

**A prospective observational comparative study of alvarado scoring system versus lintula scoring system in clinical diagnosis of acute appendicitis**

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Abstract

Introduction: Acute appendicitis is one of the most common surgical emergencies, requiring rapid and accurate diagnosis to avoid complications such as perforation. While clinical scoring models like the Alvarado and Lintula systems help improve diagnostic precision, their comparative efficacy requires ongoing evaluation.

Objectives: This study aimed to compare the diagnostic efficacy of the Alvarado scoring system versus the Lintula scoring system in patients presenting with clinical signs and symptoms of acute appendicitis, using histopathological examination as the reference standard.

Material and Methods: This prospective observational comparative study was conducted in the Department of General Surgery at JLN Medical

College and Associated Group of Hospitals, Ajmer, from June 2024 to November 2025. A total of 100 adult patients (age 18 years) presenting with clinical features of acute appendicitis were evaluated. Standardized clinical data, laboratory investigations, and radiological findings were recorded concurrently to compute both the Alvarado and Lintula scores, which were subsequently correlated with operative findings and histopathological reports.

Results: The study had a mean age of 43.69 ± 8.86 years with a significant male predominance of 69% ($p = 0.0001$). Histopathological examination confirmed acute appendicitis in 90% of the resected specimens. The Alvarado score demonstrated a sensitivity of 76.67%, a specificity of 50.00%, a positive predictive value (PPV) of 93.24%, and a negative predictive value (NPV) of 19.23%. In comparison, the Lintula score showed a sensitivity of 67.78%, a specificity of 50.00%, a PPV of 92.42%, and an NPV of 14.71%.

Conclusion: Both scoring systems are practical non-invasive tools for risk-stratifying patients with suspected acute appendicitis. However, the Alvarado scoring system demonstrated superior diagnostic performance with higher overall sensitivity, predictive values, and diagnostic accuracy compared to the Lintula scoring system.

Keywords: Acute appendicitis, Alvarado Score and Lintula Score.

Introduction

Acute appendicitis is one of the commonest surgical emergencies, and it is more prevalent in the second and third decades and decreasing with age¹. Appendicitis should be considered in the differential diagnosis of almost every patient with acute abdominal pain. The typical presentation begins with peri-umbilical pain,

followed by anorexia and nausea. The pain localizes to the right lower quadrant as the inflammatory process progresses to involve the parietal peritoneum overlying the appendix. This classic pattern of migratory pain is the most reliable symptom of acute appendicitis². Estimated life time prevalence of acute appendicitis is approximately 1 in 71. Estimated incidence is about 1.5 to 1.9 per 1000 population. Men are affected 1.4 times greater than women. Appendicular inflammation is diagnosed mainly based on the clinical history and clinical examination along with some lab investigations like, increased leukocyte count. Even though appendicitis is a common surgical problem, in some cases appendicitis remains a difficult diagnosis to establish, mostly in very young or old age groups and women of reproductive age group, because of other genitourinary and gynaecological conditions that can also present with symptoms and signs of appendicitis³. A quick and correct diagnosis of acute appendicitis leading to early appendectomy and avoidance of complications arising from perforation can be difficult at times. Radiological modalities such as computed tomography (CT) imaging further aid in making a definite diagnosis and have been reported to have high sensitivity (94%) and specificity (95%) for diagnosing acute appendicitis⁴. Thus, in most large hospitals, it is routine to request for CT imaging in all patients suspected of acute appendicitis⁵. However, such routine practice will inflate the cost of healthcare substantially. Furthermore, the process of arranging for CT imaging may cause further delay for emergency appendectomy. A study has suggested that such indiscriminate use of CT imaging may lead to the detection of early low-grade appendicitis and unnecessary appendectomies in a condition that

would otherwise have resolved spontaneously with antibiotic therapy.⁶

Misdiagnosis frequently results in negative exploration rates which can lead on to longer length of stay in hospital, higher costs and added morbidity and mortality as well. It is accepted that not all cases of appendicitis need to be treated surgically, especially those cases involving catarrhal appendicitis.⁷ Unnecessary appendicectomies also should be avoided to avoid potential complications such as ileus (found in 1.2% of cases), incisional hernias (found in 0.68% of cases) and increased cost to the patient.⁸ Therefore, clinically oriented scoring systems such as the Alvarado Score and Lintula score have been traced so as to help improve the rate of clinical diagnosis for acute appendicitis.

The Alvarado Score⁹, formulated by Alvarado in 1986, is the most commonly used scoring system, incorporating eight clinical, physical, and laboratory parameters (maximum score of 10). Although validated globally as a standard diagnostic tool, its sensitivity and specificity vary, and it relies partly on laboratory evaluations like neutrophilic left shift which may not be readily available in resource-limited settings.

To overcome limitations associated with laboratory dependency, Hannu Lintula and colleagues developed the Lintula Score¹⁰ in Turku, Finland in 2009. The Lintula scoring system relies exclusively on nine bedside clinical and physical examination criteria (maximum score of 32), omitting laboratory tests entirely.

Objectives: To compare the efficacy of Alvarado scoring system versus Lintula scoring system by clinical findings and correlation with histopathological

examination of resected appendix and to improve the accuracy of clinical diagnosis of acute appendicitis.

Material and Methods

This study was conducted as a prospective observational comparative investigation in the Department of General Surgery at JLN Medical College & Associated Group of Hospitals, Ajmer (Raj.) from June 2024 to November 2025 on 100 patients. The study included patients aged 18 years or older who presented with clinical signs and symptoms indicative of acute appendicitis. Patients under 18 years of age, individuals who were unfit or unwilling to undergo surgery, and those presenting with generalized peritonitis, an appendicular abscess, or an appendicular mass. Furthermore, patients with acute abdominal pain stemming from alternative non-appendicular pathologies, as well as those with a past history of abdominal surgery or acute abdominal trauma, were excluded from the study. Observations were tabulated according to the pre-designed proforma. To describe about the data descriptive statistics mean $\pm$ S.D were used. In all the above statistical tools the probability value 0.05 is considered as significant level.

All patients presenting with a provisional clinical diagnosis of acute appendicitis underwent an immediate, standardized clinical evaluation and physical examination upon admission. The assessment captured subjective symptoms—including pain migration to the right iliac fossa (RIF), anorexia, nausea, vomiting, and bowel habit changes—alongside objective signs such as RIF tenderness, rebound tenderness (Blumberg's sign), guarding, fever, and specialized clinical signs like Rovsing's and Psoas signs. Simultaneously, patients underwent routine

blood work (complete blood count, PT-INR, blood sugar, electrolytes, LFT, RFT, and viral screening) and radiological evaluations (chest X-ray and whole-abdomen ultrasound). The clinical and biochemical parameters required to compute both the Alvarado and Lintula scoring systems were recorded concurrently on a dedicated proforma to prevent temporal bias, with results subsequently correlated against operative findings, ultrasound reports, and histopathological examination.

Results

Table 1: Demographic Distribution of Patients by Age and Sex (N = 100)

Demographic Variable		Number (Percentage)	Statistical Significance
Age Distribution	20–40 years	n = 41 (41%)	Mean age: 43.69±8.86 years
	41–60 years	n = 58 (58%)	
	61–80 years	n = 1 (1%)	
Sex Distribution	Male	n = 69 (69%)	$\chi^2 = 14.44$, p = 0.0001 (Significant)
	Female	n = 31 (31%)	
Total		N = 100 (100%)	

Table 2: Clinical Symptoms and Physical Examination Findings of Patients (N = 100)

Clinical Parameter	Frequency / Percentage	P-Value
Symptoms	n=100 (100%)	P < 0.001 (Significant)
Pain in Right Lower Quadrant (RLQ)		
Relocation of Pain	n=74 (74%)	P < 0.001 (Significant)
Anorexia	n=64 (64%)	P < 0.001 (Significant)
Nausea and Vomiting	n=61 (61%)	P < 0.001 (Significant)
Physical Examination Findings	n=94 (n = 94)	
Bowel Sounds (Abnormal / High-pitched / Tinkling)		—
RIF Tenderness	n=78 (78%)	—
Rebound Tenderness	n=75 (75%)	—
Fever	n=73 (73%)	—
Guarding	n=10 (10%)	—

Table 3: Histopathological Findings of Resected Appendix Specimens (N = 100)

Histopathological Finding	Number of Patients	Percentage	P value
Positive for Acute Appendicitis	90	90%	P < 0.0001 (Significant)
Negative for Acute Appendicitis	10	10%	
Total	100	100%	

Table 4: Risk Stratification of Patients Using Alvarado and Lintula Scoring Systems

Scoring System		Number of Patients	Percentage (%)	Statistical Significance
Alvarado Score	High Probability (>7)	74	74%	$\chi^2 = 23.04$, P < 0.0001 (Significant)
	Low/Moderate Probability (< 7)	26	26%	
Lintula Score	Moderate to High Risk (>16)	75	75%	$\chi^2 = 25$, P < 0.0001 (Significant)
	Low Risk (< 16)	25	25%	
Total		100	100%	

Table 5: Diagnostic Performance Comparison of Alvarado and Lintula Scoring Systems

Diagnostic Scoring System	Sensitivity (%)	Specificity (%)	Positive Predictive Value (PPV) (%)	Negative Predictive Value (NPV) (%)
Alvarado Score	76.67	50	93.24	19.23
Lintula Score	67.78	50	92.42	14.71

Discussion

The present prospective observational comparative study evaluated and compared the diagnostic efficacy of the Alvarado scoring system versus the Lintula scoring system in 100 patients presenting with clinical signs and symptoms suggestive of acute appendicitis. Regarding the demographic profile, the mean age of patients in the present study was 43.69±8.86 years. This was considerably higher than the mean age reported by Ojuka D et al. (26.3±2.65 years)¹¹, and Alali A et al.¹² (21.8±6.72 years). This variance indicates that the present study encompassed an older patient population, with the majority of participants concentrated in the middle-aged cohort (58% aged 41–60 years). In terms of sex distribution, the present study demonstrated a clear and statistically significant male predominance,

comprising 69% males and 31% females (p = 0.0001).

This finding aligns closely with Makwana N et al.¹³, who reported 74% males and 26% females. A similar male predilection was observed by Patil SK et al.¹⁴ (60% males, 40% females) and Alali A et al.¹² (56% males, 44% females). Conversely, Omar AS et al.¹⁵ noted a female predominance with 46.9% males and 53.1%. (Table 1)

Analysis of symptomatology revealed that right lower quadrant (RLQ) pain was universally present in 100% of the cohort, matching the findings of Makwana N et al.¹³ (100%) and comparing favorably with Alali A et al.¹² (92%) and Omar AS et al.¹⁵ (87.5%). Relocation of pain occurred in 74% of patients, which is higher than the rates documented by Makwana N et al.¹³ (66%) and Omar AS et al. (56%)¹⁵. Anorexia was

observed in 64% of patients, slightly lower than the 83% reported by Alali A et al.¹², while nausea and vomiting were present in 61% of cases, consistent with Omar AS et al. (65.6%) and Makwana N et al. (66%)¹³. For physical examination findings, RIF tenderness was elicited in 78% of the patients, aligning with Alali A et al.¹² (87%). Rebound tenderness was documented in 75% of patients, exceeding the figures reported by Makwana N et al.¹³ (66%) and Omar AS et al.¹⁵ (55%). Fever was present in 73% of patients, which is higher than the 57.5% reported by Omar AS et al.¹⁵. Abnormal bowel sounds were noted in 94% of patients compared to 75.6% in Omar AS et al.'s study, while abdominal guarding was present in 10%, consistent with Alali A et al.¹² (12%). (Table 2)

Histopathological examination of resected appendicular specimens confirmed acute appendicitis in 90% of patients ($p < 0.0001$), demonstrating high diagnostic correlation with the initial clinical assessment. Risk stratification using scoring thresholds revealed that 74% of patients had an Alvarado score of >7 ($p < 0.0001$) and 75% had a Lintula score of >16 ($p < 0.0001$). (Table 3)

When comparing diagnostic performance, the Alvarado score in the present study demonstrated a sensitivity of 76.67% and a specificity of 50.0%. The sensitivity was higher than that reported by Alali A et al. (70.3%)¹² but lower than Omar AS et al.¹⁵ (82.7%), whereas the 50.0% specificity remained comparable to prior literature. For the Lintula score, the present study demonstrated a sensitivity of 67.78% and a specificity of 50.0%, closely tracking the sensitivities reported by Alali A et al.¹² (67.6%) and Omar AS et al.¹⁵ (67.0%). Furthermore, predictive value analysis indicated that both systems possess high positive predictive values

(PPV)—93.24% for the Alvarado score and 92.42% for the Lintula score—confirming their reliability in verifying disease among screen-positive patients. However, both tools showed limited negative predictive values (NPV of 19.23% for Alvarado and 14.71% for Lintula), indicating that scores below the diagnostic cut-off should not be relied upon independently to exclude acute appendicitis.

Conclusion

Both the Alvarado and Lintula scoring systems are practical, non-invasive clinical tools that effectively risk-stratify patients with suspected acute appendicitis, helping clinicians make prompt decisions regarding surgical interventions in resource-limited environments. However, comparative analysis reveals that the Alvarado scoring system demonstrates superior diagnostic performance, exhibiting higher overall sensitivity, positive predictive value, negative predictive value, and diagnostic accuracy compared to the Lintula scoring system, while sharing equivalent specificity. Therefore, the Alvarado score is a more reliable bedside and emergency-department tool for managing acute appendicitis.

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