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Research Article

A PROSPECTIVE STUDY OF COMPARATIVE ANALYSIS OF THE ACCURACY OF MODIFIED ALVARADO, LINTULA, OHMANN, RIPASA AND TZANAKIS SCORES IN DIAGNOSIS OF ACUTE APPENDICITIS

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ABSTRACT

Introduction: Acute appendicitis is still one of the common diseases in surgical practice. But most of the time appendicitis does not have its classical presentation. So the diagnosis of atypical presentation is challenging. This study aimed to compare the accuracy of Modified Alvarado, LINTULA, Ohmann, Raja Isteri Pengiran Anak Saleha (RIPASA), and Tzanakis scores in predicting the need for appendectomy in Acute Appendicitis patients. **Methods**: This Analytical study conducted at PDU Medical College and Hospital, Rajkot, Gujarat for a period of 2 years, from year 2020 to 2022, with Sample size of 230 patients, with the mean age of 29 +/- 9.7 years, who were admitted in surgery department. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy, predicted negative appendectomy and receiver operating characteristic (ROC) curve of Modified Alvarado, LINTULA, Ohmann, Raja Isteri Pengiran Anak Saleha (RIPASA), and Tzanakis scores were evaluated and compared. Statistical analysis was done with $p<0.05$ was considered to be significant. **Results**: The diagnosis was histopathologically confirmed in 199 cases (86.5%). The area under the curve (AUC), sensitivity, and specificity of RIPASA score in the cut-off value of 7.5 were 0.98, 97.98%, and 90.32%, respectively. RIPASA scoring system had the best screening performance in detection of cases with Appendicitis as compared to other scoring systems, as per our study. **Conclusion**: RIPASA score is more sensitive and specific than Modified Alvarado, Tzanakis, LINTULA and Ohmann scores in diagnosing Acute appendicitis patients needing appendectomy.

INTRODUCTION

Acute appendicitis is still one of the common diseases in surgical practice.[1] From the time that it was first described by Reginald Heber Fitz in 1886, it has remained a topic of serial research works for various factors ranging from its etiology, to its management options.[2] The diagnosis of acute appendicitis is based on clinical history and examination and laboratory investigations and also Imaging modalities such as radiography, ultrasound, CT scan, and MRI are used to diagnose but their unavailability at small centers makes the diagnostic approach more difficult towards acute appendicitis. Most of the time appendicitis does not have its classical presentation. So the diagnosis of atypical presentation is challenging, particularly among the young, the elderly and females of reproductive age, where other genitourinary and gynecological inflammatory conditions can present with signs and symptoms that are similar to those of acute appendicitis.[3-4]. Delay in diagnosis definitely increases the morbidity and mortality risk due to perforation and peritonitis. Many scoring systems have been developed to aid in diagnostic and management approach towards acute appendicitis. Most of these scoring systems are based on demographic, clinical and laboratory parameters for better diagnostic approach towards acute appendicitis without the need for costly imaging modalities that so even in small healthcare setups [5-6]. The aim of this study is to compare the accuracy of different scoring systems including RIPASA, Tzanakis, LINTULA, Ohmann and Modified Alvarado for diagnosis and management approach directing towards acute appendicitis.

METHODS

Study design

This prospective study was carried out on 230 patients admitted in surgery department in our tertiary care center for a period of 2 years from the year 2020 to 2022 after obtaining informed consent, and based on inclusion and exclusion criteria. This study was approved by the Institutional ethics committee of the hospital.

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Participants

Inclusion criteria

- All the patients with Pain in Right iliac fossa with suspected acute appendicitis
- Age > 12 years

Exclusion Criteria

- Patient managed conservatively not undergone surgery.
- Age < 12 years

Data gathering

Relevant history including age and gender, examination findings including important clinical symptoms and signs like anorexia, nausea and vomiting, RIF pain, tenderness and guarding, also Rebound tenderness and Rovsing's sign were recorded, laboratory investigations including WBC count and Urinalysis and radiological investigations including USG and CT scan were done. The obtained data were used to evaluate Modified Alvarado, Tzanakis, RIPASA, LINTULA and Ohmann scores. All patients underwent appendectomy and were categorized into two groups according to histopathologic diagnosis: positive appendectomy (PA) and negative appendectomy (NA). Parameters of different scoring systems are given in tabular format (Table 1-5)

PARAMETERS	ALVARADO SCORE
Pain migration to rif	1
Anorexia	1
Nausea & vomitting	1
Rif tenderness	2
Rebound tenderness	1
Fever	1
Raised wbc count	2
TOTAL	9

PARAMETERS	TZANAKI SCORE
Rif tenderness	4
Rebound tenderness	3
Raised wbc count >12k	2
+Ve usg find.	6
TOTAL	15

PARAMETERS	OHMANN SCORE
Age<50 yrs	1.5
Rif pain	2
Pain migration to rif	1
Rif tenderness	4.5
Rebound tenderness	2.5
Guarding	1
Raised wbc count	1.5
-Ve urinalysis	2
TOTAL	16

PARAMETERS	LINTULA SCORE	
Gender	MALE	2
	FEMALE	0
Rif pain		4
Pain migration to rif		4
Nausea & vomitting		2
Rebound tenderness		7
Guarding		4
Fever		3
Bowel sounds	ABSENT	4
	NORMAL	0
Intensity of pain	SEVERE	2
	MILD	0
TOTAL		32

PARAMETERS	RIPASA SCORE	
GENDER	MALE	1
	FEMALE	0.5
Age	<39.9YRS	1
	>40 YRS	0.5
Rif pain	0.5	
Pain migration to rif	0.5	
Anorexia	1	
Nausea & vomiting	1	
Duration of symptoms	<48HRS	1
	>48HRS	0.5
Rif tenderness	1	
Rebound tenderness	1	
Guarding	2	
Fever	1	
Raised wbc count	1	
-Ve urinalysis	1	
Rovsing's sign	2	
TOTAL	16.5	

Statistical Analysis

The data was analysed using Microsoft excel 2010. The impact of parameters with respect to different scoring systems were evaluated and their association with diagnosis of acute appendicitis was done using Chi-square test with $p<0.05$ was considered statistically significant. The accuracy of different scores were evaluated by calculating their sensitivity, specificity, Positive Predictive Value, Negative Predictive Value and Diagnostic accuracy using different excel formulas. Also False Positive Rate and True Positive Rate were evaluated for constructing receiver operating characteristic (ROC) curve. A greater area under the receiver operating characteristic (ROC) curve (AUC) indicates better diagnostic value. The median value of scoring systems were derived and related to their respective high probability scores. The continuous data based on normal distribution was calculated using mean +/- SD.

RESULTS

The mean age of our study population was 29 +/- 9.7 years. The gender distribution was 150(65%) male and 80(35%) female. The diagnoses of 230 patients were confirmed by HPE (Histopathological Examination) out of which 199 patients (86.5%) were confirmed as acute appendicitis. Out of 199 patients, 20 patients were having Perforated/Gangrenous Appendicitis (8.7%). While 31 patients turned out to be negative for acute appendicitis in Histopathological examination with negative appendectomy rate of 13.5%. Out of total 31 cases with Non-appendicitis etiology, 16(52%) cases were having Chronic Lymphoid Hyperplasia, 8(26%) cases were having underlying Urological cause, 2(6%) cases were being diagnosed with Mesenteric Lymphadenitis, 2(6%) cases were having some underlying Gynecological causes, while remaining 4 were having other causes, of which 3(6%) were having enteritis and 1(3%) was having other idiopathic cause.

Table 6 Distribution of patients as per age and gender

Sex Distribution (Age wise)	Male		Female	
	No. of patients	Percentage (%)	No. of patients	Percentage (%)
<20	25	16.66	7	8.75
20-40	110	73.33	61	76.25
41-60	15	10	11	13.75
>60	0	0	1	1.25
Total	150	100	80	100

Chart 1 Distribution of Non Appendicitis Etiologies

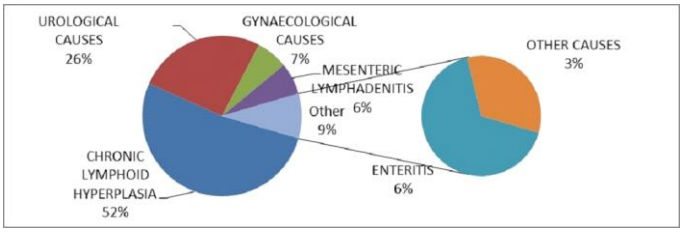

Table 7 Statistical significance of Parameters

Parameters		Appendicitis (A)	Non Appendicitis (NA)	P- value
Age	<40 years	136	21	0.9467
	>40 years	63	10	
Gender	Male	127	23	0.2592
	Female	72	8	
Mig. Pain	Present	124	75	<0.05
	Absent	6	25	
RIF tenderness	Present	184	15	<0.05
	Absent	19	12	
Anorexia	Present	190	9	0.7419
	Absent	30	1	
Nausea/ Vomiting	Present	105	94	0.6499
	Absent	15	16	
Duration of symptoms	<48 hours	157	42	<0.05
	>48 hours	13	18	
Guarding	Present	42	157	0.00466
	Absent	0	31	
Rebound Tenderness	Present	129	70	<0.05
	Absent	2	29	
Rovsing's sign	Present	20	179	0.0647
	Absent	0	31	
Fever	Present	104	95	0.000178
	Absent	5	26	
Raised Total Count	>12 k	146	53	<0.05
	<12 k	10	21	
Negative urinalysis	Present	192	7	<0.05
	Absent	18	13	
Bowel Sounds	Present	157	42	0.00466
	Absent	31	0	
Intensity of pain	Mild	157	42	0.00466
	Severe	31	0	

Different parameters of scoring system and their association with diagnosis of acute appendicitis were studied, Demographic parameters like Age (p=0.94) and Gender (p=0.26) were not found to be creating any impact in diagnostic approach towards acute appendicitis. Clinical parameters like absence of Anorexia(p=0.74)and Nausea/Vomiting(p=0.65) does not rule out acute appendicitis. Likewise, presence of Rovsing sign (p=0.06) was definitely associated with acute appendicitis, absence of which does not rule out acute appendicitis. Clinical Parameters like RIF tenderness, Guarding, Rebound tenderness and migratory pain, Intensity of Pain, presence of Bowel sounds, duration of symptoms, fever, and laboratory parameters like Raised WBC count and Negative urinalysis created a significant impact in diagnostic approach towards acute appendicitis with p<0.05. RIF pain was an inclusion criteria, present in all 230 patients.

Table 8 Statistical significance, Cut-off and Median score of studied scoring systems

Scoring System	High Probability Score	Median Score(min-max)	P value
RIPASA	>7.5	8(4.5-13.5)	<0.05
TZANAKIS	>8	13(3-15)	<0.05
LINTULA	>21	24(10-32)	<0.05
OHMANN	>12	12.5(4-16)	<0.05
MODIFIED ALVARADO	>7	7(2-9)	<0.05

All scoring systems contributed significantly for diagnostic as well as management approach towards acute appendicitis, on the basis of their high probability score and median values. Values lower than high probability score can be considered for further diagnostic evaluation or can be kept conservative. As per our study, median scores of RIPASA, Tzanakis, LINTULA, Ohmann and Modified Alvarado were greater than their high probability score with p<0.05, considered statistically significant for diagnosing acute appendicitis.

Comparing the scores

RIPASA score was able to determine Acute Appendicitis better than the other scoring systems, followed by Tzanakis, Ohmann, LINTULA, and Modified Alvarado scores, respectively (based on AUC). AUC, sensitivity, and specificity of RIPASA score in the cut-off value of 7.5 were 0.98, 98%, and 90%, respectively. The second most effective scoring system was Tzanakis with above measures were 0.97, 98%, 85.2%, respectively. For Ohmann and Alvarado scores, these measures were 0.92; 82%, 93.5% and 0.84, 57.7%, 93.5%, respectively. For LINTULA scores, these measures were 0.90; 76%, 93.5%, respectively. RIPASA scoring system had the best screening performance in detection of cases with Acute Appendicitis.

Table 9 Comparative Analysis of Different Scores

	Alvarado	Ohmann	Ripasa	Tzanakis	Lintula
TP	114	165	195	195	156
TN	29	29	28	23	29
FP	2	2	3	8	2
FN	85	34	4	4	43
Sensitivity (%)	57.27	83	98	98	76
Specificity (%)	93.5	93.5	90	85.2	93.5
PPV(%)	98	98.78	98.5	96	97
NPV(%)	26	46	87.5	85.2	40
Diagnostic Accuracy (%)	62	83.5	96.5	94.8	79
AUC	0.84	0.92	0.98	0.97	0.90

*AUC= Area Under Curve; PPV=Positive Predictive Value; NPV=Negative Predictive Value; TP= True Positive; FP= False Positive; TN= True Negative; FN= False Negative

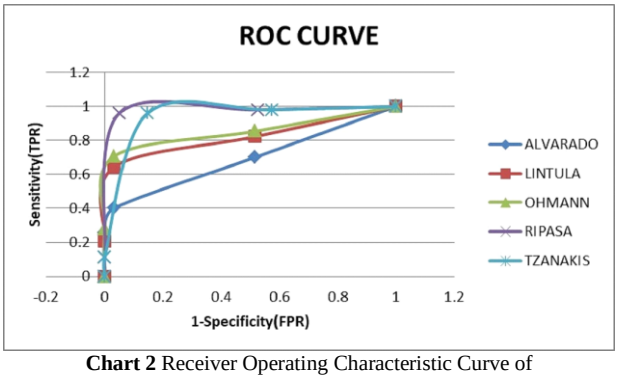

Chart 2 Receiver Operating Characteristic Curve of different scoring systems

DISCUSSION

Diagnostic approach of acute appendicitis is dependent on clinical examination and laboratory investigations making the approach difficult and not predictable [7-8]. Role of different scoring systems is to make this cumbersome diagnostic approach more precise and predictable thereby reducing complications and Negative Appendectomy Rates. Alvarado is the first scoring system developed and used widely and can successfully predict Appendicitis [9- 10]. The Modified Alvarado scoring system is a reliable and practicable diagnostic modality to increase the accuracy in diagnosis of acute appendicitis and thus to minimize unnecessary appendectomy [11]. Subraman and Elhosseiny et al. compared the Modified Alvarado with RIPASA and Ohmann scores respectively found the sensitivity and specificity of Alvarado score to be 68% and 86.96%, and 65.2% and 100%, respectively [12-13]. Based on our study, Modified Alvarado is found to be having least sensitivity of 57.7% and high specificity of 93.5% with AUC = 0.84 with least diagnostic ability among all other scoring systems. In our study, we have found that the sensitivity and specificity for the RIPASA score was 98% and 90% respectively which is highest among all other scoring systems as it contains more number of impactful clinical and laboratory parameters yielding better diagnostic results, Butt MQ et al. reported sensitivity of RIPASA score was 96.7%, specificity 93.0%, diagnostic accuracy was 95.1%, positive predictive value was 94.8% and negative predictive value was 95.54% [14]. Pasumarthi V et al. compared the RIPASA and Modified Alvarado scoring systems and found the sensitivity and specificity of the RIPASA scoring system were 96.2% and 90.5% respectively, while the sensitivity and specificity of the Alvarado scoring system were 58.9% and 85.7% respectively. The RIPASA score is currently a better diagnostic scoring system for acute appendicitis compared to the Alvarado score, with the former achieving significantly higher sensitivity and diagnostic accuracy, particularly in Indian population [15]. Tzanakis scoring system is an effective modality in the establishment of accuracy in diagnosis of acute appendicitis, but the limitation is observer bias which may vary the scoring system [16]. The Tzanakis score was suggested as a combined clinical evaluation of ultrasound results and parameters after the inflammatory The sensitivity and specificity were 98% and 85.2%, respectively, Sigdel and Malla et al. reported that the Tzanakis score was as effective as the Alvarado score, with a lower false-negative rate [17,18]. In our study sensitivity and specificity of Ohmann score were 83% and 93.5%. The AUC of Ohmann score was found to be more than Modified Alvarado due to inclusion of age variable. Yilmaz EM et al reported that Ohmann score is more useful to provide guidance and eliminate acute appendicitis from consideration when conditions are more uncertain and obscured [19]. In our study sensitivity and specificity of LINTULA score were 76% and 93.5%. Lintula score may provide more precisely a diagnosis of Acute Appendicitis but that a repeated clinical examination may be more sensitive to rule out Acute Appendicitis [20-21]. Lintula et al. demonstrated that, the diagnostic accuracy of the score was 92% and negative appendicectomies rate were 17% in their prospective study. Following repeated clinical examination the diagnostic accuracy was significantly improve [22]. Erdem et al. in their study concluded that, Ohmann and RIPASA scoring systems have the highest specificity for the diagnosis of acute appendicitis[23]. Korkut et al. reported that, the Tzanakis score has higher sensitivity and specificity in diagnosis of Acute Appendicitis compared to Alvarado, RIPASA, Eskelinen and Ohmann score [24]. Based on the findings of the present study, RIPASA score has higher sensitivity and specificity in the diagnosis of Appendicitis compared to Modified Alvarado, Tzanakis, LINTULA and Ohmann scores.

Limitation

The notable short comings of this study are:

1. The study has been done in a single centre.
2. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out

CONCLUSION

RIPASA score has higher sensitivity and specificity in diagnosis of Acute Appemdicitis compared to Modified Alvarado, Tzanakis, LINTULA and Ohmann scores due to inclusion of more number of clinical variables and laboratory parameters yielding better diagnostic results. As per our analysis the screening performance of Tzanakis score is comparable to RIPASA score in diagnosis of acute appendicitis due to inclusion of radiological variable as an impactful parameter increasing its sensitivity. The screening performance of LINTULA is comparable to Ohmann score based on the much similarity of their variables. The sensitivity and specificity of Modified Alvarado score is least among all other scoring systems with least diagnostic ability due to high number of false negative results.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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