An Evaluation of Efficacy of Alvarado, Tzanakis and Ripasa Scores in the Diagnosis of Acute Appendicitis

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Abstract

Background: Acute Appendicitis is the most common cause of emergency GI surgery worldwide with an incidence of 100 in 1 lakh population per year in developing countries. However, the diagnosis is largely dependent on the clinical judgement, although additional investigations may be helpful. Several scoring systems has been developed to differentiate the patients who require the surgery from who do not, thus reducing the burden of negative appendectomy.

Methods: This is a cross-sectional observational study conducted at Department of General Surgery, ASRAM for a period of 8 months from January 2023 to August 2023, aimed to evaluate the efficacy of Alvarado, Tzanakis and RIPASA scores in the diagnosis of acute appendicitis. The study population includes 70 patients who were suspected with acute appendicitis and underwent appendectomy. All the patients were given scores based on the Alvarado, Tzanakis and RIPASA scoring systems to determine the need for appendectomy and the diagnosis is confirmed by histopathological examination. Descriptive analysis, ROC analysis and diagnostic tests were used to assess the efficiency of the three scoring systems.

Results: In this study among the 70 patients who met the inclusion and exclusion criteria, appendicitis was more common in males with a mean age of 28.6 ± 11.8 years. Among the 3 scoring systems Tzanakis has the higher diagnostic probability, might be due to inclusion of ultrasound findings. However, the RIPASA scoring system has the better sensitivity and accuracy compared to Alvarado's and Tzanakis, therefore, is recommended as better diagnostic tool for appendicitis to prevent negative appendectomies.

Keywords: Alvarado, Diagnostic Tool, Appendectomies

Introduction

Acute appendicitis is one of the most common surgical emergencies worldwide, affecting approximately 7% of

the population at some point in their lives (Addiss et al., 1990). The condition involves an inflammation of the vermiform appendix and can lead to severe complications, such as rupture or peritonitis, if not diagnosed and treated promptly. The clinical significance of acute appendicitis stems from its potentially life-threatening nature and the urgency associated with its accurate diagnosis and management.

Diagnosing acute appendicitis remains challenging due to the variability of its presentation and symptoms that often overlap with other abdominal conditions (Birnbaum & Wilson, 2000). Traditional diagnosis relies on clinical evaluation, laboratory testing, and imaging studies; however, these methods can lead to diagnostic uncertainty, delayed treatment, or unnecessary surgeries. Thus, there is a pressing need for effective scoring systems that can streamline the diagnostic process and enhance decision-making.

Several scoring systems have been developed to address these challenges, including the Alvarado, Tzanakis, and RIPASA scores. The **Alvarado score**, introduced in 1986, is one of the earliest and uses a combination of clinical symptoms, signs, and laboratory findings to predict the likelihood of appendicitis (Alvarado, 1986). The **Tzanakis score** later supplemented these criteria with ultrasound findings, aiming to improve diagnostic accuracy (Tzanakis et al., 2005). The **RIPASA score**, more recent, was specifically developed for Asian populations and includes a broader range of clinical features (Chong et al., 2010).

The aim of this research is to evaluate the efficacy of these three scoring systems—Alvarado, Tzanakis, and RIPASA—in diagnosing acute appendicitis, with histopathology as the gold standard. The objectives include determining the most effective scoring system to minimize negative appendectomies and identifying which system provides the most reliable diagnostic assurance.

Objectives

The primary objectives of this research are twofold, aimed at enhancing the diagnostic approach to acute appendicitis using established scoring systems. Detailed enumeration of these objectives is as follows:

Assess the Efficacy of Scoring Systems: To assess the efficacy of the Alvarado, Tzanakis, and RIPASA scoring systems in the diagnosis of acute appendicitis, using histopathological examination as the gold standard. This objective seeks to validate each scoring system's accuracy and reliability by comparing their predictive results against confirmed histopathological findings. The aim is to determine how well each score correlates with the actual presence of appendicitis in surgical specimens, thereby evaluating the true diagnostic value of each system.

Comparison for Reducing Negative Appendectomies: To compare the Alvarado, Tzanakis, and RIPASA scores to identify the most effective scoring system for reducing negative appendectomies. This involves analysing the sensitivity, specificity, and overall diagnostic accuracy of each score in predicting the need for surgical intervention. The goal is to ascertain which scoring system best minimizes the occurrence of negative appendectomies—surgical procedures performed where the appendix is found to be normal upon histological examination. This comparison is crucial for improving patient outcomes and reducing healthcare costs associated with unwarranted surgeries.

Materials and Methods

Study Design: This research was designed as a Prospective Study, conducted over the period from

January 2023 to August 2023. The aim was to evaluate and compare the diagnostic accuracy of the Alvarado, Tzanakis, and RIPASA scoring systems in predicting acute appendicitis.

Participant Selection Criteria

Inclusion Criteria

- Patients aged between 10 and 75 years.
- Patients who presented with symptoms suggestive of acute appendicitis and were subsequently subjected to an appendectomy based on clinical judgment.

Exclusion Criteria

- Patients with significant comorbid conditions that could alter the clinical presentation of appendicitis.
- Patients who received a different diagnosis during surgery that explained their symptoms (e.g., gynecological pathology).
- Pregnant women.
- Patients diagnosed with appendicular abscess, appendicular mass, or generalized peritonitis.

Methodology for Applying Scoring Systems

All the patients included in the study, after thorough history taking and clinical examination underwent laboratory investigations and ultrasound. Each patient included in the study was evaluated using the **Alvarado (table 1)**, **Tzanakis (Table 2)**, and **RIPASA** (table 3) scoring systems upon admission.

Feature	Score
Migratory Pain	1
Anorexia	1
Nausea	1
Tenderness in right lower quadrant	2
Rebound tenderness	1
Elevated temperature	1
Leucocytosis	2
Shift of WBC to left	1
Total	10

Table 1: ALVARADO scoring system

	Score
Signs	
Presence of right lower quadrant tenderness	4
Rebound tenderness	3
Laboratory findings	
WBC>12000	2
Ultrasonography	
Presence of positive ultrasound findings of acute appendicitis	6
Total	15

Table 2: Tzanakis scoring system

Characteristics	Score
Female	0.5
Male	1.0
Age <39.9 years	1.0
Age >40 years	0.5
Right Iliac fossa pain	0.5
Pain migration to RIF	0.5
Anorexia	1.0
Nausea and vomiting	1.0
Duration of symptoms <48 hrs	1.0
Duration of symptoms >48 hrs	0.5
RIF Tenderness	1.0
RIF guarding	2.0
Rebound tenderness	1.0
Rovsing sign	2.0
Fever >37° C - <39° C	1.0
Investigations	
Raised WBC	1.0
Negative urine analysis	1.0
Foreign nationality	1.0
Total score	17.5

Table 3 : RIPASA scoring system

Patients were suspected to have Acute appendicitis if the total score of Alvarado of >7,Tzanakis score of 8-15 and RIPASA score of >7.5.Patients with scores below the index of suspicion of each score would still undergo surgery, depending on surgeons clinical decision.Histopathological examination was considered gold standard to confirm the diagnosis.

Statistical Methods

The following statistical methods were employed to analyse the data:

Descriptive Analysis: Used to summarize the demographics and basic characteristics of the study population.Among the 70 patients who met the inclusion and exclusion criteria, 42 (60%) were male, 28(40%) were female with a mean age of 37 years. There were 41(58.57%) patients with appendicitis and 29(41.43%) patients without appendicitis. Mean age of the patients with appendicitis and non- appendicitis are 28.6 ± 11.8 years and 28.19 ± 9.7 years respectively.(table 4)

Characteristics	Appendicitis	Non Appendicitis	P-value
	41	29	
Age	28.6 ± 11.8	28.19 ± 9.7	0.974
Alvarado score (mean±SD)	6.9 ± 1.5	6 ± 1.4	0.004
Tzanaki score (mean±SD)	10.7 ± 2.7	7.5 ± 3.3	0.000
RIPASA score (mean±SD)	10.6 ± 1.7	8.1 ±2.2	0.000

Table 4: Respondent Characteristics

Among the 70 patients, Alvarado score was ≥ 7 for 36 patients, Tzanakis score ≥ 8 for 47 cases and RIPASA score ≥7.5 for 52 patients. (Table 5, Table 6, Table 7)

HPE Report	≥7	<7
Appendicitis	26	15
Non appendicitis	19	19
Total	36	34

Table 5: Alvarado scoring in study population

HPE Report	≥8	<8
Appendicitis	36	5
Non appendicitis	10	19
Total	47	24

Table 6: Tzanaki scoring results in study population

HPE Report	≥7.5	<7.5
Appendicitis	40	1
Non appendicitis	12	17
Total	52	18

Table 7: RIPASA scoring results in study population

Receiver Operator Characteristics (ROC) Analysis: Employed to assess the diagnostic performance of each scoring system. The area under the ROC curve (AUC) was calculated to measure the ability of the scores to correctly classify those with and without the disease.
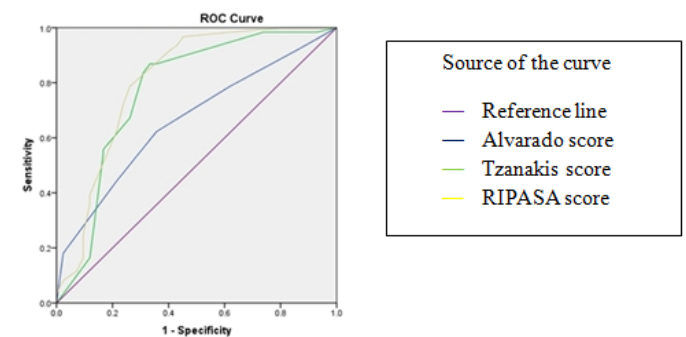
The ROC curve of Alvarado score sensitivity obtained with an AUC was 66.2%.

This means among 70 respondents, the correct conclusion can be drawn in 46 patients using Alvarado scoring, which is lesser than the minimum AUC value expected i.e., 70.The sensitivity value of the Tzanakis score obtained with an AUC was 77.3%,Which indicates among 70 patients, the correct conclusion is obtained in

54 patients. The AUC value of Tzanakis is >70% which is quite satisfactory. The sensitivity of the RIPASA score calculated with AUC was 80.7%Which indicates among 70 patients, the correct conclusion is obtained in 56 patients.The AUC value of RIPASA is >70% which is quite satisfactory.

Diagnostic Tests: Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each scoring system to evaluate their effectiveness in diagnosing acute appendicitis.

	Alvarado	Tzanakis	RIPASA
Sensitivity	63.41%	87.8%	97.56%
Specificity	65.52%	65.52%	58.6%
Positive predictive value	72.25%	78.28%	76.94%
Negative predictive value	55.85%	79.15%	94.44%
Accuracy	64.29%	78.57%	81.43%
Positive likelihood ratio	1.839	2.54	2.36

The statistical analysis was conducted using SPSS software (Version 25.0), and a p-value of less than 0.05 was considered statistically significant.

Results

The effectiveness of each scoring system—Alvarado, Tzanakis, and RIPASA—was evaluated based on their diagnostic accuracy as measured by Receiver Operator Characteristics (ROC) curves, sensitivity, specificity, and likelihood ratios. Alvarado Score has a ROC AUC of 66.2%, indicating moderate accuracy, Sensitivity of 63.41%, reflecting the percentage of actual positives correctly identified, Specificity of 65.52%, indicating the percentage of negatives correctly identified and a Positive Likelihood Ratio of 1.84, suggesting a moderate increase in probability of appendicitis following a

positive test. Tzanakis Score has a ROC AUC of 77.3%, showing good diagnostic accuracy, Sensitivity of 87.8%, indicating higher reliability in detecting actual positives, Specificity of 65.52%, consistent with Alvarado's specificity and a Positive Likelihood Ratio: 2.54, reflecting a better diagnostic ability compared to Alvarado and RIPASA, which could be attributed to the inclusion of USG findings in the scoring system. RIPASA Score has a ROC AUC of 80.7%, the highest among the scores, indicating excellent diagnostic accuracy, Sensitivity of 97.56%, the highest sensitivity, showing superior detection of actual positives, Specificity: 58.6%, slightly lower than the other two scores, indicating a small trade-off for higher sensitivity and a Positive Likelihood Ratio: 2.36, demonstrating an effective diagnostic probability. The statistical significance of the differences observed in scoring system outcomes was confirmed by p-values. Alvarado Score has a p-value of 0.004, indicating a statistically significant difference between scores of patients with and without appendicitis. Tzanakis Score has a p-value < 0.001, showing a highly significant difference, underscoring its greater diagnostic accuracy. RIPASA Score has a p-value< 0.001, also highly significant, highlighting its effectiveness, particularly in sensitivity.

Discussion

The results of this study illustrate significant variances in the performance of the Alvarado, Tzanakis, and RIPASA scoring systems in diagnosing acute appendicitis. The Receiver Operator Characteristics (ROC) analysis indicated that the RIPASA score, with the highest Area under Curve (AUC) of 80.7%, demonstrates excellent diagnostic accuracy, followed by the Tzanakis score at 77.3% and the Alvarado score at 66.2%. These findings suggest that while all three

scoring systems are useful, the RIPASA score may offer the best combination of sensitivity and diagnostic accuracy.

The statistical analysis reinforced these observations, with significant p-values ($p < 0.001$) for the Tzanakis and RIPASA scores and ($p=0.004$) for Alvarado scores indicating robust diagnostic probabilities.

In terms of sensitivity, the RIPASA score excelled with 97.56%, significantly higher than the other scores. This high sensitivity suggests that the RIPASA score is particularly effective at identifying patients with acute appendicitis, thereby reducing the likelihood of false negatives. However, its specificity was slightly lower at 58.6%, which might increase the risk of false positives.

Conversely, the Tzanakis score, which includes ultrasound parameters, showed balanced sensitivity (87.8%) and specificity (65.52%), providing a good diagnostic threshold without heavily favoring sensitivity or specificity. The Alvarado score showed moderate values in both sensitivity (63.41%) and specificity (65.52%), indicating a fair but less optimal performance in diagnosing appendicitis compared to the other scoring systems.

The clinical implications of these findings are substantial. The high sensitivity of the RIPASA score makes it particularly valuable in settings where ruling out appendicitis is crucial to prevent negative surgical outcomes. The Tzanakis score's balance between sensitivity and specificity makes it a reliable option in environments where ultrasound facilities are available. Given the limitations observed with the Alvarado score, clinicians might consider combining it with other diagnostic tools or reserve its use for cases where typical symptoms of appendicitis are evident.

Conclusion

The results clearly illustrate the varied performance of the Alvarado, Tzanakis, and RIPASA scores in diagnosing acute appendicitis. Tzanakis and RIPASA scores showed superior diagnostic probabilities with significantly higher sensitivity, making them more reliable for ruling in appendicitis when positive. The RIPASA score, despite its slightly lower specificity, provided the highest sensitivity, suggesting it as the most effective tool to reduce unnecessary appendectomies among diverse populations. These findings support the use of these scoring systems, especially in varied clinical settings, to enhance diagnostic accuracy and patient outcomes.

Limitations and Future Research

The main limitation of this study is the relatively small sample size, which may affect the generalizability of the findings. Additionally, the study focused on a single geographic region, which could influence the applicability of the RIPASA score, originally developed for an Asian demographic, to other populations.

Future research should focus on larger, multi-centre studies to validate these findings across diverse populations and settings. Further exploration into how these scoring systems can be integrated into clinical workflows, potentially in combination with imaging technologies or other diagnostic tests, would also be beneficial.

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