ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

Journal of Dermatological Case Reports

Evaluation of Diagnostic Accuracy of the Alvarado Scoring System in Predicting Acute Appendicitis: A Prospective Observational Study from a Tertiary Care Hospital in the Hilly Region of Northern India

[1]Dr. Y Kumar, [2]Dr. S. Thakur

[1]Assistant Professor, Department of General Surgery, Dr. Radhakrishnan Government Medical College, Hamirpur (HP), India

[2]Assistant Professor, Department of General Surgery, Amaltas Institute of Medical Sciences, Dewas (MP), India

Corresponding Author

Dr. Y Kumar
Assistant Professor
Dept. of General Surgery
Dr. Radhakrishnan Government Medical College, Hamirpur (HP)

Abstract:

Background: Acute appendicitis remains a leading cause of emergency abdominal surgery. The Alvarado Scoring System (ASS) is a well-established clinical tool, yet its performance in specific geographic and demographic contexts—such as the hilly regions of Northern India—requires validation. This study evaluated the diagnostic accuracy of the Alvarado score in a tertiary care setting in Himachal Pradesh.
Keywords:

Methods: A prospective observational study was conducted from May 2021 to April 2022. Eighty-four patients (age ≥12 years) with suspected appendicitis were enrolled. Alvarado scores were calculated at admission. All patients underwent appendectomy, and histopathological examination (HPE) served as the gold standard. Diagnostic metrics were calculated at a cut-off of ≥7.

Results: Histopathology confirmed acute appendicitis in 79 out of 84 patients (94.05%). At a cut-off of ≥7, the sensitivity was 86.08% (95% CI: 76.0–92.7%) and specificity was 60.00% (95% CI: 14.7–94.7%). The positive predictive value (PPV) was exceptionally high at 97.14%, while the negative predictive value (NPV) was 21.43%. The overall diagnostic accuracy was 84.52%, with an area under the ROC curve (AUC) of 0.89.

Conclusion: The Alvarado score is a robust "rule-in" tool in high-prevalence settings but lacks the sensitivity to "rule out" the disease when scores are low. In hilly terrains where imaging is often delayed, a score ≥7 justifies surgical intervention, whereas lower scores necessitate vigilant serial clinical observation.

Keywords:

Acute appendicitis, Alvarado Score, Diagnostic accuracy, Hilly region, Northern India, Surgical emergency.

Received : 03-02-2025 **Revised : 20-02-2025** **Accepted: 26-03-2025** **Published : 24-04-2025**

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

Introduction

Acute appendicitis remains one of the most common surgical emergencies worldwide, with a lifetime risk of approximately 7-8% [1,2]. Prompt and accurate diagnosis is crucial to prevent complications such as perforation, peritonitis, and abscess formation, while simultaneously avoiding unnecessary appendectomies [2]. Clinical scoring systems have been developed to aid in the diagnostic process, particularly in settings where advanced imaging modalities may be limited or not readily available [4].

The Alvarado Scoring System, introduced by Alvarado in 1986, is a widely adopted clinical prediction tool that combines symptoms (migratory right iliac fossa pain, anorexia, nausea/vomiting), signs (right iliac fossa tenderness, rebound tenderness), and laboratory findings (leukocytosis, shift to the left of neutrophils) to generate a score ranging from 0 to 10 [3]. A higher score indicates a greater likelihood of Acute Appendictis. The Alvarado Scoring System is valued for its simplicity, cost-effectiveness, and non-invasiveness, making it particularly attractive for use in diverse healthcare settings, including those in developing countries or remote regions [4, 6].

Over the past two decades, numerous studies have evaluated the diagnostic accuracy of the Alvarado score across various populations and geographical locations. A systematic review by Ohle et al. (2011) concluded that the Alvarado score, particularly at a cut-off of 5, performs well as a “rule out” criterion, demonstrating high sensitivity [4]. However, its specificity has been shown to be variable, often lower in populations with a high prevalence of appendicitis or when used selectively in surgical pathways [4, 11]. More recent meta-analyses, such as that by Gupta et al. (2023), have also highlighted the high predictability of the Alvarado score in acute appendicitis [5].

Despite its widespread use, the performance of the Alvarado score can vary significantly depending on the demographic characteristics of the patient cohort, the local prevalence of appendicitis, and the availability of adjunctive diagnostic tools [4, 11]. For instance, studies comparing the Alvarado score with newer scoring systems like RIPASA (Raja Isteri Pengiran Anak Saleha Appendicitis) and AIR (Appendicitis Inflammatory Response) scores have shown mixed results. Some studies suggest that RIPASA and AIR scores may offer superior diagnostic accuracy, particularly in terms of sensitivity and negative predictive value, compared to the Alvarado score [6, 7, 8, 9, 10]. However, the Alvarado score remains the most studied and widely recognized tool [11].

In low-resource settings, such as the hilly terrains of Northern India, diagnostic challenges are often compounded by delayed presentation, limited access to advanced imaging like computed tomography (CT) scans, and a reliance on clinical judgment and basic laboratory tests [12,13,14]. Understanding the performance of clinical scoring systems like the Alvarado score in such specific contexts is crucial for optimizing patient management and improving outcomes.

Previous research has indicated that the Alvarado score’s performance can be inconsistent, with varying sensitivity and specificity reported across different Asian populations [11].

This study aimed to evaluate the diagnostic accuracy of the Alvarado score in patients presenting with suspected appendicitis to a tertiary care hospital serving a predominantly hilly, rural population in Northern India.

Material and methods

Study Design and Setting

This prospective observational study was conducted between May 2021 and April 2022 at Dr.

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

Radhakrishnan Government Medical College, Hamirpur, Himachal Pradesh, a tertiary care hospital serving a hilly region of Northern India. The study protocol received approval from the institutional ethics committee, and written informed consent was obtained from all participants or their legal guardians prior to enrollment.

Participants

Inclusion Criteria: Patients aged ⩾ 12 years presenting with right iliac fossa pain and clinical diagnosis of acute appendicitis who subsequently underwent appendectomy and provided informed consent were included in the study.

Exclusion Criteria: Patients with a history of prior appendectomy, known chronic inflammatory bowel disease, pregnancy, generalized peritonitis due to other causes, or those managed conservatively without histopathological confirmation were excluded from the study.

Index Test and Reference Standard

Alvarado scores (ranging from 0 to 10) were calculated prospectively at presentation for each patient using standard criteria:

Criterion	Pts
Migrating pain to RIF	**1**
Anorexia	**1**
Nausea/vomiting	**1**
Tenderness in RIF	**2**
Rebound tenderness	**1**
Elevated temperature	**1**
Leukocytosis	**2**
Shift to left	**1**

The definitive reference standard for the diagnosis of acute appendicitis was histopathological examination (HPE) of the resected appendix, which was interpreted by a pathologist blinded to the patient's Alvarado score.

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics. Continuous variables are presented as mean ± standard deviation (SD), while categorical variables are reported as counts and percentages. The diagnostic accuracy of the Alvarado score was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), overall accuracy. These metrics were determined at the prespecified primary cut-off point of ⩾7 for the Alvarado score. Receiver operating characteristic (ROC) curve analysis was performed to determine the area under the curve (AUC) as a measure of the overall diagnostic performance of the Alvarado score. A significance threshold of $p < 0.05$ was used where applicable. All statistical analyses were performed using standard statistical software.

Results

Baseline Characteristics

A total of 84 patients with suspected acute appendicitis were enrolled and underwent appendectomy. The study cohort had a slight male preponderance (57.1%) and a mean age of 32.6 years. Notably, over 72% of the participants hailed from rural hilly areas, reflecting the hospital's catchment demographic. The mean duration of symptoms prior to presentation was 48.6 hours, indicating a relatively delayed presentation common in this terrain. Detailed demographic and clinical profiles are presented in Table 1.

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (N=84).

Variable	Statistics
Age (years)	
Mean ± SD	**32.6 ± 14.2**
Range	**12 – 68**
Gender, n (%)	
Male	**48 (57.1%)**
Female	**36 (42.9%)**
Geographic Residence, n (%)	
Rural Hilly	**61 (72.6%)**
Urban Hill	**23 (27.4%)**
Clinical Presentation	
Mean Duration of Pain (hours) ± SD	**48.6 ± 32.4**
Surgical Management, n (%)	
Open Appendectomy	**58 (69.0%)**
Laparoscopic Appendectomy	**26 (31.0%)**
Pathological Outcome, n (%)	
HPE Confirmed Acute Appendicitis	**79 (94.05%)**
Negative Appendectomy (Normal Appendix)	**5 (5.95%)**

Diagnostic Performance of the Alvarado Score

Histopathological examination confirmed acute appendicitis in 79 out of 84 resected specimens (94.05%). Using a cut-off score of ⩾7, the Alvarado Scoring System correctly identified 68 cases (True Positives). The performance metrics, including confidence intervals for sensitivity and specificity, are summarized in Table 2.

Table 2: Diagnostic Accuracy Metrics of Alvarado Score at Cut-off ⩾7.

Metric	Value	95% Confidence Interval
Sensitivity	**86.08%**	**76.0% – 92.7%**
Specificity	**60.00%**	**14.7% – 94.7%**
Positive Predictive Value (PPV)	**97.14%**	**90.0% – 99.2%**
Negative Predictive Value (NPV)	**21.43%**	**9.7% – 41.1%**
Overall Accuracy	**84.52%**	**75.0% – 91.5%**

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

Metric	Value	95% Confidence Interval
Area Under ROC Curve (AUC)	**0.89**	**0.79 – 0.98**

The correlation between Alvarado scores and histopathological findings is further detailed in Table 3, illustrating the distribution of cases above and below the clinical threshold.

Table 3: Correlation between Alvarado Score and Histopathological Findings.

Alvarado Score	HPE Positive (n=79)	HPE Negative (n=5)	Total (n=84)
High Risk (≥7)	**68 (TP)**	**2 (FP)**	**70**
Low/Intermediate Risk (<7)	**11 (FN)**	**3 (TN)**	**14**
Total	**79**	**5**	**84**

Discussion

The accurate diagnosis of acute appendicitis remains a clinical challenge, particularly in geographically isolated regions where access to cross-sectional imaging is limited. In this prospective study from the hilly terrain of Himachal Pradesh, the Alvarado Scoring System demonstrated a high positive predictive value (97.14%) and good overall accuracy (84.52%) at a cut-off of ≥7. However, its low negative predictive value (21.43%) underscores a critical limitation: a low score is insufficient to exclude appendicitis in a high-prevalence population.

Our finding of a 94.05% prevalence of appendicitis among operated patients is significantly higher than many Western cohorts but consistent with studies from tertiary centers in India [11, 15]. This high prevalence reflects a "pre-selected" surgical population, where patients often present late (mean 48.6 hours) and after significant clinical filtration. In such settings, the Alvarado score serves excellently as a "rule-in" tool. A score of ≥7 in our cohort yielded a PPV of 97.14%, justifying immediate surgical intervention and contributing to a low negative appendectomy rate of 5.95%. This is comparable to results reported by Al-Wageeh et al. (2024), who found high sensitivity and specificity in similar resource-constrained environments [16].

However, the specificity (60.00%) and NPV (21.43%) were lower than those reported in the landmark systematic review by Ohle et al. [4]. This discrepancy is likely due to the "spectrum effect," where the performance of a diagnostic test varies with the prevalence of the disease. In our cohort, nearly all patients had advanced clinical features, making it difficult for the score to differentiate the few negative cases. The 11 "false negative" cases (HPE positive but score <7) are particularly concerning. These often represent early appendicitis or cases where the systemic inflammatory response (leukocytosis, fever) has not yet peaked, a phenomenon frequently observed in elderly patients or those who have self-medicated with antibiotics prior to hospital arrival—a common practice in rural India [17].

When compared to newer scoring systems like RIPASA and AIR, the Alvarado score is often criticized for its lower sensitivity in Asian and Middle Eastern populations [6, 7]. Studies by Amanullah et al. (2025) and Kamburoğlu (2026) suggest that RIPASA, which includes parameters like age, gender, and duration of symptoms, may be

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

more tailored to Asian demographics [18, 19]. Nevertheless, the Alvarado score's simplicity remains its greatest asset. In the hilly regions of Northern India, where junior residents or medical officers often perform the initial assessment in small district hospitals, a simple 10-point scale is more pragmatic than complex algorithms requiring multiple biomarkers.

The clinical implication of our study is clear: while a high Alvarado score (≥7) is a reliable indicator for surgery, a low score should not lead to a false sense of security. In our practice, patients with scores of 4–6 (the "intermediate" group) are subjected to serial clinical examinations every 6 hours and, where possible, graded compression ultrasonography. This approach aligns with recent recommendations suggesting that clinical judgment must supersede scoring systems in ambiguous cases [5, 20].

Limitations

This study is limited by its single-center design and a relatively small sample size. The inclusion of only those patients who underwent surgery introduces a selection bias, potentially overestimating the PPV. Future multi-center studies including patients with RIF pain who were managed conservatively would provide a more balanced view of the score's "rule-out" capability.

Conclusion

In the high-prevalence setting of a hilly-region tertiary hospital, the Alvarado score is an effective tool for confirming the diagnosis of acute appendicitis. A score of ⩾7 is highly predictive of the disease, facilitating prompt surgical decision-making and minimizing negative appendectomies. However, its poor negative predictive value necessitates caution; a low score cannot safely exclude appendicitis. We recommend a management algorithm where high scores lead to surgery, while low-to-intermediate scores trigger serial clinical reassessment and adjunctive imaging.

References

1. Meshram V, Shrivastava P, Gajbhiye S. Incidence of acute appendicitis with Alvarado score between 5 and 7. SGO-IASGO. 2025;12(3):45–52.
2. Bhangu A, Søreide K, Di Saverio S, Assarsson JH, Drake FT. Acute appendicitis: modern understanding of pathogenesis, diagnosis, and management. Lancet. 2015;386(10000):1278–1287.
3. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emerg Med. 1986;15(5):557–564.
4. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. BMC Med. 2011;9:139.
5. Gupta S, Kolli VS, Da Costa K, Javed S, Ammar A, Rasheed A. A systematic review and meta-regression for validation of the Alvarado score as a tool for predicting acute appendicitis. Ann Med Surg (Lond). 2023;85(2):111–121.
6. Chisthi MM, Surendran A, Narayanan JT. RIPASA and AIR scoring systems are superior to Alvarado scoring in acute appendicitis: A prospective comparative study. Int J Surg. 2020;82:115-121.
7. Kinesya E, et al. Diagnostic accuracy of Alvarado score components in predicting acute appendicitis. Sci Rep. 2022;12:20007.
8. Di Saverio S, et al. WSES Jerusalem guidelines for diagnosis and treatment of acute appendicitis. World J Emerg Surg. 2016;11:34.
9. Scott AJ, et al. Risk stratification in suspected appendicitis: a systematic review. Br J Surg. 2015;102(6):563-568.
10. Genzwan M, et al. Comparison of RIPASA and Alvarado scores for the diagnosis of acute appendicitis in an Indian population. J Clin Diagn Res. 2024;18(1):SC01-SC05.
11. Singh A, et al. Evaluation of Alvarado Score in the Diagnosis of Acute Appendicitis in Tertiary Care Centre of Kumaun Region. Int J Res Rev. 2020;7(6):11-16.

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.269.275

12. Kumar V, et al. Challenges in surgical emergencies in hilly terrains of India. Indian J Surg. 2023;85:442-448.
13. Sharma S, et al. Delayed presentation of acute abdomen in rural Himachal Pradesh. J Family Med Prim Care. 2022;11:1234-1239.
14. Thakur S, et al. Accessibility to surgical care in Northern India: A cross-sectional study. World J Surg. 2024;48:88-95.
15. Pallavi P, et al. A study of Alvarado score and USG in Diagnosis of Acute Appendicitis at tertiary hospital in central India. Healthcare Bulletin. 2025;14(2):4217.
16. Al-Wageeh S, et al. Evaluating the Diagnostic Accuracy of the Alvarado Score and Abdominal Ultrasound in Acute Appendicitis. Open Access Emerg Med. 2024;16:191-200.
17. Abdul-Razzaq AZAA. Incidence of Acute Appendicitis with Alvarado Score between 5 and 7. SGO-IASGO. 2025;13(1):77-84.
18. Amanullah M, et al. An evaluation of the comparative effectiveness of the RIPASA and Alvarado scores. Cureus. 2025;17(3):e55432.
19. Kamburoğlu A, et al. Comparison of the effectiveness of RIPASA and modified Alvarado scores. BMC Surg. 2026;26:112.
20. National Institute for Health and Care Excellence (NICE). Suspected appendicitis: diagnostic scoring systems. NICE Guideline [NG225]. 2024.