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Original Article

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Comparative Evaluation of Tzanakis and Alvarado Scoring Systems in the Diagnosis of Acute Appendicitis: A Prospective Observational Study

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Abstract

Background: Acute appendicitis remains the most common surgical emergency, yet its diagnosis can be challenging due to atypical presentations. The Alvarado and Tzanakis scoring systems are commonly employed tools for preoperative diagnosis, but their relative diagnostic accuracy remains under debate. ***Objectives:*** This study aimed to compare the diagnostic efficacy of the Tzanakis score versus the Alvarado score in patients with suspected acute appendicitis and to validate these scores against histopathological findings. ***Methods:*** A prospective observational study was conducted from August 2023 to December 2024 at the Department of General Surgery, Sri Ramachandra Institute of Higher Education and Research. Ninety adult patients with clinical suspicion of acute appendicitis who underwent laparoscopic appendicectomy were included. Alvarado and Tzanakis scores were calculated preoperatively, and results were correlated with postoperative histopathology. ***Results:*** Of the 90 patients, histopathology confirmed acute appendicitis in 95.5%. Tzanakis score ≥8 had a sensitivity of 87.21% and specificity of 75%, outperforming the Alvarado score ≥7, which had a sensitivity of 76.74% and specificity of 50%. Tzanakis score also demonstrated higher predictive accuracy in identifying true positive cases. ***Conclusion:*** Both scoring systems are useful in diagnosing acute appendicitis; however, the Tzanakis score demonstrated superior diagnostic performance. Incorporation of Tzanakis scoring into routine practice may improve diagnostic accuracy and reduce negative appendectomy rates, especially in resource-constrained settings.

Keywords: ***Acute appendicitis, Tzanakis score, Alvarado score, Appendicitis diagnosis, Clinical scoring systems.***

Introduction

Reginald Heber Fitz in 1886 first described inflammation of the appendix as appendicitis [1]. Appendicitis is the most common cause of acute abdominal pain, with an incidence of 110 per 100,000 [2]. Timely diagnosis and surgical intervention are critical, as delays can lead to increased morbidity and mortality. The risk of developing acute appendicitis in men and women is 9% and 7%, respectively [5]. Acute appendicitis can be diagnosed only in 70–80% of cases by clinical examination. Twenty percent of patients deviate from typical clinical signs, making it difficult to establish a diagnosis. False-positive and false-negative results remain common, with rates of negative appendectomy ranging from 15% to 26% [6].

Puylaert was the first to diagnose acute appendicitis via ultrasonography [7]. Most acute appendicitis patients can be diagnosed clinically due to their typical history and clinical findings. Many factors contribute to acute appendicitis, including dietary habits, luminal causes, and familial predisposition [5]. The laparoscopic approach is the minimally invasive method to diagnose and treat various conditions encountered in patients with suspected appendicitis [8]. The addition of various operator-dependent techniques to graded compression sonography allows improved visualization of both normal and abnormal appendices [7].

Patients presenting in the emergency room and primary health care settings, especially in low-resource countries, would benefit most from the implementation of the **Alvarado score**, which includes migratory pain, anorexia, nausea, vomiting, RIF tenderness, rebound tenderness, elevated body temperature, leukocytosis, and a shift to the left as a triage decision rule [9]. The **Tzanakis score**, integrating clinical evaluation, ultrasonography, and inflammatory markers, has been proposed as a more comprehensive and potentially more accurate alternative modality for diagnosing acute appendicitis, with the limitation of observer bias impacting the scoring system. A score greater than 8 indicates the need for surgical intervention, with good sensitivity and specificity [10].

While both scores are utilized in clinical practice, there remains a need for comparison to determine their relative diagnostic utility.

Aims and Objectives

To compare the efficacy of Tzanakis score with Alvarado score in diagnosing Acute Appendicitis and correlate its accuracy with Histopathology.

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Materials and Methods

This is prospective observational study, where all the patients presented to Dept of General surgery Sri Ramachandra Institute of Higher Education and Research with history and clinical features suggestive of Acute Appendicitis between the period of August 2023 to December 2024 were included.

Inclusion Criteria

Patients aged above 18 years with clinical diagnosis of acute appendicitis undergoing Laparoscopic/ open Appendicectomy.

Exclusion Criteria

- Age < 18 years.
- Patients with appendicular abscess/ mass.
- Generalized peritonitis.
- Recurrent Appendicitis.
- Patients not fit/ willing for surgery.

Method

After getting approval from the institution ethics committee, all patients diagnosed with Acute Appendicitis by clinical, radiological or laboratory findings meeting the inclusion, exclusion criteria were included in the study. Tzanakis and Alvarado scores were calculated and documented in a preformed proforma. The specimen was sent to Histopathological examination postoperatively and efficacy of the above scoring systems will be calculated accordingly.

Table 1: ALVARADO SCORING

	Parameters	SCORE
Symptoms	Migratory Rif Pain	1
	Anorexia	1
	Nausea/Vomiting	1
Signs	Rif Tenderness	2
	Rebound Tenderness	1
	Elevated Body Temperature	1
Lab Investigations	Leucocytosis	2
	Shift To Left	1
	TOTAL	**10**

Table 1. Alvarado scoring system: Score greater than or equal to 7 is diagnostic of Acute Appendicitis

Table 2: TZANAKIS SCORING:

Parameters	Score
Presence of right lower abdominal tenderness	4
Rebound tenderness	3
Laboratory findings: Presence of white blood cells greater than 12,000 in the blood	2
Ultrasound finding: Presence of positive ultrasound scan findings for appendicitis	6
Total	**15**

Table 2. Tzanakis scoring system: Score greater than or equal to 8 was diagnostic of Acute Appendicitis.

Results

Table 3: Age distribution of study participants

Age Category	Frequency	Percentage
< 20 Years	14	15.5 %
21 – 30 Years	42	46.6 %
31 – 40 Years	9	10 %
41 – 50 Years	20	22.2 %
> 51 Years	5	5.5 %
Total	**90**	**100 %**

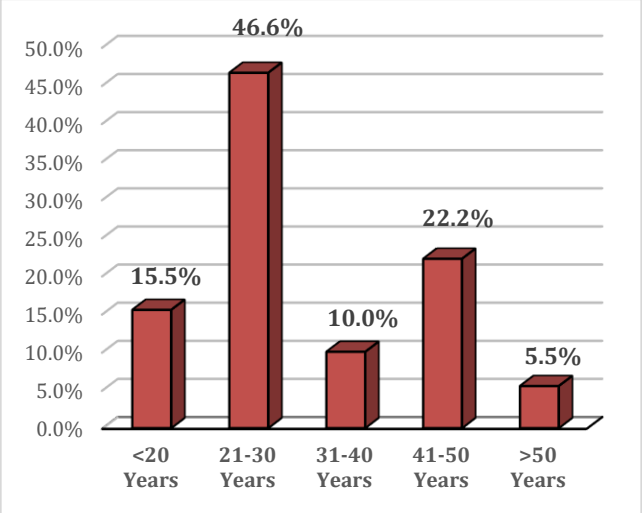

Figure 3: Age distribution of study participants

The mean age of the study participants is 31.4 ± 11.43 years and ranged from 19-59 years. Majority belong to age group of 21 – 30 years (46.6%) followed by 41-50 years (22.2%0. 15.5% belong to the age group of 51 years of age.

Table 4: Gender distribution of study participants

Gender	Frequency	Percentage
Male	54	60 %
Female	36	40 %
Total	**90**	**100 %**

Table 5: Distribution of study participants based on hours of presentation after symptom onset

Hours of presentation	Frequency	Percentage
< 12 Hrs	59	65.6 %
> 12 Hrs	31	34.4 %
Total	**90**	**100 %**

Majority of the study participants (65.6%) presented within 12 hours of symptom onset. 34.4% presented after 12 hours of symptom onset. The duration of symptom onset to presentation ranged from 6 – 36 hours with mean duration 14.8 ± 6.9 hours.

Table 6: Distribution of study participants based on symptoms of presentation

Complaints	Frequency	Percentage
Nausea/ Vomiting	43	47.7 %
Anorexia	68	75.6 %
Pain in Right iliac fossa	90	100 %
Migrating Pain	38	42.3 %
Rebound Tenderness	33	36.7 %
Temperature (37.3 °C)	48	53.4 %

All study participants presented with pain in RIF (100%) followed by anorexia 75.6%, temperature >37. 3o C (53.4%), nausea/vomiting in 47.7%. 42.3% complained of migrating pain, 36.7% of patients with rebound tenderness.

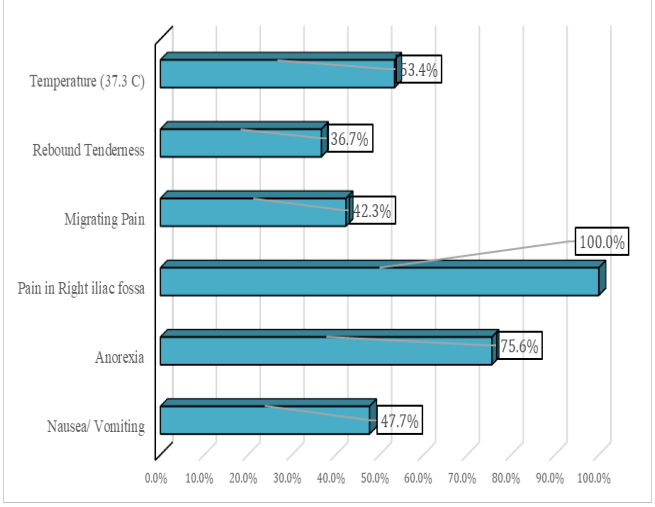

Figure 4: Distribution of study participants based on symptoms of presentation

All the study participants underwent laparoscopic surgery for appendicectomy (100%).

Table 7: Distribution of study participants based on position of appendix

Position of Appendix	Frequency	Percentage
Retrocecal	48	53.3%
Pelvic	40	44.4%
Sub-cecal	2	2.2%
Total	**90**	**100%**

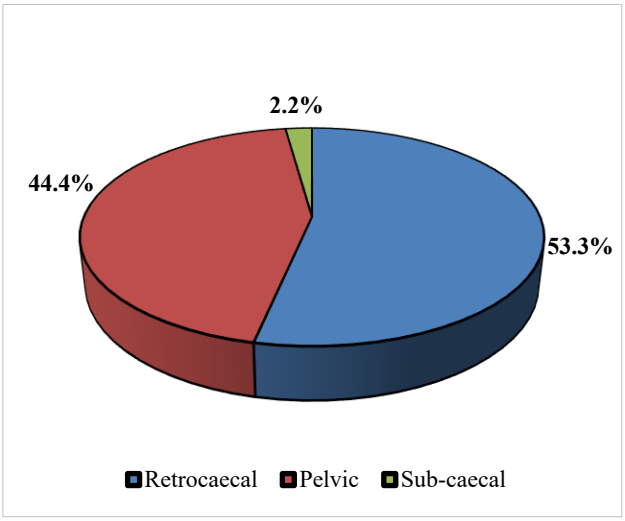

Figure 5: Distribution of study participants based on position of appendix

Table 8: Distribution of study participants based on Alvarado score

ALVARADO Score	Frequency	Percentage
≥ 7	67	74.5 %
< 7	23	25.5 %
Total	**90**	**100 %**

Table 9: Distribution of study participants based on Tzanakis score

TZANAKIS Score	Frequency	Percentage
≥ 8	76	84.4 %
< 8	14	15.6 %
Total	**90**	**100 %**

Table 10: Distribution of study participants based on Histopathological examination

Histopathological Examination	Frequency	Percentage
Acute Appendicitis	86	95.5 %
Appendix with reactive lymphoid hyperplasia	4	4.5 %
Total	**90**	**100 %**

Histopathological examination revealed that 95.5% had acute appendicitis. 4.6% had no appendicitis.

Table 11: Distribution of study participants based on Alvarado score vs Histopathological examination

	Histopathological Examination		
ALVARADO Score	**Acute Appendicitis**	**Appendix with reactive lymphoid hyperplasia**	**Total**
≥ 7	66 (76.7 %)	2 (50 %)	66 (74.4 %)
< 7	20 (23.2 %)	2 (50 %)	20 (25.6 %)
Total	86 (100 %)	4 (100 %)	90 (100 %)

In the present study, 76.7% of the acute appendicitis cases on HPE had Alvarado score of >7. Based on HPE, Alvarado score had a sensitivity of 76.74% (95%CI= 66.39% to 85.18%) and specificity of 50% (95%CI= 6.76% to 93.24%).

Table 12: Distribution of study participants based on Tzanakis score vs Histopathological examination

	Histopathological Examination		
TZANAKIS Score	**Acute Appendicitis**	**Appendix with reactive lymphoid hyperplasia**	**Total**
≥ 8	75 (87.2 %)	1 (25 %)	76 (84.4 %)
< 8	11 (12.7 %)	3 (75 %)	14 (15.6 %)
Total	86 (100 %)	4 (100 %)	90 (100 %)

In the present study, 87.2% of the acute appendicitis cases on HPE had Tzanakis score of >8. Based on HPE, Tzanakis score had a sensitivity of 87.21% (95%CI= 78.27% to 93.44%) and specificity of 75% (95%CI= 19.41% to 99.37%).

Scoring System Performance

- **Alvarado Score:**
  - Sensitivity: 76.74% (95% CI: 66.39–85.18%)
  - Specificity: 50.00% (95% CI: 6.76–93.24%)
- **Tzanakis Score:**
  - Sensitivity: 87.21% (95% CI: 78.27–93.44%)
  - Specificity: 75.00% (95% CI: 19.41–99.37%)

Tzanakis score >8 was observed in 87.2% of histopathologically confirmed cases, while Alvarado score >7 was noted in 76.7% of confirmed cases.

Table 13: Comparison of Tzanakis score and Alvarado score

	TZANAKIS Score	ALVARADO Score
Sensitivity	87.21 %	76.74 %
Specificity	75 %	50 %
Positive Predictive Value	98.68 %	97.06 %
Negative Predictive Value	21.43 %	9.09 %

Discussion

Diagnosing acute appendicitis is often complex for a surgeon because various other pathologies can mimic it. Complications occur as a consequence of late diagnosis which leads to increased morbidity and mortality, whereas early interventions without proper evaluation can lead to increased negative Appendicectomy rates which further increases mortality and morbidity. Therefore, in addition to the clinical evaluation, various scoring systems like alvarado, modified alvarado, tzanakis, ripasa, paediatrics appendicitis, kharbanda, lintula, eskelinen, ohmann scoring system, fenyo-lindberg scoring systems have been implemented to accurately diagnose acute appendicitis. In the present study, 90 patients underwent appendicectomy for suspected clinical and laboratory correlation during the mentioned period for whom Alvarado and tzanaki scoring systems were calculated. All the patients underwent laparoscopic appendicectomy.

Out of them, 4 patients have Appendix with lymphoid proliferation that is 4.4%.

In our study most patients were between 21-30 years of age groups. Appendix in this age group is particularly liable to obstruct and inflamed because of the large proportion of lymphoid tissue it contains. Appendicitis in elderly patients is associated with higher morbidity and mortality because of the late and atypical presentation of appendicitis in this age group; a good index of suspicion and early intervention is important in avoiding perforation and subsequent morbidity. In general, adolescents and young adults (13-40 years) have had the highest incidence of nonperforated appendicitis. Perforated appendicitis occurred at almost the same rate irrespective of age.

Male predominance has been noted in this study in all racial/ethnic groups for most ages. A study by Roger Luckmann *et al.,* also revealed similar findings. Salo *et al.,* state that girls had negative appendectomies more often, despite having more preoperative imaging, and they had operative complications more frequently, despite having less frequent perforations [11].

In this study Pain in RIF, Anorexia, nausea/vomiting, migrating pain were the major presenting complaints in most of the patients. Other symptoms include: Fever, rebound tenderness, migrating pain. Andy *et al.,* in his study states that abdominal pain is the primary presenting complaint in a case of acute appendicitis. Nausea, vomiting, and anorexia occur in varying degrees [12]. Mike Hardin *et al.,* in another study stated that abdominal pain is a common presenting symptom in outpatient care; family physicians play a critical role in the diagnosis of appendicitis [13].

In our study the most common location of the appendix was retrocecal followed by a pelvic presentation. In a study Humaira Naushaba *et al.,* showed that retrocaecal was more common, followed by pelvic and post ileal position [14]. Golalipour, M. J *et al.,* study showed that pelvic location of the appendix is more common, followed by retrocecal in 32.4%, preileal in 18.8%, and subcaecal in 12.8%, respectively [15].

The Alvarado score sensitivity was 76.74% in the present study, which is like many studies of sensitivity of 73-91%. The specificity in this study was 50%. Many studies showed a specificity of 78-92% [16]. The specificity in this study are comparatively very low when compared to other studies [17]. BR Malla *et al.,* also reported the same in their study. In their study; the specificity, sensitivity, positive predictive value, and negative predictive value of Alvarado score was 75.0%, 76.0%, 97.2%, and 21.4% respectively [18]. P. Macklin *et al.,* showed the overall sensitivity of a modified Alvarado score of > or = 7 was 76.3%, and its specificity was 78.8% [19]. Ahmed M. Al-Hashemy *et al.,* published that the overall sensitivity and specificity Alvarado score was 53.8% and 80% respectively [20]. Srivastava UK *et al.,*'s studies showed a specificity and sensitivity of 59.4 and 69.2 respectively [21]. Rodrigues *et al.,* showed a specificity and sensitivity of 75% and 88.8 % [22]. With a sensitivity of 72%, Alvarado score is less sensitive than clinical judgment in excluding acute appendicitis, as stated by Andrew C.Meltzer *et al.,*[25].

Table 14. Sensitivity and specificity of the Alvarado score published by various authors:

Studies	Sensitivity (%) of Alvarado Score	Specificity (%) of Alvarado Score
BR MALLA *et al.,*	75	76
P. Macklin *et al.,*	78.8	76.3
Ahmed M. Al-Hashemy *et al.,*	80	53.8
Srivastava UK *et al.,*	59.4	69.2
Rodrigues *et al.,*	75	88.8
Ayaz Ahmed Memon *et al.,*	88.9	58.2
Andrew C. Meltzer *et al.,*	69	72
Present Study	76.74	50

When compared to other studies, sensitivity is similar in the present study. However specificity is comparatively low.

Some authors used the Tzanakis score as a diagnostic modality for detecting acute appendicitis.

Table 15. Sensitivity and specificity of the Tzanakis score published by various authors:

Studies	Sensitivity (%) of Alvarado Score	Specificity (%) of Alvarado Score
Sidgel *et al.,*	91.4	66.6
Malla. B *et al.,*	86.9	75
Arun Kumar S. *et al.,*	85.4	71.4
Nikolaos E *et al.,*	95.4	97.4
Mulago hospital *et al.,*	100	63.6
Muhammad Mansoor	99	91
Present Study	87.21	76.74

The specificity and sensitivity of the Tzanakis score in this study were 87.21% and 76.74%, respectively. Many other studies also reported the same. In this study, Both the scores have been compared regarding the specificity, sensitivity, positive predictive value, negative predictive value to know which score is preferred to the other. In this study, all the tests of validity were proved to be higher in the Tzanakis score when compared to the Alvarado score. From the results published, we can prefer the Tzanakis score to the Alvarado score and prevent the incidence of negative appendicectomy.

Table 16. List of studies that proved Tzanakis score superior to the Alvarado in diagnosing acute appendicitis [27-31]

Author	Result
In this study	Tzanakis score was superior
Sidgel GS *et al.,*	Tzanakis score was superior
Malla B *et al.,*	Tzanakis score was superior
Harsha Hedge *et al.,*	Tzanakis score was superior
Anoop Sharma *et al.,*	Alvarado score was superior
S. Dharmarajan *et al.,*	Tzanakis score was superior
R. Anupriya *et al.,*	Tzanakis score was superior

Faris Muhammed *et al.,*	Tzanakis score was superior
Arvind Raj, R *et al.,*	Tzanakis score was superior
Shahid-ul-Haq Dar *et al.,*	Tzanakis score was superior

Due to good clinical examination, imaging modalities like Contrast enhanced CT, Diagnostic Laparoscopy appendicectomy rates have been very low in our institute. The specificity, sensitivity, positive predictive value, negative predictive value was more in favor of the Tzanakis score when compared to the Alvarado score. This study shows that the usage of the Tzanakis score is very helpful in diagnosing acute appendicitis when compared to the Alvarado score.

Conclusion

Acute appendicitis is one of the most common infections predominantly affecting teenagers and in early adulthood. Early diagnosis and treatment is crucial. This study compared the two scoring systems, namely Alvarado and Tzanakis scoring systems and demonstrates that while both are valuable diagnostic tools, the Tzanakis score exhibits superior sensitivity, specificity, and overall diagnostic accuracy when correlated with histopathological findings.

Incorporating the Tzanakis score into clinical practice, particularly in resource-limited settings, may significantly enhance diagnostic confidence and reduce the rate of negative appendectomies. A structured approach combining detailed clinical evaluation, laboratory markers, and imaging findings—hallmarks of the Tzanakis scoring system—proves to be more reliable in guiding surgical decision-making for suspected acute appendicitis.

Abbreviation

RIF: Right Iliac Fossa
HPE: Histopathological Examination
CI: Confidence Interval
CT: Computed Tomography
°C: Degree Celsius (Temperature)
PPV: Positive Predictive Value
NPV: Negative Predictive Value
CECT: Contrast-Enhanced Computed Tomography
USG: Ultrasonography
Dept: Department
%: Percent

Declaration

Ethics approval and consent to participate

Written informed consent was obtained from the patient. Ethics committee approval was obtained. [Reference number: CSP-MED/22/MAR/75/43]

Consent for publication

I on behalf of all co-authors, hereby give my consent for publication of the manuscript in your esteemed journal.

Availability of supportive data

If needed, we give consent to provide supplementary Data.

Competing Interests

None

Funding Statement

None

Author's contributions

Monisha P and Kodali Adiseshu was involved in data collection and drafting the manuscript, Kishor RJ and Prof Mohanapriya T were involved in reviewing, editing and finalising the manuscript

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None

Conflict of interest

The authors have no conflicts of interest to declare

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