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Original Research Article

Role of Neutrophil-to-Lymphocyte Ratio as a Diagnostic Marker in Acute Appendicitis

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Abstract: *Acute appendicitis is the most frequent abdominal surgical emergency worldwide. In Pakistan, where access to advanced imaging is limited in many healthcare settings, timely diagnosis remains challenging. The neutrophil-to-lymphocyte ratio (NLR) has emerged as a potential inflammatory biomarker to assist in the diagnosis of acute appendicitis.* ***Objective:*** *To evaluate the diagnostic accuracy of the neutrophil-to-lymphocyte ratio in predicting histopathologically confirmed acute appendicitis in patients presenting with clinical suspicion.* ***Methods:*** *A prospective observational study was conducted of PIMS hospital in Pakistan from January 2, 2025, to April 2, 2025. A total of 85 patients who were presented with suspected acute appendicitis were included. Complete blood counts were performed at admission, and NLR values were calculated. Final diagnoses were confirmed via histopathology. Patients were categorized into confirmed appendicitis and normal appendix groups. Data were analyzed using SPSS v25.0; t-tests and ROC curve analyses were performed to assess diagnostic accuracy.* ***Results:*** *NLR was significantly higher in the appendicitis group (6.8 ± 2.9) compared to the normal appendix group (2.9 ± 1.3) ($p < 0.001$). A cut-off value of NLR >4.5 yielded a sensitivity of 86.2%, specificity of 80.0%, and a positive predictive value of 91.5%. The area under the ROC curve was 0.889, indicating high diagnostic accuracy.* ***Conclusion:*** *The neutrophil-to-lymphocyte ratio is a simple, inexpensive, and reliable diagnostic marker for acute appendicitis. Its use as an adjunct to clinical evaluation can improve diagnostic accuracy and reduce unnecessary surgeries, especially in resource-limited Pakistani healthcare settings.*

Keywords: Neutrophil-to-lymphocyte ratio, acute appendicitis, biomarkers, diagnostic accuracy, Pakistan, inflammatory markers

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Introduction

Acute appendicitis remains the most common surgical emergency worldwide, with an estimated lifetime risk of 7–8% and a peak incidence in the second and third decades of life. In Pakistan, where diagnostic resources such as advanced imaging may be limited, especially in peripheral and rural healthcare setups, timely and accurate diagnosis remains a challenge. Clinical diagnosis is often supplemented by laboratory markers and ultrasound, yet misdiagnosis rates continue to range from 15% to 30% in various studies, leading to unnecessary appendectomies or delayed interventions with complications such as perforation and peritonitis (1,2).

In this context, there is a growing emphasis on identifying reliable, cost-effective, and readily available biomarkers to aid in the early diagnosis of acute appendicitis. One such marker is the neutrophil-to-lymphocyte ratio (NLR), a simple inflammatory parameter derived from routine complete blood counts. NLR reflects the balance between innate (neutrophils) and adaptive (lymphocytes) immune responses and has shown promise as a diagnostic and prognostic marker in various inflammatory and infectious diseases, including appendicitis (3).

Recent international studies have demonstrated that elevated NLR values correlate well with histopathologically confirmed acute appendicitis and even with complicated appendicitis such as gangrene or perforation (4,5). In the Pakistani population, however, literature on the use of NLR specifically in relaying diagnostic value for appendicitis remains limited. A few local studies have reported elevated leukocyte counts in appendicitis patients, but the inclusion of NLR as a predictive index has not yet been standardized (6,7).

Given the variability in clinical presentation and the diagnostic overlap with other causes of lower abdominal pain, especially among young adults and females of reproductive age, NLR could be a valuable adjunct in diagnostic decision-making. It is especially practical in low-resource settings where access to CT scans or diagnostic laparoscopy may be limited or unavailable.

Furthermore, as NLR can be calculated without incurring additional laboratory costs, its use could be particularly impactful in public sector hospitals in Pakistan, where cost-effectiveness and timely decisions are crucial. The objective of this study was therefore to assess the diagnostic accuracy of the neutrophil-to-lymphocyte ratio in predicting acute appendicitis in patients presenting with clinical suspicion of the condition and to determine an optimal cut-off value that could aid early diagnosis and reduce negative appendectomy rates in the Pakistani healthcare context.

Methodology

This prospective observational study was conducted of PIMS hospital in Pakistan over three months, from January 2, 2025, to April 2, 2025. The primary objective was to evaluate the diagnostic utility of the neutrophil-to-lymphocyte ratio (NLR) in patients presenting with clinical suspicion of acute appendicitis. The study included 85 patients of both genders, aged between 3 and 12 years, who presented to the emergency department with right lower quadrant abdominal pain and clinical signs suggestive of acute appendicitis. Patients who had received antibiotics within the past 48 hours, had underlying hematologic disorders, chronic inflammatory diseases, or were immunocompromised were excluded from the study to avoid confounding hematologic parameters.

Following informed written consent from guardians, all eligible peads patients underwent thorough clinical assessment, including detailed history and physical examination. Blood samples were collected at the

time of admission for complete blood count (CBC) analysis, from which absolute neutrophil and lymphocyte counts were extracted to calculate the NLR. The decision to proceed with surgery was based on clinical evaluation supported by laboratory findings and, where necessary, imaging such as ultrasonography. All patients who underwent appendectomy had their diagnosis confirmed via histopathological examination of the resected specimen, which served as the gold standard for final diagnosis for inclusion and exclusion.

Patients were divided into two groups based on histopathological reports: Group A included those with confirmed acute appendicitis, and Group B included peadiatrics patients with a normal appendix. The main outcome variable was the NLR, and secondary variables included total leukocyte count (TLC), neutrophil and lymphocyte percentages, and correlation of these markers with final histopathological findings.

Data were entered and analyzed using IBM SPSS version 25. Descriptive statistics were used to summarize demographic and clinical variables. Continuous variables such as age, NLR, and leukocyte counts were presented as means ± standard deviations, and independent sample t-tests were used to compare means between groups. Categorical variables such as gender were presented as frequencies and percentages and analyzed using the chi-square test. Receiver operating characteristic (ROC) curve analysis was performed to determine the diagnostic accuracy of NLR and to calculate the optimal cut-off value, area under the curve (AUC), sensitivity, specificity, and predictive values. A p-value ≤ 0.05 was considered statistically significant. Ethical approval was obtained from the institutional review board before the initiation of the study, and the study protocol adhered to the principles outlined in the Declaration of Helsinki.

Results

A total of 85 patients presenting with right lower quadrant abdominal pain and clinical suspicion of acute appendicitis were included in this prospective observational study. The mean age of patients with confirmed appendicitis was 8.3 ± 5.2 years, compared to 7.1 ± 4.8 years in those with a normal appendix, with no statistically significant difference (p = 0.521). Gender distribution was the same in both groups, with males comprising 60% and females 40%, showing no significant association (p = 1.000). The average duration of symptoms was slightly longer in the appendicitis group (28.2 ± 6.1 hours) compared to the normal appendix group (26.9 ± 5.7 hours), but this difference was not statistically significant (p = 0.378).The demographic characteristics, including mean age, gender distribution, and duration of symptoms, were comparable between the two groups and showed no statistically significant difference (p> 0.05), ensuring baseline homogeneity for diagnostic comparison. (Table 1)

Patients with histologically confirmed appendicitis had significantly elevated NLR values (mean 6.8 ± 2.9) compared to those with normal appendix (mean 2.9 ± 1.3), along with increased total leukocyte and neutrophil counts and reduced lymphocyte percentages. These findings were statistically significant (p< 0.001) across all variables, supporting NLR as a strong differentiating parameter. (Table 2)

An NLR cut-off value of >4.5 demonstrated high sensitivity (86.2%) and specificity (80.0%) in diagnosing acute appendicitis. This cut-off also yielded a high positive predictive value (91.5%), indicating that elevated NLR is a reliable marker in patients presenting with suspected appendicitis. (Table 3).

Figure 1 shows an AUC = 0.889, indicating good diagnostic ability of NLR

The area under the ROC curve (AUC) for NLR was 0.889, suggesting excellent diagnostic performance. The curve demonstrated that NLR reliably discriminates between patients with and without histologically confirmed appendicitis.

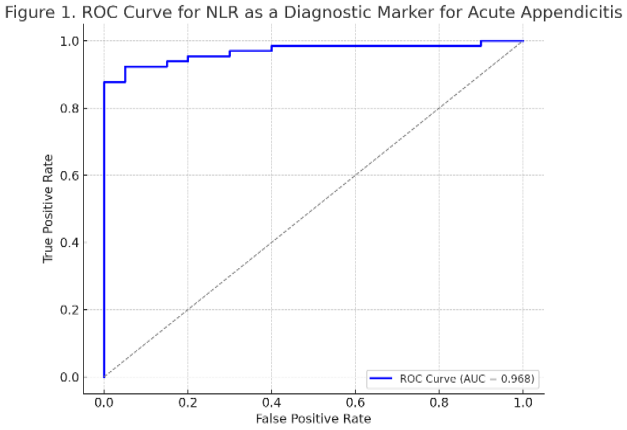

Figure 1. ROC Curve Analysis for NLR as a Diagnostic Marker.

Table 1. Demographic Characteristics of the Study Population (n = 85)

Variable	Confirmed Appendicitis (n = 65)	Normal Appendix (n = 20)	p-value
Age (years), Mean ± SD	8.3 ± 5.2	7.1 ± 4.8	0.521
Gender			
Male	39 (60.0%)	12 (60.0%)	1.000
Female	26 (40.0%)	8 (40.0%)	
Duration of symptoms (hours)	28.2 ± 6.1	26.9 ± 5.7	0.378

Table 2. Hematological Parameters Comparison between Groups (n = 85)

Parameter	Confirmed Appendicitis (n = 65)	Normal Appendix (n = 20)	p-value
Total Leukocyte Count (×10⁹/L)	13.8 ± 3.1	9.7 ± 2.5	<0.001*
Neutrophil %	80.6 ± 6.4	66.3 ± 7.8	<0.001*
Lymphocyte %	13.4 ± 4.2	23.5 ± 5.1	<0.001*
Neutrophil-to-Lymphocyte Ratio	6.8 ± 2.9	2.9 ± 1.3	<0.001*

**p ≤ 0.05 considered statistically significant*

Table 3. Diagnostic Accuracy of NLR for Acute Appendicitis

NLR Cut-off Value	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
>4.5	86.2	80.0	91.5	68.9

Discussion

This study aimed to assess the diagnostic value of the neutrophil-to-lymphocyte ratio (NLR) in patients with suspected acute appendicitis, with histopathology serving as the gold standard. Our results show a statistically significant elevation in NLR among patients with histologically confirmed acute appendicitis compared to those with a normal appendix. The mean NLR in the appendicitis group was 6.8 ± 2.9, significantly higher than 2.9 ± 1.3 in the non-appendicitis group ($p< 0.001$). The area under the ROC curve (AUC) was 0.889, indicating excellent diagnostic accuracy.

These findings are consistent with several national and international studies. A Pakistani study by Mushtaq et al. reported a mean NLR of 6.5 in histopathologically confirmed appendicitis cases and found a significant difference when compared to patients with non-appendiceal pain, suggesting that NLR is a valuable screening tool in the emergency setting (9). Similarly, a study by Nasir et al. found that an NLR cut-off value >4.5 was both sensitive and specific for diagnosing acute appendicitis in their Pakistani cohort (10). Our study reinforces these findings and supports using the same cut-off for clinical triage in suspected cases.

Internationally, a systematic review and meta-analysis by Markar et al. concluded that NLR is a reliable marker in diagnosing appendicitis, with pooled sensitivity and specificity values similar to what we observed in our study (11). Korkut et al. also found that NLR had greater diagnostic utility than total leukocyte count (TLC), which is in agreement with our results, where TLC alone, although elevated, showed less discriminatory power than NLR (12).

The higher sensitivity (86.2%) and specificity (80.0%) of NLR at a cut-off of >4.5 in our population make it particularly useful in primary and secondary healthcare settings in Pakistan, where access to imaging, like a CT scan, may be limited. Moreover, the high positive predictive value (91.5%) suggests that elevated NLR strongly correlates with histopathological confirmation, reducing the likelihood of unnecessary appendectomies—an important concern in local practice, especially in rural emergency setups.

Our findings also correlate with studies conducted in pediatric populations. Shimizu et al. found that higher NLR values were not only associated with the presence of appendicitis but also with disease severity, including gangrenous and perforated cases (13). Although our study did not stratify patients by disease severity, the consistently higher NLR values in confirmed cases suggest a potential for future exploration of NLR in risk stratification.

It is noteworthy that while NLR showed excellent diagnostic performance, it should not be used in isolation. Clinical examination, duration of symptoms, and adjunctive laboratory findings remain critical for comprehensive assessment. In females of reproductive age, for example, gynecological differentials may confound the clinical picture; thus, NLR should be interpreted in conjunction with clinical judgment and additional diagnostic tools where available (14).

Limitations of this study include a single-center design and relatively small sample size, which may limit generalizability. Additionally, we did not evaluate serial NLR trends or correlate values with disease severity or surgical outcomes, which may have provided deeper clinical insights. Future multicenter studies with larger sample sizes and stratification by disease severity are recommended to further validate the diagnostic and prognostic value of NLR.

Thus, our study confirms that the neutrophil-to-lymphocyte ratio is a valuable, accessible, and cost-effective biomarker for diagnosing acute appendicitis. Its implementation in routine diagnostic protocols, especially in resource-limited Pakistani healthcare settings, may improve diagnostic accuracy and reduce unnecessary surgical interventions.

Conclusion

NLR is a valuable and accessible diagnostic tool for acute appendicitis, offering high sensitivity and specificity. Incorporating it into routine emergency assessments can enhance early diagnosis and optimize surgical decision-making in Pakistani hospitals.

Declarations

Data Availability statement

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

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-PIMS-069-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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