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# Role of the Neutrophil-to-Lymphocyte Ratio (NLR) in Predicting Severity of Acute Appendicitis and Differentiated between Complicated and Uncomplicated Appendicitis

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**Abstract |** Acute appendicitis is one of the predominant causes of emergency abdominal surgery, delay or misdiagnosis of AA can increase the risk of perforation. White blood cell count (WBC), absolute neutrophil count (ANC), and C-reactive protein (CRP) test are widely used in diagnosis, but their extrapolative exactness vestiges restricted. The Neutrophil / Lymphocyte Ratio (N/L ratio) may offer a more wide-ranging appraisal by revealing both inflammatory and severity condition. **Aim of Study:** To evaluate the usefulness of NLR in the differentiation between uncomplicated and complicated acute appendicitis. **Methods:** The investigation comprised 105 sufferers who performed appendectomy between January 2022 and December2023. Based on surgical and pathological findings, participants were pigeonholed into two groups: complicated and uncomplicated appendicitis. Sociodemographic data, combined with lymphocyte, WBC, CRP, and N/L ratio values, were documented. The diagnostic performance of these parameters was statistically inspection. **Results:** Among the 105 participants, 50 (47.6%) were identified as having severe appendicitis. Complicated group exhibited a significantly higher mean of age CRP, WBC, ANC, and N/L ratio than uncomplicated acute appendicitis. The cut-off value for NLR to differentiate between complicated acute appendicitis and uncomplicated acute appendicitis was taken as 8.6, with a sensitivity of 84 % and specificity of 85%. **Conclusion:** The boundary value of NLR is 8.6 may provide more helpful information for prophesying the severity of appendicitis, therefore NLR can be used to discriminate between complicated and uncomplicated appendicitis and help to diminish the negative appendectomy incidence.

**Key Words:** Complicated Acute Appendicitis, Uncomplicated Acute Appendicitis, Neutrophil, Lymphocyte Ratio (N/LR)

## INTRODUCTION

Acute appendicitis is one of the greatest predominant acute abdominal predicaments globally, and can develop in any age group human when men have a higher risk compared to women [1]. Abdominal pain is the most common symptom, but its overlap with other medical conditions like peptic ulcer disease, urinary tract infection, ovarian cysts, and kidney stones [2] makes diagnosing it challenging even for experienced surgeons in young and elderly patients [3-5]. Therefore, early diagnosis is important to avoid the increased rate of appendicle perforation, intestinal obstruction, and abdominal fluid accumulation that associated with high mortality [6-8].

Acute appendicitis is characterized mainly through clinical presentation and laboratory results with radiological investigation, but despite all diagnostic tools, the negative appendectomy rate is 30% [9-10]. Therefore, new markers are required to forecast the prognosis of acute appendicitis in order to diminish the negative effects of unreal treatment techniques [11]. Within indicators of systemic inflammatory markers; CRP,

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leucocyte count, neutrophil count, lymphocyte count have been proposed as markers of severity of disease in numerous serious diseases including appendicitis [6,12]. Ratio of neutrophils to lymphocytes is used as a systemic immune irritation index, and gives an insight into the function of the immune and inflammatory pathways, with increased NLR values correlating to poor clinical outcomes [13].

Recently, a few papers have indicated the NLR as a marker and its potential role in preoperative diagnosis of acute appendicitis and the distinction between uncomplicated and complicated appendicitis [14-17].

The purpose of this research is to estimate the ability of pre-operative N/L ratio and acute-phase protein (CRP) as biomarkers in forecasting cruelty of AA.

## MATERIALS AND METHODS

In this study, one hundred and five (105) patients were enrolled for this study who were admitted to hospital of Medical city hospital and AL-Kadhimiya educational hospital during the period from 21st February, 2022 to 29th January, 2023 on suspicion of acute appendicitis and were subjected to appendicectomy. Based on the intra-operative findings the participants were categorized into two individuals uncomplicated acute appendicitis (inflamed appendix) and complicated acute appendicitis (punctured appendix, intra-abdominal abscess and gangrenous appendix). Exclusion criteria were age of less than 18 years, pregnancy, underlying chronic inflammatory diseases, autoimmune disease, immunized patients and patients with nonspecific abdominal pain. Variables studied were age, gender, and preoperative laboratory data including; WBC, neutrophil, lymphocyte, C-reactive protein (CRP) and neurtophil-lymphocyte ratio (divide the absolute neutrophil number by absolute lymphocyte number).

### Statistical Examination

Collected data are expressed as percentage (%) and as mean± standard deviation Results were explored by chi square test, Student's t- test and Mann-Whitney U tests. Laboratory parameters were assessed for diagnostic accuracy in predicting complicated AA using receiver operating characteristic (ROC) curve analysis. Confidence limits (CI) was placed at 95% and a p-value of <0.05 was considered statistically significant.

## RESULTS

A total of 105 patients, 64 (60.9%) were men and 41 (39.1%) were women. The Average age for uncomplicated appendicitis was 37.82±17.10 years and for complicated appendicitis was 51.14±18.85 years.

The CAA group demonstrated three times higher values of WBC, Neutrophil, CRP and NLR compared to UCA (p<0.000). The lymphocyte count in CAA was three and half times less than UCA (p<0.000), registered in Table 1.

The intensity of various blood laboratory parameters to diagnose AA was assessed by ROC analysis (Table 2), with the greatest area under the curve was seen in the NLR. While NLR proved to be a good predictor of complicated appendicitis (cut off > 8) with a sensitivity of 84% and specificity of 85%, Area under the receiver operating characteristic curve of 0.916 also proved its usefulness as a diagnostic tool, though a high NLR was not specific for complicated appendicitis. Total WBC counts and CRP counts also produced good areas under the headset operator curves, with 0.884 (95 % CI 0.823–0.945), and 0.868 (95 % CI 0.803–0.933, p<0.000), respectively. The best cut off was calculated to be >17 and >30 respectively, with 77% sensitivity and 80% specificity, and 84% sensitivity and 74% specificity.

Table 1: Demographic and Clinical Characteristics of Participants

| Parameters Total (n = 105) | Patients group | | p-value |
|---|---|---|---|
| | Complicated appendicitis (n = 50) | Uncomplicated appendicitis (n=55) | |
| Age (years) | 51.14±18.85 | 37.82±17.10 | 0.000 |
| Gender | | | |
| Male | 24 | 40 | 0.000 |
| Female | 26 | 15 | |
| **Biomarkers** | | | |
| WBC count ($X10^9$/L) | 20.98±5.25 | 12.51±4.91 | 0.000 |
| Neutrophil count ($X10^9$/L) | 17.13±5.01 | 9.80 ±4.59 | 0.000 |
| Lymphocyte count (X109/L) | 2.17±1.65 | 4.83±4.16 | 0.000 |
| Neutrophil/Lymphocyte ratio | 20.17±13.42 | 7.24±5.10 | 0.000 |
| CRP (mg/dL) | 131.66±118.18 | 19.69±25.98 | 0.000 |

Tabel 2: ROC Analysis for NLR and Inflammatory Parameters to Differentiate between Complicated and Uncomplicated Acute Appendicitis

| Test | NLR | WBCs | Lymphocyte | Neutrophil | CRP |
|---|---|---|---|---|---|
| Sensitivity | 84 | 77 | 98 | 84 | 84 |
| Speceficity | 85 | 80 | 45 | 73 | 74 |
| Area under curve (AUC) | 0.916 | 0.884 | 0.774 | 0.867 | 0.868 |
| Cutoff value | 80.6 | 17 | 10.6 | 110.5 | 30 |
| 95% CI | 866-967 | 823-945 | 0.686-0.862 | 0.801-0.933 | 803-0.933 |
| SE | 0.026 | 0.031 | 0.045 | 0.034 | 0.033 |
| P-value | 0≤0.0001 | 0≤0.0001 | 0≤0.0001 | 0≤0.0001 | 0≤0.0001 |

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Other parameters such as Neutrophil count showed reliable diagnostic performance with an AUC of 0.867 (p<0.001). The lymphocyte count revealed the poorest detective reliability through an AUC of 0.774 (95% CI 0.686–0.867).

## DISCUSSION

In order to avoid the complication of acute appendicitis, it needs early diagnosis and early treatment. For this reason, a number of biomarkers were utilized to stratify the severity of AA; among those, white blood cells counts are most among the most commonly used ones in the diagnosis of acute appendicitis as a general marker of inflammation. As demonstrated by the studies conducted by Amer *et al.* [18] and Adel *et al.* [19] and Ali, [20] citing from who demonstrated, that WBC is a good marker in the diagnosis of complicated appendicitis, and a raised WBC is related with an increased risk of damage.

As in our present study and unlike the other presenting studies, WBC count was elevated in the complicated groups, but the area under curve (AUC) obtained from the ROC analysis suggested a highly diagnostic value (AUC: 0.884) with a sensitivity of 84% and a specificity of 85%. Our present study and the other presenting studies, showed that the WBCs were an important factor for predicting the complications of acute appendicitis and WBCs were considered as easy measurable marker for the preoperative diagnosis of complicated appendicitis [21-23]. An observed rise in the neutrophil count suggests onset of systemic inflammatory re-sponse syndrome and multiple organ failure, markers of severe AA.

Increased serum CRP concentration is an indicator of tissue inflammation, serving as an accurate biomarker of the acute phase inflammatory response. Our data were in agreement with Michael *et al*. [24]; Shankare *et al*. [25] who assessed the diagnostic usefulness of serum CRP which was a more reliable diagnostic marker than the classical markers to prognose the complications. In the same line, Mirza et al. [26]; Prabhash and Dileep [27] reported that serum CRP test was highly sensitive and specific for the identification of patients who truly had acute appendicitis. The ROC analysis of our study revealed the AUC = 0.868 with a sensitivity of 84% and specificity of 74%, which indicating complicated appendicitis patients has more inflammation and higher serum CRP level.

The best cut-off value of NLR to further differentiate patients with acute appendicitis was ≥8 showing a good sensitivity (84%) and specificity (85%). And this agree with the study of Matthias and Ralf-Bodo [28] found that a cutoff value of 6.0 for NLR to classify complicated appendicitis after simple appendicitis with a sensitivity of 75% and specificity of 82%.29.

Anastasakis *et al.* [29], observed that an NLR >7.92 was related with perforated appendicitis, with a sensitivity of 62.5% and a specificity of 74.2%. A study conducted by Chen *et al.* [30], NLR at a cut-off >10.83 diagnostic higher predictive values (sensitivity 96.3% and specificity 85.0%) for early perforation. Other study by Sinan *et al.* [31] found the ROC analysis gave a cut-off value of 6.09 with 67.65% sensitivity and 63.64% specificity in predicting the complicated AA. According to the large number of studies recommended that preoperative NLR is a useful factor in diagnosis of AA and in differentiation among simple and complicate appendicitis. In appendicitis that progresses to perforation, the inflammatory process grow into more severe, then bacteria spread to the peritoneal cavity and leading to peritonitis, which stimulates a significant increase in the number of neutrophils and lymphocytes decrease as an inhibitory adaptive immune response. This change indicated an increase in NLR among subjects with perforated appendicitis contrasted to those without perforated appendicitis. Thus, it is possible that NLR could be used for checking the severity of infection among appendicitis patients and for noticing perforations among them [32]. A high level of NLR not only indicates that inflammation is increasing but also helps in decision-making in treating appendicitis.

## CONCLUSIONS

The neutrophil to lymphocyte ratio is emerging as a highly precise and promising tool can aid in predicting the diagnosis and severity of appendicitis that's leads to reduce the negative appendectomy rate.

### Recommendation

Future potential studies on larger number of individuals are needed to approve and support the findings. NLR when combined with inflammatory biomarkers and appendicitis score support the examinations.

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