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The usefulness of hemogram parameters in the differential diagnosis of patients with abdominal pain who are being treated for acute appendicitis

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Abstract

Acute appendicitis (AA) is among the most common immediate surgical operations in children for all age groups. To determine whether complete blood count (CBC) criteria may be used to help physicians differentiate between AA and other causes of abdominal pain in patients who visit the emergency room. The data of 116 patients with abdominal pain who were brought into the emergency room and hospitalized between January 20 and December 21 were analyzed retrospectively. The CBC parameters of 53 patients diagnosed with AA (Group 1) and 63 patients who received non-AA medical treatment (Group 2) were compared. In addition, receiver operating characteristic (ROC) curve analyses were performed to determine the sensitivity and specificity of these parameters at the optimum cutoff values. The M/F ratio of the patients was 36/17 in Group 1 and 40/23 in Group 2. White blood cell (WBC), neutrophil and neutrophil-to-lymphocyte ratio (NLR) values were noticeably higher in AA patients than in patients receiving medical treatment ($p < 0.001$). According to the 9.84 cutoff value of WBC, the sensitivity value was 84.1%, and the specificity was 73.6, for neutrophils, the sensitivity was 87.3% and the specificity was 62.3% (4.81 cutoffs), while 2.19 NLR showed a sensitivity of 74.6% and specificity of 56.6%, with a cutoff value of 2.19. We believe that the values of CBC parameters such as WBC, neutrophil and NLR should still be considered when treating various patient groups and making a differential diagnosis.

Keywords: Abdominal pain, appendicitis, complete blood count

Introduction

The phrase “acute abdomen” refers to a nontraumatic condition in which abdominal pain is the major symptom, which can occur suddenly and requires immediate surgical intervention [1]. One of the most frequent reasons for pediatric intra-abdominal surgery is acute appendicitis (AA). Although its features and treatments were defined more than 100 years ago, appendicitis is still a surgical emergency with the highest rate of misdiagnosis [2]. AA in young patients is still difficult to diagnose clinically. Delayed diagnosis of AA increases the risk

of serious and advanced complications such as perforation [3]. Physicians and parents may find it challenging to understand the nonspecific nature of the symptoms (irritability, loss of appetite, and lethargy) of appendicitis, resulting in a high rate of false positives. Misdiagnosis rates for AA are usually 70% in children under the age of three, 19-57% in preschoolers, 12-28% in school-age children, and up to 15% in adolescents [2,3]. An important consideration in acute appendicitis is timely diagnosis to prevent development of complications, requiring the need to perform an appendectomy. Although there has been a significant

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decrease in acute appendicitis deaths in recent years, there has been no decrease in perforation rates or negative appendectomies despite advances in technology and diagnostic methods [4,5]. The diagnosis of AA includes a combination of physical findings, laboratory findings and imaging studies. [6]

C-reactive protein (CRP), white blood cell count (WBC), erythrocyte sedimentation rate (ESR), and body temperature have nonspecific and variable reliability in distinguishing acute bacterial inflammation from other inflammation types [7]. Recent systemic inflammatory markers include the neutrophil-to-lymphocyte ratio (NLR) and platelet-to-lymphocyte ratio (PLR), which have come to the forefront as effective, easy, and inexpensive methods for reducing negative appendectomy rates [8,9].

The present study examined differences in biochemical markers such as WBC, neutrophil and NLR between children admitted with abdominal pain, patients who underwent surgery, and patients who recovered with medical treatment with a diagnosis of AA.

Material and Methods

The data of 116 patients admitted to the Hisar Intercontinental Hospital Pediatric Surgery Clinic with abdominal pain and hospitalized between January 2020 and December 2021 were analyzed retrospectively. The patients were divided into two groups, namely, received medical treatment group (Group 1) and diagnosed with acute appendicitis group (Group 2). Blood samples were obtained from all research participants at admission or before surgery; WBC, neutrophil, lymphocyte, immature

granulocyte (IG), NLR, red blood cell (RBC), erythrocyte distribution width (RDW), hemoglobin (Hb), mean corpuscular hemoglobin concentration (MCHC), platelet (PLT), and mean platelet volume (MPV) values were studied on Sysmex XN 1000 (Sysmex Corp. Japan).

Inclusion criteria: Children aged 0-17 years admitted with acute abdomen who received inpatient treatment.

Exclusion criteria: Those with underlying comorbidities, those who had previously undergone an appendectomy, and those with trauma history in etiology.

Hisar Intercontinental Hospital's Clinical Research Ethics Committee gave their approval to this study (28.02.2022/22-21).

Statistical analysis

The Statistical Package for the Social Sciences (SPSS) for Windows, version 25.0 (IBM Corp.: Armonk, NY) was used for all analyses. The differences between the data of the patient groups were examined using the Independent Samples Test (Student's T-test). In addition, optimal cut-off values, sensitivity, and specificity values were determined using receiver operating characteristic (ROC) curve analysis. Data is presented as mean values and SD. Statistical significance value was set at $p < 0.05$.

Results

The study included 116 patients. The M/F rate of the patients was 36/17 for Group 1 and 40/23 for Group 2. The mean age of the patients in Group 1 was 6.90 ± 4.42 and 8.12 ± 3.67 in Group 2, with no significant difference between the groups ($p=0.107$) (Table 1, Figure 1).

Table 1. General characteristics and laboratory data of patients included in the study

	Group I (abdominal pain) (N=53)	Group II (acute appendicitis) (N=63)	P
Gender (M/F)	36/17	40/23	
Age (years)	6.90 ± 4.42	8.12 ± 3.67	0.107
WBC ($10^3/\mu\text{L}$)	8.98 ± 3.08	14.12 ± 4.43	0.000*
Neutrophil ($10^3/\mu\text{L}$)	5.04 ± 3.24	9.88 ± 4.80	0.000*
Lymphocyte ($10^3/\mu\text{L}$)	2.89 ± 1.58	2.60 ± 1.53	0.334
NLR	2.76 ± 3.02	6.55 ± 7.01	0.000*
IG ($10^3/\mu\text{L}$)	0.047 ± 0.08	0.043 ± 0.07	0.762
RBC ($10^6/\mu\text{L}$)	4.49 ± 0.37	4.47 ± 0.35	0.632
Hb (g/dL)	11.85 ± 2.47	12.21 ± 1.18	0.308
MCHC(g/dL)	33.50 ± 3.18	33.68 ± 2.96	0.746
RDW (fL)	12.41 ± 1.52	12.46 ± 1.41	0.853
PLT ($10^3/\mu\text{L}$)	304.90 ± 94.51	289.22 ± 98.65	0.387
MPV (fL)	9.55 ± 1.08	9.86 ± 1.80	0.274

NLR: neutrophil-to-lymphocyte ratio, IG: immature granulocyte, * $p < 0.001$

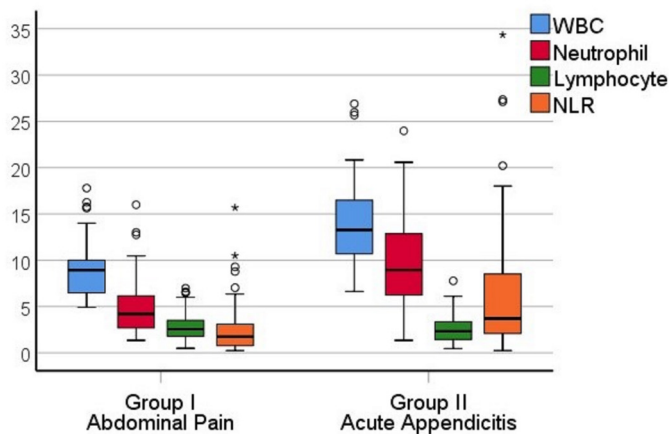


Figure 1. Box plots of white cell count (WBC), neutrophil, and lymphocyte counts (10³/μL) as well as Neutrophil-to-Lymphocyte Ratio (NLR) in patient groups

Patients who were admitted with acute abdomen and received medical treatment comprised Group 1 (n=53), while patients who were diagnosed with acute appendicitis and underwent appendectomies comprised Group 2 (n=63).

There was no significant difference between Group 1 and Group 2 patients in terms of IG, RBC, Hb, MCHC, RDW, PLT, or MPV values (P>0.05). However, there was a significant difference in terms of WBC, neutrophils, lymphocytes, and NLR values (p<0.001) (Table 1).

WBC and neutrophil counts were found to be valuable parameters for acute appendicitis in the ROC curve analysis, with area under the curve (AUC) values of 0.852 and 0.808, respectively (p<0.001). While the AUC value of lymphocytes was low, NLR neutrophil can be considered a marker due to its AUC value of 0.726 (Table 2, Figure 2).

Table 2. Optimal cut-off values, AUC, sensitivity and specificity values

	Sensitivity %	Specificity %	Cut-off value	AUC	p
WBC 10³/μL	84.1	73.6	9.84	0.852	0.000*
Neutrophil 10³/μL	87.3	62.3	4.81	0.808	0.000*
Lymphocyte 10³/μL	45.3	61.9	2.71	0.449	0.343
NLR	74.6	56.6	2.19	0.726	0.000*

AUC: area under the ROC curve, NLR: neutrophil-to-lymphocyte ratio, *p<0.001

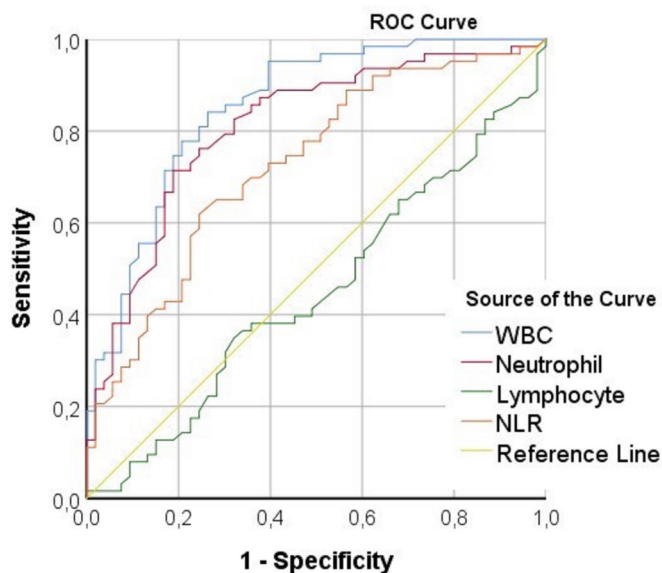


Figure 2. Receiver Operating Characteristics (ROC) analysis of white cell count (WBC), Neutrophil, Lymphocyte and Neutrophil-to-Lymphocyte Ratio (NLR)

Discussion

Acute appendicitis in young patients is still difficult to diagnose clinically. Delayed diagnosis of AA increases the risk of serious and advanced complications such as perforation [3,10]. According to reports, individuals who have had appendectomies and have symptoms that continue longer than 24 hours are more likely to develop severe appendicitis. Therefore, there is a growing need to research easy and affordable biochemical test conditions that can aid in diagnosis [11].

Due to the increase in the rate of perforation caused by delays in diagnosis, research on early diagnosis continues as well. In medical practice, the WBC count is commonly used to diagnose AA. An increase in WBC values is correlated with how severe AA is, but it is not absolute and is not reliable in predicting the extent of the disease [12]. In the current research, the WBC values of the AA group were significantly higher than those of the medical treatment group (p=0.000). This is consistent with the literature.

The WBC, MPV, RDW, NLR and PLR are known to reflect inflammatory processes. Some studies have shown that these inflammatory markers are valuable [13]. WBC and neutrophil

values are often high in AA [14]. The NLR, PLR, and systemic immune-inflammation index (SII) are biomarkers calculated from complete blood count (CBC) and each has reportedly been found to be helpful in the diagnosis, follow-up, and examination of numerous inflammatory processes throughout the body [15].

The WBC and neutrophil counts were observed to be significantly higher in the AA group in the current study. Furthermore, WBC was found to be useful for AA in the ROC curve analysis, with AUC values of 0.852.

Acute appendicitis diagnosis and appendiceal perforation prediction have both been achieved by using NLR values [9].

In a study by Markar et al. [16], the diagnostic value of NLR was more significant than that of WBC in 1117 pediatric patients who underwent appendectomies. In the present study, neutrophil values were more significant. Additionally, the NLR in the AA group was also discovered to be considerably greater. While the AUC value for lymphocytes was low, the NLR could be considered a marker due to its AUC value of 0.726.

High WBC and NLR values alone are insufficient to safely and adequately confirm or exclude the diagnosis of AA.

While MPV increases in many chronic diseases, it decreases in many acute diseases [17,18]. MPV was found to be lower in patients with acute appendicitis than in controls in a study looking at the connection between acute appendicitis and MPV in children [3]. The present study found no significant difference between the two groups in terms of MPV.

In a study investigating biochemical markers in the diagnosis of acute appendicitis in pregnant patients, neutrophil count, WBC and PLR were found to be the most valuable inflammatory parameters, while RDW, lymphocyte count and MPV levels were not valuable markers in terms of sensitivity and specificity [19]. Another study examining the effectiveness of hemogram parameters in the differential diagnosis of acute appendicitis and renal colic in the emergency department suggested that PLR and NLR values could be used in the differential diagnosis of renal colic in the acute period [20].

The present research had some limitations. Its nature of being a retrospective, two-year and single-center study can be attributed to the limited number of patients. The effect of time within the parameters could not be examined because patients were not asked when their pain began nor was this information recorded. Furthermore, imaging methods or pathological findings were not included in the study.

Conclusions

In conclusion, in our study, high WBC, NLR and neutrophil values can be some of the basic parameters that can be used to distinguish patients with AA from those receiving medical treatment. In this study, we examined the differences in biochemical markers between children presenting with abdominal pain, patients who underwent surgery and patients who were diagnosed with AA and recovered with medical treatment. Further research is needed on this subject.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

This study was approved by the Clinical Research Ethics Committee of Hisar Intercontinental Hospital (28.02.2022/22-21).

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References

1. Flum DR, Koepsell T. The clinical and economic correlates of misdiagnosed appendicitis: nationwide analysis. *Arch Surg.* 2002;137:799-804.
2. Rothrock SG, Pagane J. Acute appendicitis in children: emergency department diagnosis and management. *Ann Emerg Med.* 2000;36:39-51.
3. Bilici S, Sekmenli T, Göksu M, et al. Mean platelet volume in diagnosis of acute appendicitis in children. *Afr Health Sci.* 2011;11427-32.
4. Bal A, Anil M, Nartürk M, et al. Importance of clinical decision making by experienced pediatric surgeons when children are suspected of having acute appendicitis: the reality in a high-volume pediatric emergency department. *Pediatr Emerg Care.* 2017;33:e38-e42.
5. Zachos K, Fouzas S, Kolonitsiou F, et al. Prediction of complicated appendicitis risk in children. *Eur Rev Med Pharmacol Sci.* 2021;25:7346-53.
6. Xiong B, Zhong B, Li Z, et al. Diagnostic accuracy of noncontrast CT in detecting acute appendicitis: a meta-analysis of prospective studies. *Am Surg.* 2015;81:626-9.
7. Meisner M. Pathobiochemistry and clinical use of procalcitonin. *Clin Chim Acta.* 2002;323:17-29.
8. Yang HR, Wang YC, Chung PK, et al. Role of leukocyte count, neutrophil percentage, and C-reactive protein in the diagnosis of acute appendicitis in the elderly. *Am Surg.* 2005;71:344-7.
9. Shimizu T, Ishizuka M, Kubota K. A lower neutrophil to lymphocyte ratio is closely associated with catarrhal appendicitis versus severe appendicitis. *Surg Today.* 2016;46:84-9.
10. Özçelik Z, Cesur İB, Tolunay O, Külahçı Ö. Acute appendicitis findings in children during the COVID-19 pandemic containment process. *J Contemp Med.* 2022;12:144-8.
11. Pehlivanlı F, Aydın O. Role of platelet to lymphocyte ratio as a biomedical marker for the pre-operative diagnosis of acute appendicitis. *Surg Infect (Larchmt).* 2019;20:631-6.
12. Nyuwi KT, Singh CG, Khumukcham S, et al. The role of serum fibrinogen level in the diagnosis of acute appendicitis. *J Clin Diagn Res.* 2017;11:PC13-PC15.
13. Peksöz R, Bayar B. The role of complete blood count parameters in diagnosing acute appendicitis and measuring the severity of inflammation. *Ulus Travma Acil Cerrahi Derg.* 2021;27:654-61.
14. Al-Gaithy ZK. Clinical value of total white blood cells and neutrophil counts in patients with suspected appendicitis: retrospective study. *World J Emerg Surg.* 2012;7:32.
15. Furuncuoğlu Y, Tulgar S, Dogan AN, et al. How obesity affects the neutrophil/lymphocyte and platelet/lymphocyte ratio, systemic immune-inflammatory index and platelet indices: a retrospective study. *Eur Rev Med Pharmacol Sci.* 2016;20:1300-6.

16. Markar SR, Karthikesalingam A, Falzon A, Kan Y. The diagnostic value of neutrophil: lymphocyte ratio in adults with suspected acute appendicitis. *Acta Chir Belg.* 2010;110:543-7.
17. Erdem H, Aktimur R, Cetinkunar S, et al. Evaluation of mean platelet volume as a diagnostic biomarker in acute appendicitis. *Int J Clin Exp Med.* 2015;8:1291-5.
18. Peksöz R, Dişçi E, Kaya A, et al. Significance of laboratory parameters in diagnosing acute appendicitis during pregnancy. *ANZ J Surg.* 2022;92:121-7.
19. Somuncu E, Bozdog E, Sarici I, et al. The diagnostic role of hemogram parameters in pregnant appendicitis. *Pol Przegl Chir.* 2021;94:48-53.
20. Sönmez A, Avcı A, Sönmez G, et al. The efficacy of hemogram parameters in the differential diagnosis of renal colic and acute appendicitis in the emergency department. *Ulus Travma Acil Cerrahi Derg.* 2021;27:26-33.