Section: General Surgery

Original Research Article

PROSPECTIVE COMPARATIVE STUDY OF TZANAKIS SCORE VERSUS ALVARADO SCORE IN THE DIAGNOSIS OF ACUTE APPENDICITIS

Nitansh Patidar[1], Gita Patel[2], Urvish Doshi[3]

[1]*Third Year Resident, Department of General Surgery, Sheth Vadilal Sarabhai General Hospital and Sheth Chinai Maternity Hospital, Ahmedabad, Gujarat, India.*
[2]*Senior Consultant (DNB Faculty) and HOD, Department of General Surgery, Sheth Vadilal Sarabhai General Hospital and Sheth Chinai Maternity Hospital, Ahmedabad, Gujarat, India.*
[3]*Professor, Department of General Surgery, Shri Satsangi Medical & Research Institute, Vadsma , Mehsana, Gujarat, India.*

Received *: 23/03/2026*
Received in revised form *: 10/05/2026*
Accepted *: 27/05/2026*

Corresponding Author:
Dr. Nitansh Patidar,
Third Year Resident, Department of General Surgery, Sheth Vadilal Sarabhai General Hospital and Sheth Chinai Maternity Hospital, Ahmedabad, Gujarat, India.
Email: nitansh1798@gmail.com

DOI: 10.70034/ijmedph.2026.2.461

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 2787-2792

ABSTRACT

Background: Acute appendicitis remains one of the most common surgical emergencies, and prompt diagnosis is essential to reduce morbidity and unnecessary appendectomies. Clinical scoring systems such as the Alvarado and Tzanakis scores are widely used to aid diagnosis. This study compared the diagnostic performance of the Tzanakis score with the Alvarado score in patients with suspected acute appendicitis.

Materials and Methods: A prospective observational comparative study was conducted from March 2024 to December 2025 in the Department of General Surgery at tertiary care teaching hospitals in Ahmedabad. A total of 160 adult patients with suspected acute appendicitis were enrolled. All patients underwent detailed clinical evaluation, laboratory investigations, ultrasonography, and assessment using both Alvarado and Tzanakis scoring systems. Histopathological examination of the resected appendix served as the reference standard.

Results: Among 160 patients, 55.6% were males and the majority belonged to the 31–50 years age group (51.2%). Right iliac fossa pain was present in all patients, while leucocytosis was observed in 76.9%. The Alvarado score demonstrated sensitivity, specificity, and diagnostic accuracy of 63.79%, 90.91%, and 71.25%, respectively. The Tzanakis score showed significantly higher sensitivity (97.41%), specificity (93.18%), and overall diagnostic accuracy (96.25%). ROC curve analysis revealed a higher area under the curve for the Tzanakis score (0.9124) compared to the Alvarado score (0.7984) with statistical significance ($p<0.0001$).

Conclusion: The Tzanakis scoring system demonstrated superior diagnostic accuracy compared to the Alvarado score and may serve as a more reliable tool for the diagnosis of acute appendicitis.

Keywords: Acute appendicitis, Alvarado score, Tzanakis score, diagnostic accuracy, ultrasonography, appendectomy.

INTRODUCTION

Acute appendicitis is among the most frequent causes of acute abdominal pain requiring emergency surgical intervention worldwide.[1] Despite advances in imaging modalities and laboratory diagnostics, establishing an accurate diagnosis remains challenging because of variable clinical presentations and overlap with other intra-abdominal pathologies.[2] Delayed diagnosis may lead to complications such as perforation, abscess formation, peritonitis, and increased postoperative morbidity, whereas overdiagnosis contributes to unnecessary appendectomies and avoidable healthcare expenditure.[1,2]

Traditionally, the diagnosis of acute appendicitis has relied on a combination of clinical history, physical examination, laboratory investigations, and imaging

findings.[3] However, no single clinical feature or laboratory parameter possesses sufficient diagnostic accuracy when used independently. In recent years, several clinical scoring systems have been developed to improve diagnostic precision, reduce negative appendectomy rates, and facilitate early surgical decision-making, especially in resource-limited settings.[3,4]

Among the available scoring systems, the Alvarado score remains one of the most widely utilized tools due to its simplicity and ease of application.[4] The score incorporates symptoms, clinical signs, and leukocyte count to stratify the probability of appendicitis. Although the Alvarado score demonstrates good specificity, studies have reported variable sensitivity across different populations, limiting its reliability as a standalone diagnostic modality.[4,5]

The Tzanakis scoring system was subsequently introduced as a combined clinicoradiological approach integrating physical examination findings, leukocytosis, and ultrasonographic evidence of appendicitis.[5] By incorporating ultrasonographic parameters, the Tzanakis score has been reported to provide superior diagnostic accuracy and better correlation with histopathological findings compared to purely clinical scoring methods.[5,6]

Recent systematic reviews and comparative studies have emphasized the importance of validated diagnostic scoring systems in improving the management of suspected appendicitis while minimizing unnecessary surgical interventions.[1,3] Nevertheless, variability in diagnostic performance across different geographic regions and healthcare settings necessitates further evaluation of these scoring systems in local populations.[6] Therefore, the present study was undertaken to compare the diagnostic accuracy of the Tzanakis score and Alvarado score in patients presenting with suspected acute appendicitis at a tertiary care teaching hospital.

MATERIALS AND METHODS

Study Design and Duration: This prospective observational comparative study was conducted over a period of 22 months from March 2024 to December 2025.

Study Setting: The study was carried out in the Department of General Surgery at Sheth Vadilal Sarabhai General Hospital and Sheth Chinai Prasuti General Hospital, tertiary care teaching hospitals affiliated with a medical teaching institute in Ahmedabad, Gujarat, India.

Study Population: The study population comprised all adult patients presenting to the Department of General Surgery with clinical suspicion of acute appendicitis during the study period.

Inclusion Criteria

- Patients presenting with right lower quadrant abdominal pain or clinically suspected acute appendicitis.
- Patients aged 18 years or older.
- Patients willing to provide written informed consent for participation.

Exclusion Criteria

- Patients diagnosed clinically with appendicular lump.
- Pregnant women.

Sample Size Calculation: The sample size was estimated using the formula for comparison of sensitivities between two diagnostic modalities:

$$n = \frac{\left[Z_{\frac{\alpha}{2}}\sqrt{2 \times \bar{P}(1-\bar{P})} + Z_{\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\right]^2}{(P_1-P_2)^2}$$

Where:

- n = required sample size
- For $\alpha = 0.05$ (95%CI) and $\beta = 0.20$ (80% power), $Z\alpha/2 = 1.96$ and $Z\beta = 0.84$ respectively.
- P1 = Sensitivity of first diagnostic test while P2 = Sensitivity of second diagnostic test.
- P is the average of P1 and P2.

The sensitivity values were derived from the reference study conducted by Datta SL. Substituting the values into the formula yielded a minimum required sample size of 61 participants. However, during the study period, a total of 160 eligible patients were enrolled consecutively.

Study Methodology: Demographic details, clinical history, physical examination findings, laboratory investigations, ultrasonographic findings, operative findings, and histopathological reports were recorded using a structured proforma.

Laboratory Investigations: All enrolled patients underwent routine baseline investigations including:

- Complete blood count (CBC)
- Liver function tests (LFT)
- Renal function tests (RFT)
- Random blood sugar (RBS)
- Prothrombin time and international normalized ratio (PT-INR)
- HIV serology
- Hepatitis B surface antigen (HBsAg)
- Hepatitis C virus (HCV) serology
- Serum electrolytes

Ultrasonographic Evaluation: All participants underwent abdominal ultrasonography. Ultrasonographic findings suggestive of acute appendicitis included:

- Enlarged non-compressible appendix with diameter greater than 6 mm
- Presence of peri-appendiceal fluid collection
- Increased echogenicity of peri-appendiceal fat
- Presence of appendicolith or localized abscess formation

Scoring Systems: The Alvarado scoring system consists of eight clinical and laboratory parameters, including migration of pain to the right iliac fossa, anorexia, nausea or vomiting, right lower quadrant tenderness, rebound tenderness, fever, leukocytosis, and neutrophilic left shift. The maximum obtainable score is 10.

In the present study

- A score of 5–6 was considered suggestive of probable appendicitis requiring further evaluation.
- A score of ≥7 was considered highly suggestive of acute appendicitis.

The Tzanakis scoring system incorporates the following variables:

- Right lower quadrant tenderness
- Rebound tenderness (Blumberg sign)
- Leukocytosis (>12,000 cells/mm³)
- Positive ultrasonographic findings suggestive of appendicitis

Patients with a Tzanakis score ≥8 were considered likely to have acute appendicitis and were considered candidates for surgical intervention. Patients with scores below the defined cutoff values were not excluded from operative management if the treating surgeon considered surgery clinically indicated.

Reference Standard: The final diagnosis of acute appendicitis was established by histopathological examination of the resected appendix specimen, which served as the gold standard for assessment of diagnostic accuracy.

Diagnostic Performance Assessment: The diagnostic performance of the Alvarado and Tzanakis scoring systems was evaluated using the following parameters:

- **Sensitivity:** proportion of true positive cases correctly identified by the test.
- **Specificity:** proportion of true negative cases correctly identified by the test.
- **Positive Predictive Value (PPV):** proportion of positive test results that were true positives.
- **Negative Predictive Value (NPV):** proportion of negative test results that were true negatives.
- **Diagnostic Accuracy:** overall proportion of correctly classified cases among all evaluated participants.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) software version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were represented as frequencies and percentages. Comparisons between quantitative variables were performed using Student's *t*-test for normally distributed variables and one-way analysis of variance (ANOVA) where appropriate. Qualitative variables were analyzed using the Chi-square test or Fisher's exact test as applicable. Sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy were calculated for both scoring systems. A *p*-value ≤0.05 was considered statistically significant.

Subject Confidentiality: Patient confidentiality was strictly maintained throughout the study. Personal identifiers including names, addresses, and contact information were excluded from study records, analyses, and publications. Data collection forms and consent documents were stored securely and accessed only by the investigators. Informed consent documents were provided in languages understandable to the study participants.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee prior to initiation of the study. Written informed consent was obtained voluntarily from all participants before enrolment. The study was conducted in accordance with institutional ethical standards and principles governing biomedical research involving human participants.

RESULTS

A total of 160 patients clinically suspected to have acute appendicitis were enrolled during the study period. Among them, 89 (55.6%) were males and 71 (44.4%) were females. The majority of the study population belonged to the 31–50 years age group (51.2%), followed by 18–30 years (41.9%) and 51–65 years (6.9%). The overall mean Tzanakis score was 11.9 ± 4.3, while the mean Alvarado score was 7.3 ± 1.3. Female patients demonstrated a slightly higher mean Tzanakis score compared to males (12.3 ± 4.1 vs 11.6 ± 4.4), whereas the mean Alvarado scores were comparable between both sexes. Increasing age was associated with higher mean Tzanakis and Alvarado scores, with the highest values observed in the 51–65 years age group (Table 1).

Clinical presentation of the study participants is summarized in Table 2. Right iliac fossa (RIF) pain was present in all patients (100%), while RIF tenderness was observed in 98.8% of cases. Nausea and vomiting were reported in 80.0% of patients, and anorexia was present in 75.0%. Leucocytosis was detected in 76.9% of patients. Guarding and Rovsing sign were each noted in 69.4% of cases, whereas rebound tenderness and symptom duration of less than 48 hours were present in 68.1% of patients. Fever was documented in 45.0% of participants, while migration of pain to the right iliac fossa was observed in only 6.3% of cases (Table 2).

The diagnostic performance of the Alvarado score is presented in Table 3. The Alvarado scoring system demonstrated a sensitivity of 63.79% and specificity of 90.91%. The positive predictive value (PPV) and negative predictive value (NPV) were 94.87% and 48.78%, respectively. The overall diagnostic accuracy of the Alvarado score was 71.25%.

In comparison, the Tzanakis score demonstrated markedly superior diagnostic performance (Table 4). The sensitivity and specificity of the Tzanakis score were 97.41% and 93.18%, respectively. Both the PPV and sensitivity were 97.41%, while the NPV was 93.18%. The overall diagnostic accuracy of the Tzanakis score was 96.25%.

Receiver operating characteristic (ROC) curve analysis further confirmed the superior discriminatory ability of the Tzanakis scoring system over the Alvarado score (Table 5). The area under the curve (AUC) for the Tzanakis score was 0.9124 (95%

CI: 0.8459–0.9890), compared to 0.7984 (95% CI: 0.7268–0.8736) for the Alvarado score. This difference was statistically highly significant ($p < 0.0001$). The ROC curve of the Tzanakis score is illustrated in Figure 1.

Association between key diagnostic findings and histopathological confirmation of appendicitis is shown in Table 6. Among patients with leucocytosis, 78.0% were histopathologically positive for appendicitis, whereas 54.1% of patients without leucocytosis also demonstrated positive histopathology. Ultrasonographic findings suggestive of appendicitis showed a strong correlation with histopathological positivity, with 97.4% of such patients confirmed to have appendicitis. Conversely, among patients with normal ultrasonography, only 6.8% were histopathologically positive (Table 6).

Regarding operative management, open appendectomy was performed in 121 patients (75.6%), while laparoscopic appendectomy was carried out in 39 patients (24.4%) (Table 7). The mean Tzanakis score was 11.8 ± 4.4 in the open appendectomy group and 12.1 ± 4.0 in the laparoscopic group. Similarly, the mean Alvarado scores were 7.4 ± 1.3 and 7.3 ± 1.2, respectively. No statistically significant difference was observed between surgical approaches with respect to either Tzanakis score ($p = 0.7057$) or Alvarado score ($p = 0.6711$).

Table 1: Demographic Characteristics

Demographic Variable	N	Percentage (%)	Mean Tzanakis Score ± SD	Mean Alvarado Score ± SD
Male	89	55.6	11.6 ± 4.4	7.3 ± 1.3
Female	71	44.4	12.3 ± 4.1	7.4 ± 1.2
18–30 years	67	41.9	11.5 ± 4.5	7.1 ± 1.3
31–50 years	82	51.2	12.0 ± 4.1	7.3 ± 1.3
51–65 years	11	6.9	13.2 ± 3.6	7.7 ± 1.2
Total	160	100.0	11.9 ± 4.3	7.3 ± 1.3

Table 2: Clinical Presentation

Clinical Finding	Frequency (N)	Percentage (%)
RIF Pain	160	100.0
RIF Tenderness	158	98.8
Nausea and Vomiting	128	80.0
Anorexia	120	75.0
Leucocytosis	123	76.9
Guarding	111	69.4
Rovsing Sign	111	69.4
Rebound Tenderness	109	68.1
Symptoms < 48 hours	109	68.1
Pain Migration to RIF	10	6.3
Fever	72	45.0

Table 3: Diagnostic Accuracy of Alvarado Score

Diagnostic Parameter	Value (%)	95% Confidence Interval
Sensitivity	63.79	54.35–72.51
Specificity	90.91	78.33–97.47
Positive Predictive Value	94.87	87.80–97.94
Negative Predictive Value	48.78	42.37–55.24
Overall Accuracy	71.25	63.57–78.12

Table 4: Diagnostic Accuracy of Tzanakis Score

Diagnostic Parameter	Value (%)	95% Confidence Interval
Sensitivity	97.41	92.63–99.46
Specificity	93.18	81.34–98.57
Positive Predictive Value	97.41	92.66–99.12
Negative Predictive Value	93.18	81.69–97.67
Overall Accuracy	96.25	92.02–98.61

Table 5: ROC Curve Analysis Comparison

ROC Statistic	Tzanakis Score	Alvarado Score	P-value
Area Under Curve (AUC)	0.9124	0.7984	< 0.0001
95% CI	0.8459–0.9890	0.7268–0.8736	—

Table 6: Association of Key Diagnostic Findings with Histopathology

Diagnostic Finding	Positive (N)	Positive (%)	Negative (N)	Negative (%)
Leucocytosis Present (n=123)	96	78.0	27	22.0
No Leucocytosis (n=37)	20	54.1	17	45.9
USG Suggestive (n=116)	113	97.4	3	2.6
USG Normal (n=44)	3	6.8	41	93.2

Table 7: Surgical Procedure Distribution

Surgical Approach	N	Percentage (%)	Mean Tzanakis ± SD	Mean Alvarado ± SD
Open Appendectomy	121	75.6	11.8 ± 4.4	7.4 ± 1.3
Laparoscopic Appendectomy	39	24.4	12.1 ± 4.0	7.3 ± 1.2
P-value	—	—	0.7057	0.6711

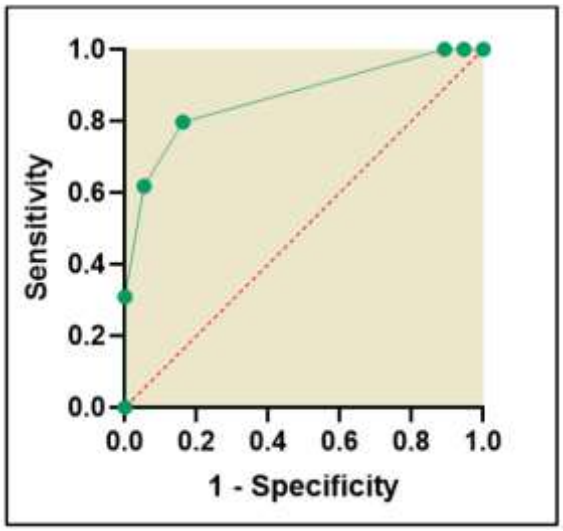

Figure 1: ROC Curve of Tzanaki's Score

DISCUSSION

Accurate and timely diagnosis of acute appendicitis continues to represent a major challenge in emergency surgical practice because of its variable clinical presentation and overlap with several abdominal pathologies.[8] Delayed diagnosis may increase the risk of perforation and postoperative morbidity, whereas unnecessary surgery contributes to negative appendectomy rates and avoidable healthcare burden.[9] Consequently, various clinical scoring systems have been developed to improve diagnostic precision and facilitate early surgical decision-making.

In the present study, males constituted 55.6% of the study population, with the majority of patients belonging to the 31–50 years age group. Similar male predominance has been reported in previous studies evaluating appendicitis scoring systems.[8,10] Right iliac fossa pain and tenderness were the most frequent clinical findings in our study, observed in 100% and 98.8% of patients, respectively. These findings are consistent with earlier reports emphasizing right lower quadrant tenderness as the most reliable clinical indicator of acute appendicitis.[11]

The Alvarado score in the present study demonstrated a sensitivity of 63.79%, specificity of 90.91%, and overall diagnostic accuracy of 71.25%. Comparable findings were observed by Mán et al., who reported that although the Alvarado score remains clinically useful because of its simplicity, its sensitivity varies considerably across patient populations.[12] Similarly, Sharma et al. observed that the Alvarado score had relatively lower sensitivity and was more useful for ruling in appendicitis rather than excluding the disease.[13]

In contrast, the Tzanakis score demonstrated markedly superior diagnostic performance in the present study, with sensitivity, specificity, and overall diagnostic accuracy of 97.41%, 93.18%, and 96.25%, respectively. These findings correlate closely with the recent systematic review and meta-analysis conducted by Alnafisah et al., which demonstrated higher pooled sensitivity and area under the curve for the Tzanakis score compared with the Alvarado score.[9] A recent prospective observational study by Monisha et al. also reported superior sensitivity and predictive accuracy of the Tzanakis score in comparison with the Alvarado score.[14]

The enhanced diagnostic performance of the Tzanakis scoring system may be attributed to incorporation of ultrasonographic findings along with clinical examination and leukocyte count. In the present study, ultrasonography suggestive of appendicitis showed a strong association with histopathological positivity, with 97.4% of such patients confirmed to have appendicitis. Similar observations were reported in comparative studies evaluating combined clinicoradiological scoring systems.[10,15] ROC curve analysis in the present study further demonstrated significantly superior discriminatory ability of the Tzanakis score (AUC 0.9124) compared to the Alvarado score (AUC 0.7984), supporting findings from recent meta-analyses and comparative investigations.[9,16]

The present study also demonstrated that open appendectomy remained the predominant surgical approach, performed in 75.6% of patients, although no significant difference in mean scoring values was observed between open and laparoscopic procedures. Ghali et al. similarly reported that clinical scoring systems are valuable adjuncts irrespective of operative technique and may assist in optimizing patient stratification and surgical planning.[8]

Despite its strengths, the present study had certain limitations. Being a single-center study, the findings may not be universally generalizable. Additionally, ultrasonographic evaluation is operator-dependent and may influence the Tzanakis score. Nevertheless, the prospective design, adequate sample size, and histopathological confirmation of diagnosis strengthen the reliability of the study findings.

CONCLUSION

The present study demonstrated that both the Alvarado and Tzanakis scoring systems are useful adjuncts in the clinical diagnosis of acute appendicitis; however, the Tzanakis score showed significantly superior diagnostic performance. The Tzanakis scoring system exhibited higher sensitivity,

specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy compared to the Alvarado score. Integration of clinical examination findings with ultrasonographic evaluation and laboratory parameters contributed to its enhanced predictive capability. Therefore, the Tzanakis score may serve as a more reliable and effective diagnostic tool for early identification of acute appendicitis, facilitating timely surgical intervention and potentially reducing the rate of negative appendectomies and diagnostic delays.

REFERENCES

1. Vaos G, Zavras N. Update on the Diagnosis and Treatment of Acute Appendicitis. J Clin Med. 2024 Dec 2;13(23):7343. doi: 10.3390/jcm13237343.
2. Gan DEY, Nik Mahmood NRK, Chuah JA, Hayati F. Performance and diagnostic accuracy of scoring systems in adult patients with suspected appendicitis. Langenbecks Arch Surg. 2023 Jul 6;408(1):267. doi: 10.1007/s00423-023-02991-5.
3. Alvarez-Lozada LA, Fernandez-Reyes BA, Arrambide-Garza FJ, García-Leal M, Alvarez-Villalobos NA, Martínez-Garza JH, et al. Clinical scores for acute appendicitis in adults: A systematic review and meta-analysis of diagnostic accuracy studies. Am J Surg. 2025;240:116123. doi:10.1016/j.amjsurg.2024.116123.
4. Rajah HK, Menon S. Clinical scoring systems in acute appendicitis-current perspectives-review article. Int J Integr Med Res. 2023;10(3):73-82. doi:10.57181/ijoimr/vol10i03/125.
5. Malla BR, Batajoo H. Comparison of Tzanakis score vs Alvarado score in the effective diagnosis of acute appendicitis. Kathmandu Univ Med J (KUMJ). 2014 Jan-Mar;12(45):48-50. doi: 10.3126/kumj.v12i1.13638. PMID: 25219994.
6. Erum U, Feroz R, Gul A, Kazim E, Zulfikar I, Khalid OB. Acomparative analysis of the diagnostic accuracy of appendicitisscoring system using histopatholotgy as the gold standard. J Surg Pakistan. 2024:29(2):34-38.
7. Datta SK, Mohan MR, Teja PL. Comparative Study of Tzanakis Score vs Alvarado Score in the Effective Diagnosis of Acute Appendicitis. Int J Dent Med Sci Res. 2022;4(1):792-811..
8. Ghali MS, Hasan S, Al-Yahri O, Mansor S, Al-Tarakji M, Obaid M, et al. Adult appendicitis score versus Alvarado score: A comparative study in the diagnosis of acute appendicitis. Surg Open Sci. 2023 Jul 20;14:96-102. doi: 10.1016/j.sopen.2023.07.007.
9. Awan AR, Khan ZU, Saleem H, Iqbal H, Ahmad W, Khan AR, Farooqi M. A comparison of the accuracy of Tzanakis and Alvarado score in the diagnosis of acute appendicitis: A systematic review and meta-analysis. Surgeon. 2024;22:e164-e170. doi:10.1016/j.surge.2024.04.013.
10. Sharma P, Jain A, Shankar G, Jinkala S, Kumbhar US, Shamanna SG. Diagnostic accuracy of Alvarado, RIPASA and Tzanakis scoring system in acute appendicitis: A prospective observational study. Trop Doct. 2021;51(4):475-481. doi:10.1177/00494755211030165.
11. Khan S, Usama M, Basir Y, Muhammad S, Jawad M, Khan T, et al. Evaluation Of Modified Alvarado, Ripasa And Lintula Scoring System As Diagnostic Tools For Acute Appendicitis. J Ayub Med Coll Abbottabad. 2020 Jan-Mar;32(1):46-50.
12. Mán E, Szilágyi A, Simonka Z, Rárosi F, Pető Z, Lázár G. Validation of the modified Alvarado score on patients attending A&E units with suspected appendicitis. BMC Emerg Med. 2023 Aug 10;23(1):87. doi: 10.1186/s12873-023-00846-2.
13. Sharma D, Koujalagi RS. A comparative study to assess efficacy of Tzanakis score and Alvarado score for effective diagnosis of patients with acute appendicitis at a tertiary care centre in North Karnataka: A one-year prospective analytical study. Int Surg J. 2020;7(6):1742-1745. doi:10.18203/2349-2902.isj20202091.
14. Monisha P, Adiseshu K, Kishor RJ, Mohanapriya T. Comparative evaluation of Tzanakis and Alvarado scoring systems in the diagnosis of acute appendicitis: A prospective observational study. Ann Med Med Sci. 2025;4(14):1651-1656.
15. Yadav H, Agrawal P, Hussain S, Dhananjay T. A study comparing modified Alvarado score and Tzanakis score for diagnosing acute appendicitis. J Neonatal Surg. 2025;14(28S):549-554.
16. Alam SI, Rahman MM, Mansur A, Khurshid MR. Comparison of the Alvarado, Acute Inflammatory Response (AIR) and Raja Isteri Pengiran Anak Saleha Appendicitis (RIPASA) Scoring Systems for Diagnosing Acute Appendicitis. Mymensingh Med J. 2026 Jan;35(1):199-204.