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Evaluation of Inflammatory Markers in the Acute Appendicitis: A Prospective Study

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Abstract: ***Background: Acute appendicitis is one of the most common surgical emergencies worldwide, yet its diagnosis remains challenging due to variable clinical presentation. Laboratory inflammatory markers such as C-reactive protein (CRP), total leukocyte count (TLC), neutrophil count, neutrophil–lymphocyte ratio (NLR), and platelet–lymphocyte ratio (PLR) have been increasingly utilized as adjuncts to improve diagnostic accuracy. Aim: To evaluate the diagnostic utility of inflammatory markers (CRP, TLC, neutrophil count, NLR, and PLR) in acute appendicitis, correlate these markers with histopathological findings, and determine their sensitivity and specificity. Methods: A prospective observational study was conducted in the Department of General Surgery at AIIMS, Udaipur, over 18 months (March 2024–September 2025). A total of 125 patients clinically diagnosed with acute appendicitis and undergoing appendectomy were included. Preoperative laboratory investigations including CRP, TLC, differential leukocyte count, NLR, and PLR were recorded. Histopathological examination of resected specimens was considered the gold standard. Statistical analysis included descriptive statistics, chi-square test, Student's t-test, and ROC curve analysis to assess diagnostic accuracy. Results: The majority of patients were in the 21–40-year age group with male predominance. Elevated TLC (73.6%) and neutrophil percentage (69.6%) were the most common findings, followed by raised CRP (64%) and NLR (65.6%). Mean CRP and TLC values were significantly elevated in patients with histopathologically confirmed appendicitis. NLR showed good correlation with disease severity. PLR demonstrated limited diagnostic value. Inflammatory markers were significantly higher in patients presenting after prolonged symptom duration (>48 hours). Histopathology confirmed acute appendicitis in 64% of cases. Combined use of CRP, TLC, and NLR improved diagnostic accuracy compared to individual markers. Conclusion: Inflammatory markers, particularly CRP, TLC, neutrophil count, and NLR, are valuable, cost-effective adjuncts in the diagnosis of acute appendicitis. Their combined use enhances diagnostic accuracy and may help reduce negative appendectomy rates. PLR appears to have limited clinical utility. These markers are especially useful in resource-limited settings where advanced imaging may not be readily available.***

Keywords: Acute appendicitis, C-reactive protein, total leukocyte count, neutrophil–lymphocyte ratio, platelet–lymphocyte ratio, inflammatory markers, histopathology.

1. Introduction

Acute appendicitis is one of the most common surgical emergencies encountered worldwide and remains a significant cause of acute abdominal pain requiring hospital admission and emergency surgery. It is estimated that approximately 6–8% of the population will develop acute appendicitis during their lifetime, with the highest incidence observed in children, adolescents, and young adults [1]. Despite being a frequently encountered condition, the diagnosis of acute appendicitis continues to pose a challenge due to its variable clinical presentation and overlap with other causes of acute abdomen.

The vermiform appendix is a blind-ended tubular structure arising from the posteromedial wall of the cecum. Obstruction of the appendiceal lumen- most commonly due to lymphoid hyperplasia, fecaliths, parasites, or foreign bodies- leads to increased intraluminal pressure, impaired venous drainage, bacterial proliferation, ischemia, and subsequent inflammation [2]. If untreated, this inflammatory process may progress to suppuration, gangrene, perforation, localized abscess formation, or generalized peritonitis, all of which are associated with increased morbidity and mortality.

Early and accurate diagnosis of acute appendicitis is therefore essential to reduce complications and improve patient outcomes. However, achieving this remains difficult in many clinical scenarios.

The diagnosis of acute appendicitis is traditionally based on clinical evaluation supported by laboratory and radiological investigations. Classic symptoms include abdominal pain initially localized to the periumbilical region and later migrating to the right iliac fossa, anorexia, nausea, vomiting, and fever. Physical signs such as tenderness at McBurney's point, rebound tenderness, guarding, and positive Rovsing's or psoas signs may be present [3].

Historically, negative appendectomy rates have ranged from 15% to 30%, even in well-equipped centres. At the same time, delayed diagnosis increases the risk of appendiceal perforation, which may occur in up to 20–30% of cases and is associated with higher postoperative complications, longer hospital stay, and increased healthcare costs [4].

These inflammatory changes form the basis for the use of laboratory markers as diagnostic tools in acute appendicitis. Total leukocyte count (TLC) is one of the most commonly used laboratory investigations in suspected acute

appendicitis. Leukocytosis occurs due to increased production and release of white blood cells in response to infection and inflammation. Several studies have demonstrated a strong association between elevated TLC and acute appendicitis, particularly in complicated cases [5].

C-reactive protein (CRP) is an acute-phase protein synthesized by the liver in response to inflammation. CRP levels begin to rise within 6–12 hours of the onset of inflammation and correlate with the severity and duration of the inflammatory process [6].

Several studies have demonstrated that elevated CRP levels are associated with acute appendicitis and are particularly useful in identifying complicated appendicitis such as gangrene or perforation [7]. When used in combination with TLC and neutrophil count, CRP has been shown to improve diagnostic accuracy.

The neutrophil–lymphocyte ratio (NLR) is a simple, inexpensive parameter derived from routine complete blood count analysis. It reflects the balance between neutrophil-mediated inflammation and lymphocyte-mediated immune regulation. Increased NLR has been shown to correlate with systemic inflammation and stress responses [8].

Platelets play an important role not only in hemostasis but also in inflammation. Platelet–lymphocyte ratio (PLR) has emerged as a novel inflammatory marker in various infectious and inflammatory conditions. Increased PLR reflects enhanced inflammatory activity and immune dysregulation [9].

Histopathological examination of the resected appendix remains the gold standard for the diagnosis of acute appendicitis. Correlating preoperative inflammatory markers with postoperative histopathological findings allows objective assessment of the diagnostic utility of these markers and helps in determining their sensitivity and specificity [10].

Aim:

1) To evaluated the inflammatory markers (CRP, TLC, **Neutrophil-Lymphocyte Ratio, Platelet-Lymphocyte Ratio**) in ACute Appendicitis.
2) Correlation of inflammatory markers (crp, tlc, neutrophil-lymphocyte rate, platelet-lymphocyte count) with histopathology findings in acute appendicitis.
3) To determine the specificity and sensitivity of inflammatory marker for acute appendicitis.

2. Materials and Methods

This prospective, observational Study was Undertaken from April, 2024 to September, 2025 on patients presenting to Department of General Surgery, American International Institute of Medical Sciences, Udaipur. The study protocol was approved by Institutional Ethics committee. The study was designed to evaluate the diagnostic role of inflammatory markers in patients with acute appendicitis and to correlate these markers with histopathological findings following appendectomy.

Inclusion criteria

1) All patients clinically diagnosed with acute appendicitis.
2) Patients undergoing appendectomy (open or laparoscopic).
3) Patients of all age groups and both sexes.
4) Patients willing to provide written informed consent (guardian consent for minors).

Exclusion criteria –

1) Patients with hematological malignancies.
2) Patients with autoimmune or chronic inflammatory diseases such as rheumatoid arthritis, systemic lupus erythematosus, or other connective tissue disorders.
3) Patients on medications influencing inflammatory markers, including corticosteroids, immunosuppressive drugs, or chemotherapy.

The study aimed to analyse commonly available inflammatory markers, namely C-reactive protein (CRP), total leukocyte count (TLC), neutrophil count, lymphocyte count, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR), and to determine their sensitivity and specificity in diagnosing acute appendicitis using histopathology as the gold standard.

3. Results

the proportion of patients with elevated inflammatory markers based on predefined cut-off values. Elevated total leukocyte count (TLC) was observed in 73.6% of patients, making it the most frequently raised marker. Increased neutrophil percentage was noted in 69.6% of cases. Elevated C-reactive protein (CRP) levels were present in 64% of patients, while 65.6% demonstrated raised neutrophil-to-lymphocyte ratio (NLR) values. In contrast, none of the patients showed platelet-to-lymphocyte ratio (PLR) values above the defined cut-off. These findings suggest that TLC, neutrophil percentage, CRP, and NLR were commonly elevated in the study population, whereas PLR showed limited elevation.

the histopathological findings of the study population. Acute appendicitis was the most common diagnosis, observed in 80 patients (64%). Other pathological findings, which included subacute and chronic appendicitis, were noted in 45 patients (36%). No cases of suppurative appendicitis or normal appendix were identified in the present study. These findings indicate that majority of patients undergoing surgery had histopathological evidence of acute appendiceal inflammation.

the comparison of total leukocyte count (TLC) across different histopathological categories. Patients with acute appendicitis had a significantly higher mean TLC (14,921 ± 2,228 cells/mm³) compared to those with complicated appendicitis (9,888 ± 1,365 cells/mm³). This difference was found to be statistically highly significant ($p < 0.001$). No cases of normal appendix were observed in the present study; therefore, statistical analysis for this group was not applicable. These findings suggest a strong association between elevated TLC levels and acute inflammatory appendiceal pathology.

compares neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) with disease severity. Patients with

uncomplicated (acute) appendicitis showed significantly higher mean NLR values (6.40 ± 1.99) compared to those with complicated appendicitis (2.37 ± 0.42). Similarly, the mean PLR was significantly higher in uncomplicated cases (25.85 ± 10.84) than in complicated cases (11.27 ± 3.37). Both differences were found to be statistically highly significant ($p < 0.001$), indicating that NLR and PLR were significantly associated with disease severity in the present study.

the distribution of elevated inflammatory markers across different histopathological categories. Among patients with acute appendicitis, elevated total leukocyte count (TLC) and neutrophil-to-lymphocyte ratio (NLR) were observed in all cases (100%), while elevated C-reactive protein (CRP) levels were present in 95% of patients. In contrast, patients with complicated appendicitis demonstrated substantially lower proportions of elevated markers, with raised CRP, TLC, and NLR observed in 8.89%, 26.67%, and 4.44% of cases, respectively. No cases of normal appendix were identified in the present study. These findings indicate that elevated inflammatory markers were predominantly associated with acute appendicitis.

The diagnostic accuracy of C-reactive protein (CRP) for identifying acute appendicitis. CRP demonstrated a high sensitivity of 95.0% and specificity of 91.1%. The positive predictive value (PPV) was 95.0%, while the negative predictive value (NPV) was 91.1%. These findings indicate that CRP is a highly reliable inflammatory marker for the diagnosis of acute appendicitis, with strong ability to correctly identify both diseased and non-diseased cases.

The diagnostic accuracy of total leukocyte count (TLC) in detecting acute appendicitis. TLC showed a sensitivity of 100%, indicating that all patients with acute appendicitis had elevated leukocyte counts. However, the specificity was lower at 73.3%. The positive predictive value (PPV) was 87.0%, while the negative predictive value (NPV) was 100.0%, suggesting that a normal TLC effectively rules out acute appendicitis. Overall, TLC proved to be an excellent screening marker but with limited specificity.

The diagnostic accuracy of the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR) in diagnosing acute appendicitis. NLR demonstrated excellent diagnostic performance, with a sensitivity of 100% and specificity of 95.6%. The positive predictive value (PPV) and negative predictive value (NPV) for NLR were 97.6% and 100%, respectively, indicating its high reliability as a diagnostic marker. In contrast, PLR showed no sensitivity (0%) despite a specificity of 100%, with a PPV of 0% and an NPV of 36%, suggesting limited diagnostic utility of PLR in the present study. These findings highlight the superiority of NLR over PLR in diagnosing acute appendicitis.

Table 1: Comparison of C-Reactive Protein Levels with Histopathological Findings

Histopathology	CRP (mg/dL) Mean ± SD	P Value
Acute	7.36 ± 1.95	<0.001
Complicated	2.90 ± 1.58	

Table 2: Comparison of Total Leukocyte Count with Histopathological Findings

Histopathology	TLC (/mm^3) Mean ± SD	P Value
Acute	14,921 ± 2,228	<0.001
Complicated	9,888 ± 1365	

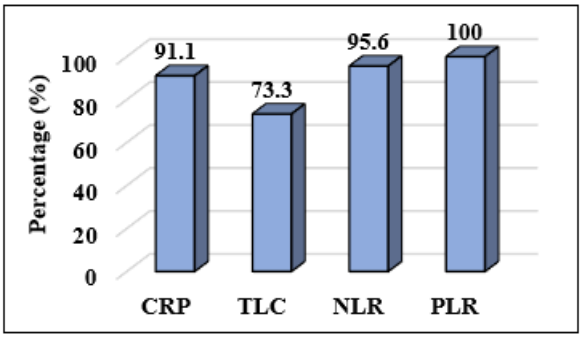


Figure 1: Comparison of Specificity

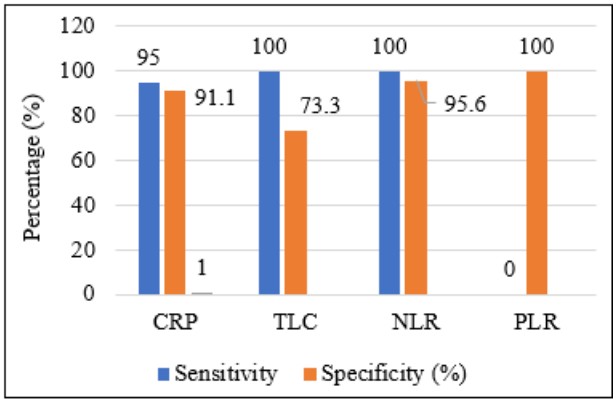
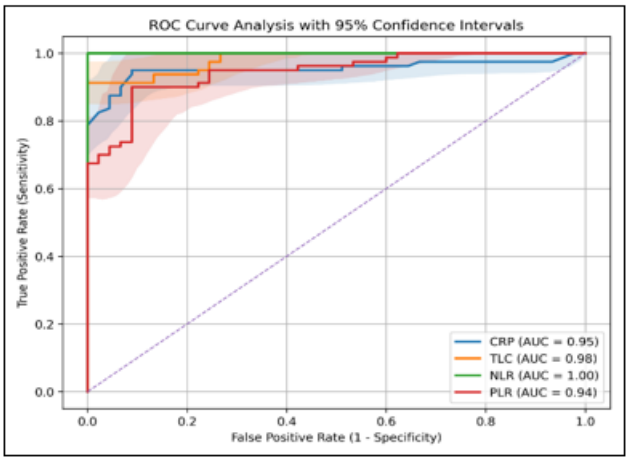


Figure 2: Diagnostic Performance of inflammatory markers



4. Conclusion

The present study evaluated the diagnostic utility of commonly used inflammatory markers- total leukocyte count (TLC), C-reactive protein (CRP), neutrophil percentage, neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR)- in patients with suspected acute appendicitis, and correlated these markers with disease severity and histopathological findings. The results of this study reaffirm the importance of laboratory inflammatory markers as valuable adjuncts to clinical assessment in the diagnosis of acute appendicitis.

Among the inflammatory markers studied, NLR emerged as the most accurate diagnostic marker, demonstrating perfect sensitivity, high specificity, and the highest area under the ROC curve. TLC showed excellent sensitivity and a high negative predictive value, making it a reliable screening tool to rule out acute appendicitis when normal. CRP demonstrated a balanced diagnostic profile with high sensitivity and specificity, supporting its role as a dependable adjunctive marker. Although PLR exhibited high specificity, its low sensitivity limited its diagnostic usefulness in the present study.

Correlation with histopathological findings revealed significantly higher levels of CRP, TLC, NLR, and PLR in patients with acute appendicitis compared to those with subacute or chronic pathology, reinforcing the association between elevated inflammatory markers and acute inflammatory pathology. ROC curve analysis further confirmed the excellent discriminative ability of these markers, particularly NLR.

In conclusion, the findings of this study suggest that NLR is the most reliable and accurate inflammatory marker for the diagnosis of acute appendicitis, while TLC and CRP serve as valuable supportive investigations. The combined use of clinical evaluation and selected inflammatory markers can improve diagnostic accuracy, reduce diagnostic uncertainty, and potentially decrease negative appendectomy rates, especially in resource-limited settings.

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