity of both the Alvarado and the Modified Alvarado scoring systems the RIPASA score was developed which was more applicable to our local population.

Alvarado score had a sensitivity and specificity of 70.12% and 78.26% respectively in the present study. The PPV was 91.52%, NPV was 43.90% and with accuracy of 72%. Alvarado score lacks parameters that have been shown to be important determinants in the diagnosis of acute appendicitis, such as age, gender and the duration of symptoms, sensitivity and specificity of the Alvarado scoring system vary with age, gender and the duration of symptoms.

In the present study gender was observed to have significant influence on appendicitis with male patients being 1.4 times more likely than their female counterparts to have the disease.

In Shepherd series, out of 1179 acute abdominal emergency operations, 472 were acute appendicitis. The disease is slightly more common in males than females. In Shepherd series, 163 were males and 122 were females.

RIPASA scoring system includes the age, duration of symptoms and gender in the scoring making it a more reliable scoring system than Alvarado. RIPASA scoring system also includes RIF guarding, Rovsing's sign, negative urinalysis. Negative urinalysis excludes urinary causes of RIF pain. The sensitivity and specificity achieved with RIPASA Scoring system were 97.40% and 56.52%, respectively, with a diagnostic accuracy of 88%. The PPV was 88.23 %, NPV was 86.67 %. The difference in diagnostic accuracy of 16% between the RIPASA score and Alvarado score was statistically significant ( $p < 0.0001$ ), indicating that the RIPASA score is a much better diagnostic tool for the diagnosis of acute appendicitis in the present study.

Chong *et al.*, [11, 17] continued to evaluate their RIPASA score by prospectively enrolling 200 adults in a comparison of the RIPASA and Alvarado Scores. In this group of patients, the RIPASA was statistically superior to the Alvarado Score in Sensitivity (98% vs. 68%), NPV (97% vs. 71%) and accuracy (92% vs. 87%). Specificity, PPV and negative appendectomy rates were similar between the 2 scores.

In the Chong *et al.*, [11] study the RIPASA score correctly classified 98% of all patients confirmed with histological acute appendicitis to the high probability group (score  $>7.5$ ) compared with 68.3% with the Alvarado score ( $>7.0$ ;  $p$  - value  $<0.0001$ )

Alnjadat I, Abdallah B [22] compared Alvarado versus RIPASA score where 600 patients were included with a mean age of 26.52 years where as in the present study mean age is 26.61+/- 14.5 years. Negative appendectomy rate was 17%. Sensitivity for RIPASA and Alvarado were 93.2% and 73.7% respectively ( $p$  value  $<0.001$ ). RIPASA accuracy (91.5%) was significantly higher than Alvarado score accuracy (74.3%). Predicted negative appendectomy rates for RIPASA and Alvarado systems were 7.8% and 8%, respectively ( $p$  value=0.88).

Sensitivity, PPV of the RIPASA scoring system in the present study are comparable to the study done by Chong CF *et al.*, in 2011 [11, 17]. The Disouza *et al.*, study showed a lesser sensitivity (91% compared to 97.4%), but a better PPV (92% compared to 88.2%), accuracy (91% compared to 88%) in comparison to the present study.

Kalan *et al.*, [23] applied the Alvarado scoring system in an Asian population and only achieved a sensitivity and specificity of 59% and 23%, respectively, with a negative appendectomy rate of 15.6%. In the present study Alvarado score had a sensitivity of 70.12% and specificity of 78.26%.

Chong CF, Adi M W, Thien A *et al.*, [11, 17] reported in the year 2010 that the RIPASA score had a sensitivity of 88% versus 97.4% in the present study,

specificity of 67% versus 56.52% in present study, positive predictive value of 93% versus 88.23% in present study, negative predictive value of 53% versus 86.67% in present study. Negative appendectomy rates decreased significantly from 16.3% to 6.9% which was a 9.4% reduction according to Chong C F study [11].

Chong CF *et al.*, [17] published their evaluation of the RIPASA score in Brunei International Medical Journal. 144 patients consecutive patients were included with a mean age of 29.5+/-13.3 years versus mean age is 26.61+/-14.52 years in the present study. At the optimal cut off threshold score of 7.5 from the ROC they calculated a sensitivity of 97.5%, specificity of 81.8%, PPV of 86.5%, NPV of 96.4% and a diagnostic accuracy of 91.8%. Our study with 100 patients as the sample size showed a sensitivity of 97.4%, specificity of 56.52%, PPV of 88.23%, NPV of 86.67%.

## CONCLUSION

The Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) score is a simple qualitative scoring system based on 14 fixed clinical parameters (two demographics, five clinical symptoms, five clinical signs and two clinical investigations) and one additional parameter (foreign national Identity card).

In RIPASA score 14 clinical parameters are present, which include a good clinical history and examination and can be easily and quickly applied, therefore a decision on the management of suspicious cases of acute appendicitis can be made early.

In the present study the RIPASA scoring system had a higher sensitivity, NPV and accuracy, than the Alvarado score in the diagnosis of Acute Appendicitis. The new appendicitis scoring system 'RIPASA' score in short, is promising and has good sensitivity, specificity and diagnostic accuracy. It is simple and easy to use, and has been specifically developed for Asian and Middle Eastern population patient group.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

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