International Journal of Academic Health and Medical Research (IJAHMR)
ISSN: 2643-9824
Vol. 9 Issue 7 July - 2025, Pages: 46-51

Diagnostic Value of Leukocyte Count and Neutrophil-to-Lymphocyte Ratio in Patients with Acute Appendicitis at Hasahiesa Emergency Hospital, Gezira State, Sudan (2023)

Tanzeel Alamin Almahdi Gorashi[1], Khalid Abdelsamea Mohamedahmed[1,2,3*], Selma O. M. Abdalla[1]

[1]Department of Hematology and Immunohematology, Faculty of Medical Laboratory Sciences, University of Gezira, Wad Medani, Sudan.
[2]Department of Immunology, Faculty of Medical Laboratory Sciences, University of Gezira, Wad Medani, Sudan. khalid.gu89@gmail.com. ORCID No: 0000-0001-7084-6106.
[3]Department of Medical Laboratory Sciences, Faculty of Applied Medical Sciences, Jerash University, Jerash, Jordan.

***Corresponding author:** Khalid Abdelsamea Mohamedahmed, Email: khalid.gu89@gmail.com

Abstract: Background: Acute appendicitis is one of the most common causes of emergency abdominal surgery worldwide; however, its diagnosis can be challenging, especially in resource-limited settings where advanced imaging modalities are often unavailable. Therefore, identifying reliable and accessible laboratory markers, such as leukocyte count and neutrophil-to-lymphocyte ratio (NLR), is essential to enhance diagnostic accuracy and improve patient outcomes. **Objectives:** This study aimed to assess the diagnostic utility of leukocyte count and neutrophil-to-lymphocyte ratio (NLR) in patients with acute appendicitis at Hasahiesa Emergency Hospital, Gezira State, Sudan. **Methods:** A prospective cross-sectional study was conducted on 100 consecutive patients presenting with suspected acute appendicitis at Hasahiesa Emergency Hospital, Gezira State, Sudan, from October 2022 to March 2023. Demographic and clinical data were collected using a structured questionnaire. Peripheral venous blood samples were analyzed for leukocyte count and neutrophil-to-lymphocyte ratio (NLR) using an automated hematology analyzer (Sysmex XP-300). Patients were classified intraoperatively as having uncomplicated or complicated appendicitis based on surgical findings. Data were analyzed using SPSS Statistics version 25 with statistical significance set at $p < 0.05$. **Results:** Of the 100 patients enrolled (44% male, 56% female; mean age 22.3 ± 6.8 years), leukocytosis was observed in 55%. The mean NLR was significantly higher in patients with complicated appendicitis (mean 6.2 ± 1.5) compared to those with uncomplicated disease (mean 4.1 ± 1.2) ($p < 0.05$). Both leukocyte count and NLR demonstrated strong associations with appendicitis severity, supporting their role as effective diagnostic markers. These findings align with previous studies, which report NLR cut-off values ranging from 3.5 to 4.7 for acute appendicitis and higher values, such as 5.7 to 8.8, for complicated cases, with good sensitivity and specificity. **Conclusion:** Leukocyte count and neutrophil-to-lymphocyte ratio (NLR) are accessible, cost-effective, and reliable biomarkers for both the diagnosis and severity assessment of acute appendicitis. Incorporating these markers into routine clinical practice, particularly in resource-limited settings, has the potential to significantly improve diagnostic accuracy and inform appropriate management strategies for patients with suspected appendicitis.

Keywords: WBCs parameters, NLR, Acute Appendicitis, Sudan

Introduction

Acute appendicitis remains one of the most common causes of emergency abdominal surgery worldwide, yet its timely and accurate diagnosis continues to pose significant challenges in clinical practice (1). Once considered a vestigial organ, the appendix is now recognized for its role in immune defense, particularly among younger individuals (2). Epidemiological studies indicate that the incidence of appendicitis peaks in adolescence and young adulthood, although it can occur at any age (3). Notably, recent data suggest a narrowing gender gap in appendicitis incidence, reflecting shifting demographic patterns in many regions (4). Clinically, appendicitis often presents with classic symptoms such as right lower quadrant abdominal pain and gastrointestinal disturbances. However, up to one-third of patients may exhibit atypical presentations, further complicating prompt diagnosis (5). Delays in recognition and management can significantly increase the risk of complications, including perforation, abscess formation, and peritonitis, all of which contribute to heightened morbidity and mortality (6). While imaging modalities such as ultrasound and computed tomography have enhanced diagnostic accuracy, their availability is frequently limited in resource-constrained settings (7). Laboratory investigations have played a supportive role in the diagnostic workup of suspected appendicitis. Traditionally, leukocyte count has served as a routine marker, with elevated levels often correlating with the severity of inflammation and helping to differentiate between uncomplicated and complicated cases. Nonetheless, leukocytosis lacks specificity, as it may also be elevated in a variety of other inflammatory or infectious conditions, thereby limiting its standalone diagnostic value (8). In recent years, the neutrophil-to-lymphocyte ratio (NLR) has emerged as a promising biomarker for systemic inflammation and has been increasingly studied for its diagnostic and prognostic utility in acute appendicitis (9-11). Multiple meta-analyses have demonstrated that NLR not only assists in distinguishing between uncomplicated and complicated appendicitis but also serves as a predictor of adverse outcomes (12). The integration of NLR into clinical assessment protocols has the potential to enhance diagnostic precision and inform the

urgency of surgical intervention. However, despite these advances, further validation of both NLR and leukocyte count is warranted across diverse populations and healthcare settings, as variations in demographic factors, comorbidities, and local disease prevalence may influence their diagnostic accuracy (13-14).

Methodology

This cross-sectional, hospital-based study was conducted at Hasahiesa Emergency Hospital, Gezira State, Sudan, between October 2022 and March 2023. A total of 100 patients diagnosed with acute appendicitis based on clinical assessment, abdominal ultrasonography, and Alvarado score were consecutively enrolled. Ethical approval was obtained from the Research and Ethics Committees of the Ministry of Health, Gezira State, Sudan. Written informed consent was obtained from each participant prior to inclusion in the study. Patients with recent antibiotic or steroid use, or those with concurrent infections, were excluded.

Venous blood samples were collected from all participants for laboratory analysis. Total leukocyte count and differential counts were performed using the Sysmex XP-300 N automated hematology analyzer. The neutrophil-to-lymphocyte ratio (NLR) was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count (9-10). Data were analyzed using SPSS version (25). Patients were classified as having uncomplicated or complicated appendicitis according to intraoperative.

Results

Among the 100 patients, 44% were male and 56% female (mean age 22.3 years). Most were students (60%), and 45% were aged 11–20. Complicated appendicitis was present in 53% of cases, while 47% had uncomplicated disease. Leukocytosis was observed in 55% of patients; 42% had normal leukocyte counts, and 3% had leukopenia. NLR was significantly higher in complicated appendicitis (mean 6.2) compared to uncomplicated cases (mean 4.1, $p<0.05$). Both leukocyte count and NLR were strongly associated with disease severity.

Table 1: Demographic characteristics of study participants.

Factors	Cases (N = 100)
Age (years)	
Mean ± SD	8.83 ± 4.20
Age group (years)	
Less than 10 years	7 (7 %)
11 – 20 years	45 (45 %)
21 – 30 years	24 (24 %)
More than 30 years	24 (24 %)
Gender	
Males	44 (44 %)
Females	56 (56 %)
Occupation	
Students	60 (60 %)
Free workers	10 (10 %)
Housekeeper	13 (13 %)
Others	17 (17 %)

Family history	
Yes	53 (53 %)
No	47 (47 %)
Severity of appendicitis	
Uncomplicated	54 (54 %)
Complicated	46 (46 %)
Types of appendicitis	
Suppurative appendicitis	9 (9 %)
Abscess appendicitis	6 (6 %)
Perforation appendicitis	22 (22 %)
Appendicular mass	7 (7 %)
Peritonitis	2 (2 %)
WBCs Frequency	
Normal	42 (42%)
Leukocytopenia	3 (3%)
Leukocytosis	55 (55%)

Table 2: Comparison of study parameters according to appendicitis severity.

Parameters	Severity		P. value
	Uncomplicated (N=47)	Complicated (N=53)	
TWBCs	9.7 ± 3.7	12.0 ± 7.0	**0.035***
Neutrophil	6.7 ± 3.5	7.9 ± 5.6	0.213
Lymphocyte	1.9 ± 0.8	2.0 ±1.2	0.843
NLR	4.1 ± 0.4	6.2 ± 0.7	**0.014***

Table 2: Comparison of study parameters between ultrasound results

Parameters	Ultrasound results		P. value
	Normal (N=70)	Abnormal (N=30)	
TWBCs	10.4 ± 6.2	12.2 ± 4.6	0157
Neutrophil	6.9 ± 5.0	9.0 ± 3.6	0.019
Lymphocyte	2.0 ± 0.8	1.9 ± 1.4	0.938
NLR	4.5 ± 0.6	6.9 ± 0.6	**0.011***

Table 3: Comparison of between types of complicated appendicitis.

Parameters	Type of severity					P. value
	Suppurative (N=9)	Abscess (N=6)	Perforation (N=22)	Mass (N=7)	Peritonitis (N=2)	
TWBCs	8.3 ± 3.4	12.9 ± 5.7	13.8 ± 9.1	16.6 ± 5.7	13.1 ± 0.0	0.236
Neutrophil	5.5 ± 2.8	9.8 ± 5.0	9.9 ± 6.9	8.9 ± 6.0	6.5 ± 0.0	0.419
Lymphocyte	1.3 ± 0.8	1.8 ± 0.4	1.87 ± 0.5	2.7 ± 1.7	5.2 ± 0.0	**0.000***
NLR	5.1 ± 1.9	8.6 ± 3.0	6.8 ± 1.6	6.7 ± 3.4	1.3 ± 0.0	0.533

Table 4. Comparison of study parameters between patients with different occupations

Parameters	Student (N=60)	Free workers (N=10)	Housekeeper (N=13)	Others (N=17)	P. value
TWBCs	10.0 ± 5.0	13.0 ± 3.1	8.7 ± 4.0	14.6 ± 8.5	**0.007***
Neutrophil	6.6 ± 4.2	10.0 ± 3.0	4.5 ± 2.1	10.3 ± 6.4	**0.001***
Lymphocyte	2.0 ± 1.1	2.5 ± 1.0	1.5 ± 0.5	1.9 ± 0.6	0.302
NLR	4.2 ± 0.4	8.7 ± 3.1	6.0 ± 0.7	6.2 ± 0.9	**0.011***

Table 5: Comparison of study parameters between Alvarado score range

Parameters	Alvarado score		P. value
	4-6 (N=43)	7-9 (N=57)	
TWBCs	7.0 ± 2.5	13.8 ± 5.8	**0.000***
Neutrophil	4.3 ± 2.2	9.6 ± 4.8	**0.000***
Lymphocyte	1.9 ± 1.2	2.0 ± 0.9	0.886
NLR	4.5 ± 0.9	5.7 ± 0.4	0.182

Discussion

Acute appendicitis (AA) is the most common cause of abdominal surgical emergency in the world, although it is very common the accurate diagnosis sometimes can be very challenging, wrong or delayed diagnosis may cause unnecessary risk of complicated AA, therefore correct and timely diagnosis is very important, any proven characteristic hematologic marker capable of diagnosis acute appendicitis would also be a clinically relevant tool for guiding management of appendicitis (15).

This was cross sectional study aimed to assess the diagnostic value of of leukocyte count and neutrophil-to-lymphocyte ratio in patients with acute appendicitis at Hasahiesa Emergency Hospital, Gezira State, Sudan. The sample was collected from Hashisa emergency hospital from October 2022 to March 2023. In addition to evaluate the effect of number of factor on Leukocyte count and NLR, included gender, age group, family history. After informed consent, blood samples were collected into two tubes first one was EDTA for CBC by sysmex and Data was analyzed by using SPSS computer program. A total of 100 suspected patients with acute appendicitis were participated according to inclusion and exclusion criteria, (44%) were males and (56%) were females, so females are slightly predominance, disagree with most studies showed a slight male predominance (16). And that is may due to their health seeking behavior and population demographic . Patients with age varies from 4-43 years, (7%) of patients had aged less than 10 years, (45%) of patients had aged between 11-20 years, (24%) of patients had aged between 21-30 years and (24%) of patients had aged more than 30 years. The peak incidence occurs in the second decades of life, agree with studies found that the peak incidence usually occurs in the second and third decades of life (17). Most patients were young adults, matching established patterns (18-19). And that is due to their immunological, anatomical and life style reasons lead to increase susceptibility in to obstruction. In this study there were (53%) of patients had a family history to the AA and (47%) had not, so they were approximately equal to each other and disagree with the study found that the risk of AA is roughly three-times higher in members of families with a positive history for AA (16). Due to genetic variations. (47%) of patients had uncomplicated appendicitis and (53%) of patients had complicated appendicitis. (9 %) of patients had suppurative appendicitis, (8%) of patients had Appendicular Abscess, (32%) of patients had perforation appendicitis, (11%) of patients had appendicular mass and (2%) of patients had Peritonitis.Study found that (55%) of patients had leukocytosis, 42% of patients had normal leukocytes count and (3%) of patients had leukopenia.

There was a significant difference in neutrophil-to-lymphocyte ratio (NLR) between complicated and uncomplicated appendicitis in our study (P = 0.014), which is consistent with the findings of study 17 (p < 0.001). This difference can be explained by the pathophysiology of acute appendicitis: complicated cases, such as those involving perforation, trigger a more intense systemic inflammatory response. This leads to a higher neutrophil count (neutrophilia) and a lower lymphocyte count (lymphocytopenia), resulting in an elevated NLR. The NLR, therefore, serves as a sensitive marker for the severity of inflammation and infection. Higher NLR values in complicated appendicitis suggest a greater degree of tissue damage and immune activation compared to uncomplicated cases. There was a highly significant difference between the severity of appendicitis and absolute lymphocyte count (P = 0.000). This finding is supported by previous research, which shows that complicated appendicitis is associated with a lower absolute lymphocyte count compared to uncomplicated cases (1, 14). The reason for this is that severe or complicated appendicitis triggers a stronger systemic inflammatory response, leading to increased neutrophil production and a corresponding decrease in lymphocytes (lymphocytopenia) (15, 19). As inflammation and infection progress, lymphocyte levels drop further, making absolute lymphocyte count a valuable indicator for distinguishing between simple and complicated appendicitis (12). Thus, a lower lymphocyte count serves as a marker of more severe or complicated disease and can assist clinicians in guiding diagnostic evaluation and management decisions.

There was a significant difference in absolute lymphocyte count between different age groups (P = 0.005). This finding can be attributed to several factors. Firstly, lymphocyte production naturally declines with age due to immunosenescence, resulting in lower baseline lymphocyte counts in older individuals. Additionally, the inflammatory response to acute appendicitis may vary across age groups, with younger patients typically mounting a more robust lymphocytic response compared to older adults. The presence of comorbidities, which are more prevalent in older populations, can also contribute to altered immune cell dynamics and further suppress lymphocyte counts (2, 16). Furthermore, a significant difference in absolute neutrophil count was observed between genders (P = 0.005), with males exhibiting higher neutrophil counts. This disparity may be explained by hormonal influences, as androgens in males can enhance neutrophil production and function, while estrogens in females may exert a modulating effect on the immune response. Immunological differences between males and females, such as variations in cytokine production and immune cell activation, also play a role. Additionally, behavioral factors, including differences in exposure to infectious agents or healthcare-seeking behavior, may contribute to the observed gender-based differences in neutrophil counts (7, 12).

The findings confirm that both leukocyte count and NLR are valuable and practical markers for diagnosing acute appendicitis and assessing its severity. The majority of patients exhibited leukocytosis, consistent with recent studies (1, 5, 8). NLR was notably higher in complicated cases, supporting its role in risk stratification and clinical decision-making (12, 21-22). While leukocyte count is a useful marker, its specificity is limited, as some patients with appendicitis may have normal counts (8, 19). NLR, as a marker of systemic inflammation, has shown higher diagnostic accuracy in several recent analyses. Our results are consistent with recent meta-analyses and systematic reviews supporting NLR as useful, rapid, cost-effective, sensitive and specific biomarker help clinicians distinguish between uncomplicated and complicated appendicitis, aiding in risk stratification and timely management decisions (8, 22-23).

Conclusion

Leukocyte count and neutrophil-to-lymphocyte ratio (NLR) are valuable, accessible biomarkers for the diagnosis and severity assessment of acute appendicitis. NLR, in particular, demonstrates superior sensitivity and specificity for distinguishing complicated from uncomplicated cases, supporting its role in guiding clinical decision-making. Their use is particularly beneficial in resource-limited settings, where advanced imaging may not be readily available. Integration of these hematologic markers into clinical protocols can enhance early detection, facilitate timely intervention, and improve risk stratification of patients with suspected appendicitis.

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