Original Research Article

ROLE OF NEUTROPHIL: LYMPHOCYTE RATIO IN DIAGNOSIS OF SUSPECTED ACUTE APPENDICITIS IN ADULTS

Pradnya Chimankar[1], Bhavini Harsiyani[2], Riddhi D Maraviya[2], Purva Shinde[1]

[1]*Assistant Professor, Department of pathology, D.Y.Patil Medical College, Kolhapur, Maharashtra, India*
[2]*Junior Resident, Department of pathology, D.Y.Patil Medical College Kolhapur, Maharashtra, India*

Corresponding Author:
Dr. Purva Shinde,
Assistant Professor, Department of pathology, D.Y.Patil Medical College, Kolhapur, Maharashtra, India.
Email: drpshindemd@gmail.com

A B S T R A C T

Background: Acute appendicitis is a common surgical emergency, yet its diagnosis remains challenging, especially in atypical presentations. Delayed diagnosis can lead to perforation and peritonitis, while overdiagnosis increases negative appendectomy rates. The neutrophil–lymphocyte ratio (NLR), a simple inflammatory marker derived from routine complete blood count, has been proposed as a useful adjunct in improving diagnostic accuracy.

Materials and Methods: This prospective observational study was conducted over six months at a tertiary care center. A total of 120 adult patients (≥18 years) with clinical suspicion of acute appendicitis who underwent appendectomy were included. Preoperative hematological parameters, including total leukocyte count, absolute neutrophil count, absolute lymphocyte count, and NLR, were recorded. NLR was calculated as the ratio of absolute neutrophil to lymphocyte count. Histopathological examination of appendectomy specimens was considered the gold standard. Statistical analysis included ANOVA and receiver operating characteristic (ROC) curve analysis.

Results: Histopathology revealed acute appendicitis in 65.0% cases, complicated appendicitis in 18.3%, and normal appendix in 16.7%. Mean NLR values increased significantly with disease severity and were highest in complicated appendicitis ($p < 0.001$). ROC analysis showed good diagnostic performance with an AUC of 0.81. An NLR cut-off ≥3.5 demonstrated 84.0% sensitivity and 70.0% specificity.

Conclusion: NLR is a simple, cost-effective, and reliable marker for diagnosing acute appendicitis and correlates well with disease severity. Its routine use may aid early diagnosis and reduce negative appendectomy rates.

Keywords: Acute appendicitis, Neutrophil–lymphocyte ratio, Complete blood count.

INTRODUCTION

Acute appendicitis remains one of the most common causes of acute abdomen requiring emergency surgical intervention in adults. Despite advances in imaging modalities, timely and accurate diagnosis continues to pose a clinical challenge, particularly in atypical presentations. Delayed diagnosis may lead to complications such as perforation, abscess formation, and peritonitis, whereas overdiagnosis contributes to unnecessary appendectomies with associated morbidity and healthcare costs. [1,2]

Traditionally, the diagnosis of acute appendicitis is based on a combination of clinical evaluation, laboratory investigations, and radiological findings. Among laboratory parameters, total leukocyte count (TLC) and differential leukocyte count are routinely used markers of inflammation; however, their diagnostic accuracy is limited when used independently.[3] Therefore, there is ongoing interest in identifying inexpensive, easily available, and reliable biomarkers that can enhance diagnostic precision.

The neutrophil–lymphocyte ratio (NLR), calculated from routine complete blood count (CBC), has emerged as a novel inflammatory marker reflecting the balance between neutrophil-mediated innate immune response and lymphocyte-dependent

adaptive immunity. During acute inflammatory states, neutrophilia coupled with relative lymphopenia results in an elevated NLR, which has been shown to correlate with disease severity in various inflammatory and infectious conditions. [4,5]

In recent years, several studies have evaluated the role of NLR in diagnosing acute appendicitis and in differentiating uncomplicated from complicated appendicitis. Elevated NLR has been associated with higher sensitivity and specificity compared to TLC alone, suggesting its potential utility as an adjunct diagnostic marker in emergency settings. [6-8] From a pathology perspective, NLR offers a reproducible, cost-effective parameter that can be readily incorporated into routine hematological reporting without additional financial burden.

The present study was undertaken to evaluate the diagnostic role of neutrophil–lymphocyte ratio in adult patients with suspected acute appendicitis and to assess its correlation with histopathological findings of the resected appendix.

MATERIALS AND METHODS

A prospective observational study conducted in the Department of Pathology, D Y Patil Medical College, Kolhapur, India in collaboration with the Departments of General Surgery and Emergency Medicine. The study was carried out over a period of 6 months.

Study Population: Adult patients aged ≥ 18 years presenting to the emergency department with clinical suspicion of acute appendicitis and subsequently undergoing appendectomy were included in the study.

Inclusion Criteria
• Patients aged 18 years and above
• Clinically suspected cases of acute appendicitis
• Patients who underwent surgical appendectomy
• Availability of complete preoperative hematological parameters

Exclusion Criteria
• Patients with known hematological disorders
• Chronic inflammatory or autoimmune diseases
• Acute infections other than appendicitis
• Patients on steroid therapy, immunosuppressive drugs, or chemotherapy
• Pregnant patients

Sample Size: A total of 120 patients fulfilling the inclusion criteria were enrolled consecutively during the study period.

Data Collection: Venous blood samples were collected preoperatively under aseptic precautions and analyzed using an automated hematology analyzer. The following hematological parameters were recorded:
• Total leukocyte count (TLC): Reference value = 4.0 – 11.0 ×10³/μL
• Absolute neutrophil count: Reference value = 2.0 – 7.5 ×10³/μL

• Absolute lymphocyte count: Reference value = 1.0 – 3.0 ×10³/μL

The NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count. Suggested NLR cutoff: ≥ 3.5 (diagnostic of appendicitis).
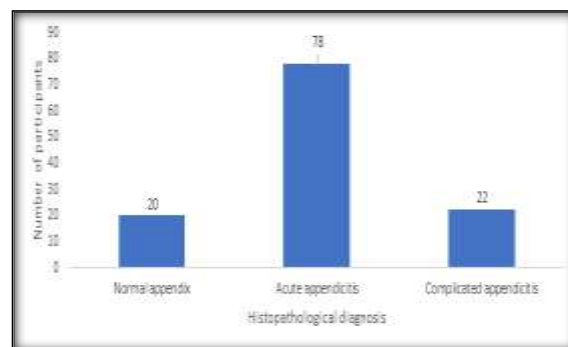
Histopathological Examination:
All appendectomy specimens were received in the pathology department, fixed in 10% buffered formalin, processed routinely, and stained with hematoxylin and eosin (H&E). Histopathological diagnosis was considered the gold standard and cases were categorized as:
• Normal appendix
• Acute appendicitis
• Complicated appendicitis (Gangrenous/ Perforated)

Data Analysis: Data were entered and analyzed using SPSS. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as percentages. The mean NLR values were compared between histopathological groups using ANOVA. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal NLR cut-off value for diagnosing acute appendicitis. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 120 adult patients with clinical suspicion of acute appendicitis who subsequently underwent appendectomy were included in the study. The study population had a mean age of 34.6 ± 11.2 years, with participants ranging from 18 to 65 years. A clear male predominance was observed, with males constituting 60.0% (72) of cases and females 40.0% (48), resulting in a male-to-female ratio of 1.5:1. The mean duration of symptoms prior to presentation was 21.4 ± 9.6 hours, suggesting that most patients sought medical care within the first 24 hours of symptom onset, a critical window for timely diagnosis and intervention to reduce the risk of complications such as perforation.

Figure 1: Distribution of study participants based on histopathological diagnosis of the resected appendix (n=120)

Histopathological examination of the appendectomy specimens revealed acute appendicitis in 78 (65.0%)

cases. Complicated appendicitis, including gangrenous or perforated appendix, was identified in 22 (18.3%) cases. A normal appendix was observed in 20 (16.7%) cases, representing the negative appendectomy rate in the study population. [Figure 1] The mean TLC was $11.9 \pm 3.4 \times 10^3/\mu L$, with values ranging from 6.2 to $18.9 \times 10^3/\mu L$. A substantial proportion of patients demonstrated leukocytosis, reflecting an underlying inflammatory response in clinically suspected cases of acute appendicitis. The mean absolute neutrophil count was 8.9 ± 3.1

$\times 10^3/\mu L$ (range: $3.8–14.6 \times 10^3/\mu L$), indicating predominant neutrophilia. In contrast, the mean absolute lymphocyte count was $1.6 \pm 0.5 \times 10^3/\mu L$, with values ranging from 0.8 to $3.1 \times 10^3/\mu L$, suggesting relative lymphopenia in a significant number of patients. The calculated mean NLR for the study population was 6.5 ± 3.2, with a wide range of 1.9 to 14.8. Notably, the majority of patients had NLR values exceeding the normal reference range, indicating a systemic inflammatory state consistent with acute appendiceal pathology. [Table 1]

**Table 1: Hematological profile of study participants (n=120)**

Parameter	Mean ± SD	Range
Total leukocyte count (TLC) (×10³/µL)	11.9 ± 3.4	6.2 – 18.9
Absolute neutrophil count (×10³/µL)	8.9 ± 3.1	3.8 – 14.6
Absolute lymphocyte count (×10³/µL)	1.6 ± 0.5	0.8 – 3.1
Neutrophil–lymphocyte ratio (NLR)	6.5 ± 3.2	1.9 – 14.8

A statistically significant difference was observed in total leukocyte count, absolute neutrophil count, absolute lymphocyte count, and NLR across the three histopathological groups ($p < 0.001$). The mean total leukocyte count (TLC) was lowest in patients with normal appendix ($8.2 \pm 1.4 \times 10^3/\mu L$), moderately elevated in acute appendicitis ($12.6 \pm 2.3 \times 10^3/\mu L$), and highest in complicated appendicitis ($15.8 \pm 3.1 \times 10^3/\mu L$), demonstrating a progressive increase with disease severity. Similarly, the absolute neutrophil count showed a stepwise rise from $5.1 \pm 1.1 \times 10^3/\mu L$

in normal appendix to $9.4 \pm 2.0 \times 10^3/\mu L$ in acute appendicitis and $12.6 \pm 2.7 \times 10^3/\mu L$ in complicated appendicitis. In contrast, the absolute lymphocyte count demonstrated a progressive decline across the groups, with mean values of $2.3 \pm 0.6 \times 10^3/\mu L$, $1.6 \pm 0.5 \times 10^3/\mu L$, and $1.1 \pm 0.4 \times 10^3/\mu L$, respectively. The mean NLR increased progressively with disease severity, measuring 2.2 ± 0.6 in normal appendix, 5.9 ± 1.8 in acute appendicitis, and 11.4 ± 3.2 in complicated appendicitis. [Table 2]

**Table 2: Comparison of Hematological Parameters According to Histopathological Diagnosis**

Parameters (Mean ± SD)	Normal appendix (n=20)	Acute appendicitis (n=78)	Complicated appendicitis (n=22)	p value
Total leukocyte count (TLC) (×10³/µL)	8.2 ± 1.4	12.6 ± 2.3	15.8 ± 3.1	<0.001
Absolute neutrophil count (×10³/µL)	5.1 ± 1.1	9.4 ± 2.0	12.6 ± 2.7	<0.001
Absolute lymphocyte count (×10³/µL)	2.3 ± 0.6	1.6 ± 0.5	1.1 ± 0.4	<0.001
Neutrophil–lymphocyte ratio (NLR)	2.2 ± 0.6	5.9 ± 1.8	11.4 ± 3.2	<0.001
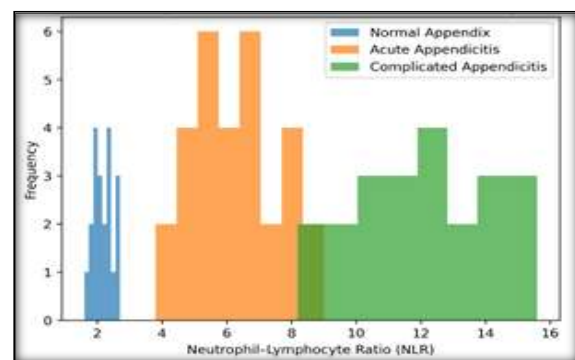
Figure 2: Distribution of NLR across Histopathological groups

The distribution of neutrophil–lymphocyte ratio (NLR) across histopathological groups is shown in [Figure 2]. Patients with a normal appendix demonstrated low and narrowly distributed NLR values, predominantly below 3.0. In contrast, acute appendicitis cases showed a clear rightward shift, with most NLR values between 4.0 and 8.0. Patients with complicated appendicitis exhibited markedly higher NLR values, largely exceeding 8.0, with a

broader distribution. Minimal overlap was observed between normal appendix and appendicitis groups, indicating a progressive increase in NLR with disease severity.
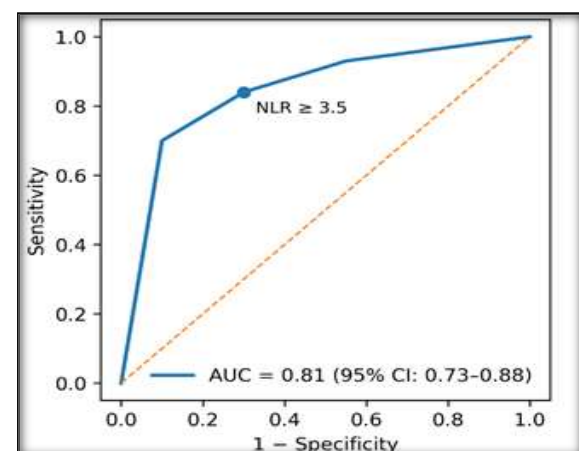
Figure 3: Receiver operating characteristic curve of NLR for diagnosis of acute appendicitis

Receiver operating characteristic (ROC) curve analysis was performed to assess the diagnostic accuracy of NLR in differentiating appendicitis (acute and complicated) from normal appendix. The ROC curve yielded an area under the curve (AUC) of 0.81, indicating good diagnostic performance. An optimal cut-off value of NLR ≥3.5, determined using the Youden index, demonstrated a sensitivity of 84.0% and specificity of 70.0%. At this threshold, the positive predictive value was 90.3%, negative predictive value was 56.0%, and overall diagnostic accuracy was 81.7%. These findings suggest that elevated NLR is strongly associated with histopathologically confirmed appendicitis. [Figure 3]

DISCUSSION

The present study demonstrates that the neutrophil–lymphocyte ratio (NLR), derived from routine complete blood count analysis, is a reliable and clinically meaningful inflammatory marker in adults with suspected acute appendicitis.[9] A statistically significant elevation in NLR was observed in patients with histopathologically confirmed appendicitis when compared with those having a normal appendix, with the highest values noted in cases of complicated appendicitis.[1,10] This progressive rise underscores the potential of NLR not only as a diagnostic marker but also as an indicator of disease severity.[11]

The increase in NLR observed in this study reflects the underlying pathophysiology of acute appendiceal inflammation. Acute inflammatory stress leads to cytokine-mediated neutrophilia, accompanied by relative lymphopenia due to redistribution and apoptosis of lymphocytes.[12] The combined effect of these opposing hematological changes results in an amplified NLR, making it a sensitive marker of systemic inflammation, as originally described by Zahorec.[4] This biological plausibility strengthens the clinical relevance of NLR in appendicitis.

The findings of the present study are consistent with and supported by existing literature. Markar et al. reported that NLR is a valuable adjunct in the diagnosis of acute appendicitis and may outperform total leukocyte count alone.[8] Similarly, Yazar et al. demonstrated significantly higher NLR values in appendicitis patients compared to those with normal appendix, supporting its role as a diagnostic aid in emergency settings.[13] Kahramanca et al. further reported superior sensitivity and specificity of NLR compared to conventional inflammatory markers, highlighting its improved diagnostic performance.[7] Importantly, the marked elevation of NLR in complicated appendicitis observed in the present study aligns with findings from Ishizuka et al., who documented significantly higher NLR values in gangrenous and perforated appendicitis.[14] Comparable results were reported by Jung et al. and Akgül et al., both of whom identified elevated NLR

as a significant predictor of complicated appendicitis.[15,16] These findings suggest that NLR may aid in early risk stratification and identification of patients at increased risk of disease progression.

Receiver operating characteristic (ROC) curve analysis in the current study demonstrated good diagnostic performance of NLR, with an area under the curve indicating strong discriminatory ability.[17] The optimal cut-off value identified in this study is consistent with thresholds reported in prior studies, reinforcing the reproducibility and applicability of NLR across different clinical settings.[7] By integrating both neutrophil predominance and lymphocyte suppression into a single parameter, NLR offers an advantage over isolated leukocyte indices, which may be influenced by a wider range of clinical conditions.[4]

CONCLUSION

The present study demonstrates that the neutrophil–lymphocyte ratio (NLR) is a simple, inexpensive, and readily available hematological marker with significant diagnostic value in adults with suspected acute appendicitis. NLR values were significantly higher in patients with histopathologically confirmed appendicitis compared to those with a normal appendix, with the highest levels seen in complicated cases, indicating a clear correlation with disease severity. This stepwise rise supports the role of NLR not only as a diagnostic marker but also as a tool for risk stratification. At a cut-off value of ≥ 3.5, NLR showed good sensitivity, specificity, and overall diagnostic accuracy, making it a useful adjunct to clinical assessment and routine laboratory tests. Incorporation of NLR into preoperative evaluation may aid early identification of high-risk patients, guide timely surgical decision-making, and help reduce negative appendectomy rates, especially in resource-limited settings. However, NLR should always be interpreted in conjunction with clinical findings, as it may be elevated in other inflammatory conditions. Further large-scale, multicenter studies are required to validate these findings and standardize cut-off values across different populations.

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