

DIAGNOSTIC ACCURACY OF NEUTROPHIL TO LYMPHOCYTE RATIO IN ACUTE APPENDICITIS WITH HISTOPATHOLOGY AS GOLD STANDARD

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Abstract: Acute appendicitis is one of the most common surgical emergencies worldwide, requiring prompt and accurate diagnosis to prevent complications. In resource-constrained settings like Pakistan, reliance on advanced imaging modalities is often impractical. The Neutrophil-to-Lymphocyte Ratio (NLR) has emerged as a cost-effective and accessible biomarker for diagnosing acute appendicitis. **Objective:** This study aimed to evaluate the diagnostic accuracy of NLR in identifying acute appendicitis using histopathology as the gold standard. **Methods:** This cross-sectional study was conducted on 124 patients clinically suspected of having acute appendicitis at a tertiary care hospital. NLR values were calculated from routine complete blood counts, and histopathological examination was used to confirm the diagnosis. Diagnostic performance metrics, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, were calculated. Stratified analyses were performed based on age, gender, and Modified Alvarado Scores. **Results:** The NLR cutoff of ≥ 3.5 demonstrated a sensitivity of 88.6%, specificity of 86.6%, PPV of 92.1%, NPV of 81.2%, and overall diagnostic accuracy of 87.9%. Diagnostic accuracy was higher in patients aged 46–70 years (92.8%) compared to those aged 18–45 years (83.8%). Male patients exhibited slightly better diagnostic accuracy (90.4%) than females (85.2%). Integration of NLR with the Modified Alvarado Score improved diagnostic precision, with accuracy reaching 88.2% in patients with scores >8 . **Conclusion:** NLR is a reliable, cost-effective biomarker for diagnosing acute appendicitis, particularly in resource-limited settings. Its integration with clinical scoring systems can enhance diagnostic accuracy, reduce unnecessary appendectomies, and improve patient outcomes. Further research is needed to standardize NLR cutoff values and validate its application in broader clinical settings.

Keywords: Neutrophil-To-Lymphocyte Ratio, Acute Appendicitis, Diagnostic Accuracy, Modified Alvarado Score, Histopathology

Introduction

Acute appendicitis is one of the most common surgical emergencies worldwide, and prompt diagnosis is crucial to prevent complications such as perforation and peritonitis. In Pakistan, acute appendicitis remains a significant healthcare burden due to delayed presentations, limited diagnostic resources, and a high rate of negative appendectomies (1). Accurate diagnosis is essential to minimize unnecessary surgeries and optimize patient outcomes in resource-constrained settings (2).

The Neutrophil-to-Lymphocyte Ratio (NLR), derived from routine complete blood count tests, has emerged as a potential biomarker for diagnosing acute appendicitis. It reflects the systemic inflammatory response, which is heightened in appendicitis, making it a cost-effective and easily accessible diagnostic tool (3). In a country like Pakistan, where advanced imaging modalities such as computed tomography (CT) are often unavailable or unaffordable for many patients, NLR could play a pivotal role in improving diagnostic accuracy (4).

Studies conducted in other low- and middle-income countries have demonstrated the utility of NLR in diagnosing acute appendicitis, reporting high sensitivity and specificity (5). However, its diagnostic performance can vary based on demographic and clinical factors, emphasizing the need for context-specific validation (6). In

Pakistan, the use of NLR as a diagnostic marker remains underexplored, with most healthcare settings relying on clinical judgment and imaging studies for diagnosis (7).

The Modified Alvarado Score, a widely used clinical scoring system, has shown moderate accuracy in diagnosing acute appendicitis but is often insufficient on its own (8). Combining NLR with clinical scoring systems like the Modified Alvarado Score could enhance diagnostic precision, reduce the rate of negative appendectomies, and optimize resource utilization (9). This approach is particularly relevant in Pakistani hospitals, where there is a need for cost-effective and reliable diagnostic tools.

This study aims to evaluate the diagnostic accuracy of NLR in detecting acute appendicitis using histopathology as the gold standard. By exploring the performance of NLR across different demographic and clinical subgroups, this research seeks to provide evidence for its integration into diagnostic protocols in Pakistani healthcare settings.

Methodology

The study employed a cross-sectional design to assess the diagnostic accuracy of the Neutrophil-to-Lymphocyte Ratio (NLR) in identifying acute appendicitis, using histopathology as the gold standard. Conducted at a tertiary care hospital, the research aimed to provide evidence for

incorporating NLR into routine diagnostic protocols to improve patient outcomes and reduce unnecessary appendectomies.

The study population included patients presenting with clinical suspicion of acute appendicitis during the study period. A total of 124 participants were enrolled using non-probability consecutive sampling. Inclusion criteria encompassed individuals aged 18–70 years who presented with clinical signs and symptoms consistent with acute appendicitis and consented to participate in the study. Exclusion criteria included patients with chronic inflammatory conditions, malignancies, autoimmune diseases, or those on immunosuppressive therapy, as these factors could potentially alter NLR levels.

Data collection involved a structured protocol comprising clinical evaluations, laboratory investigations, and surgical interventions. Following a detailed history and clinical examination, baseline blood samples were collected from all participants for complete blood count (CBC) analysis. The NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count.

Surgical intervention was performed based on clinical indications, and appendectomy specimens were sent for histopathological examination to confirm the diagnosis of acute appendicitis. Histopathological findings were considered the gold standard for diagnosis.

Ethical approval for the study was obtained from the institutional review board, ensuring adherence to ethical principles. Informed consent was obtained from all participants, and confidentiality of their data was maintained throughout the research.

The collected data were analyzed using SPSS version 26. Descriptive statistics, such as means, standard deviations, frequencies, and percentages, were used to summarize the demographic and clinical characteristics of the participants. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of NLR were calculated, with a predefined cutoff value of ≥ 3.5 . Stratified analyses were conducted to explore the diagnostic performance of NLR across different age groups, genders, and Modified Alvarado Score categories. A p-value of less than 0.05 was considered statistically significant.

Results

This study assessed the diagnostic accuracy of the Neutrophil-to-Lymphocyte Ratio (NLR) for diagnosing acute appendicitis using histopathology as the gold standard. The findings are presented below, including demographic characteristics, histopathological findings,

and the diagnostic accuracy of NLR. The study included 124 patients, with a mean age of 47.58 ± 10.57 years. Of these, 63 (50.8%) were male, and 61 (49.2%) were female. The majority of participants fell within the age range of 18–45 years (54.8%). These findings are summarized in Table 1.

Out of the total sample, 79 (63.7%) patients had histopathological confirmation of acute appendicitis, while 45 (36.3%) had normal appendices.

The NLR ratio of ≥ 3.5 demonstrated a sensitivity of 88.6%, specificity of 86.6%, positive predictive value (PPV) of 92.1%, negative predictive value (NPV) of 81.2%, and overall diagnostic accuracy of 87.9%. These findings are detailed in Table 2.

In the 18–45 years age group, NLR had a sensitivity of 82.6%, specificity of 86.3%, and diagnostic accuracy of 83.8%. In the 46–70 years age group, the sensitivity was 96.9%, specificity 86.9%, and diagnostic accuracy 92.8%. (Table 3).

Among male patients, the diagnostic accuracy was 90.4%, with a sensitivity of 90.9%. Among females, the diagnostic accuracy was slightly lower at 85.2%, with a sensitivity of 85.7% (Table 4).

Patients with a Modified Alvarado Score ≤ 8 showed a diagnostic accuracy of 87.6%, while those with a score > 8 had an accuracy of 88.2%. The stratified metrics are provided in Table 5.

These findings underscore the utility of NLR as a reliable diagnostic tool for acute appendicitis, particularly when stratified by age, gender, and Modified Alvarado Score. Integration of NLR into routine clinical practice could enhance diagnostic precision, reduce negative appendectomies, and improve patient outcomes.

Table 1: Demographic Characteristics of Participants

Variable	Category	Frequency	Percentage (%)
Age (Years)	18–45	68	54.8
	46–70	56	45.2
Gender	Male	63	50.8
	Female	61	49.2

Table 2: Diagnostic Accuracy of NLR (≥ 3.5) for Acute Appendicitis

Metric	Value (%)
Sensitivity	88.6
Specificity	86.6
Positive Predictive Value	92.1
Negative Predictive Value	81.2
Diagnostic Accuracy	87.9

Table 3: Diagnostic Accuracy by Age Group

Age Group (Years)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
18–45	82.6	86.3	92.6	70.3	83.8
46–70	96.9	86.9	91.4	95.2	92.8

Table 4: Diagnostic Accuracy by Gender

Gender	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Male	90.9	89.4	95.2	80.9	90.4
Female	85.7	84.6	88.2	81.4	85.2

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Table 5: Diagnostic Accuracy by Modified Alvarado Score

Score Range	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
≤8	88.6	86.2	90.6	83.3	87.6
>8	88.5	87.5	93.9	77.7	88.2

Discussion

This study evaluated the diagnostic accuracy of the Neutrophil-to-Lymphocyte Ratio (NLR) in diagnosing acute appendicitis, using histopathology as the gold standard. The findings revealed that NLR is a reliable, cost-effective biomarker with high sensitivity (88.6%), specificity (86.6%), and overall diagnostic accuracy (87.9%), supporting its integration into routine diagnostic protocols in resource-constrained settings like Pakistan.

The sensitivity and specificity values reported in this study align with previous research. For instance, Ahmed et al. found that NLR had a sensitivity of 89% and specificity of 85% in diagnosing acute appendicitis, emphasizing its reliability as a diagnostic marker (10). Similarly, Kim et al. conducted a meta-analysis and reported pooled sensitivity and specificity values of 85% and 83%, respectively, underscoring the global applicability of NLR in various healthcare settings (11).

Stratified analysis in this study demonstrated variations in NLR performance across age groups and genders. Among patients aged 46–70 years, NLR exhibited a higher diagnostic accuracy (92.8%) compared to younger patients. This is consistent with findings by Zafar et al., who noted that older patients tend to exhibit more pronounced inflammatory responses, enhancing the diagnostic utility of NLR (12). Gender-based differences were also observed, with slightly higher diagnostic accuracy in male patients (90.4%) than females (85.2%). These variations may reflect biological differences in immune response and warrant further investigation (13).

The integration of NLR with the Modified Alvarado Score in this study revealed an improvement in diagnostic precision, particularly for patients with ambiguous clinical presentations. Patients with a Modified Alvarado Score ≤8 demonstrated a diagnostic accuracy of 87.6%, while those with scores >8 had an accuracy of 88.2%. Malik et al. similarly reported that combining clinical scores with NLR enhanced diagnostic accuracy, reducing the rate of unnecessary surgeries by 25% (14).

Despite its promising diagnostic potential, the utility of NLR is influenced by systemic and inflammatory conditions, which can alter neutrophil and lymphocyte counts. Studies by Rehman et al. highlighted the need to interpret NLR values cautiously, particularly in patients with co-morbid conditions such as diabetes or autoimmune disorders, which may confound results (15). This limitation underscores the importance of comprehensive clinical evaluations in conjunction with NLR measurements. Compared to advanced imaging techniques like CT scans, which have higher diagnostic accuracy but are expensive and not always accessible in resource-limited settings, NLR offers a practical alternative. Ahmed et al. emphasized the cost-effectiveness of NLR in LMICs, where healthcare budgets and resources are constrained (16). However, the reliance on histopathology as the gold standard in this study

provides robust validation of NLR's diagnostic performance.

Conclusion

The findings of this study reinforce the role of NLR as a valuable diagnostic tool for acute appendicitis, particularly in settings with limited access to advanced diagnostic modalities. Future research should focus on standardizing NLR cutoff values and integrating them into clinical guidelines to optimize patient care.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRBEC-TCHI-02324/23)

Consent for publication

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Conflict of interest

The authors declared absence of conflict of interest.

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