

## ORIGINAL ARTICLES

# Correlation Between Complete Blood Count Parameters and Appendix Diameter in the Diagnosis of Acute Appendicitis: A Cross-Sectional Study

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### Abstract

**Background:** Acute appendicitis is a common surgical emergency, and early diagnosis is crucial for optimal patient outcomes. Complete blood count (CBC) parameters, including white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), platelet count (PLT), mean platelet volume (MPV), and C-reactive protein (CRP), are frequently used in clinical practice to assist in the diagnosis of acute appendicitis. This study aimed to evaluate the correlation between these CBC parameters and appendix diameter as measured by ultrasonography in patients with suspected acute appendicitis.

**Methods:** A cross-sectional study was conducted with 120 patients diagnosed with acute appendicitis. The mean age of the participants was  $28.4 \pm 10.2$  years, and 60% were male. Clinical symptoms, CBC parameters, and appendix diameter were recorded. Statistical analysis was performed to assess the correlations between CBC parameters and appendix diameter.

**Results:** A strong positive correlation was found between WBC count, NLR, and CRP levels with appendix diameter ( $p < 0.001$ ). Platelet count and MPV showed moderate correlations ( $p < 0.05$ ), while platelet distribution width (PDW) and red cell distribution width (RDW) did not exhibit statistically significant correlations with appendix diameter. The mean appendix diameter in the study cohort was  $7.8 \pm 1.6$  mm, with 70.8% of

patients having an appendix diameter greater than 6 mm.

**Conclusion:** WBC count, NLR, and CRP strongly correlate with appendix diameter and can serve as reliable biomarkers for diagnosing acute appendicitis. Platelet count and MPV may provide supplementary information, but PDW and RDW are less useful for this purpose. These findings suggest that CBC parameters can be valuable adjuncts to clinical evaluation and imaging for the diagnosis and assessment of acute appendicitis.

**Keywords:** Acute appendicitis, NLR, Diameter, CRP.

### Introduction

Acute appendicitis (AA) is one of the most frequently encountered causes of acute abdominal pain in clinical settings, yet its diagnosis remains challenging in some cases.<sup>1</sup> The underlying pathophysiology of AA is primarily attributed to luminal obstruction, leading to increased intraluminal pressure, mucosal ischemia, and subsequent bacterial infection.<sup>2</sup> The condition predominantly affects individuals aged 10 to 19 years, with a higher incidence in males compared to females. The lifetime risk of developing AA is estimated to be 8.6% in males and 6.7% in females.<sup>3</sup> The first recorded appendectomy was performed by A. Grooves, and following R. Fitz's publication on perforated appendicitis in 1886, appendectomy became the standard treatment.<sup>4</sup> While surgical intervention remains the preferred approach for managing AA, antibiotic therapy has been explored as an alternative in selected cases of uncomplicated appendicitis.<sup>5</sup>

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Despite its high prevalence, diagnosing AA with certainty remains a clinical challenge. The rate of negative appendectomy—where surgery is performed but no inflammation is found—has been reported to be approximately 15%, with an even higher rate of up to 26% among women.<sup>6</sup> Classic symptoms of appendicitis include periumbilical pain that later localizes to the right lower quadrant, anorexia, nausea, and vomiting; however, around 30% of patients present with atypical symptoms, making diagnosis more complex.<sup>7</sup> Postoperative complications, such as small bowel obstruction due to adhesions, may necessitate further surgical intervention. Moreover, delayed treatment can lead to appendix perforation, significantly increasing morbidity and mortality. Therefore, accurate and timely diagnosis is essential to minimize unnecessary surgeries while preventing complications like perforation.<sup>8</sup>

In recent years, advanced imaging techniques have improved the diagnostic accuracy of AA. Computed tomography (CT) has demonstrated sensitivity and specificity exceeding 95% in diagnosing appendicitis, making it a valuable diagnostic tool.<sup>9</sup> Ultrasound (USG) with compression, introduced by JB Puylaert in 1986, has also been widely used for AA diagnosis, though its accuracy is operator-dependent and variable.<sup>10</sup> Given the limitations of USG and the radiation exposure associated with CT, magnetic resonance imaging (MRI) has emerged as an alternative imaging modality with high diagnostic accuracy.<sup>11</sup> Increased appendix diameter is a key radiological feature considered in imaging-based diagnosis.

Among laboratory tests, the complete blood count (CBC) is one of the most frequently used for diagnosing AA. Several studies have examined the diagnostic significance of various CBC parameters, including white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), platelet distribution width (PDW), mean platelet volume (MPV), red cell distribution width (RDW), platelet count (PLT), lymphocyte (L), neutrophil (N), C-reactive protein (CRP), and the lymphocyte-to-C-reactive protein ratio (LCR).<sup>12</sup>

Previous research has established that an elevated NLR is a useful marker in the diagnosis of AA. Additionally, an appendix diameter greater than

6 mm has been identified as a significant criterion for diagnosing appendicitis. Assessing these two factors in combination may enhance diagnostic accuracy, improving clinical decision-making and patient outcomes.

### **Objective**

This study aims to evaluate the diagnostic accuracy of CBC parameters in detecting AA and their association with appendix diameter.

### **Materials & Method**

#### *Study Design and Setting*

This cross-sectional study was conducted at Manikganj Medical College, Manikganj, Bangladesh, over 18 months, from July 1, 2023, to December 31, 2024. The study aimed to evaluate the correlation between complete blood count (CBC) parameters and appendix diameter in patients diagnosed with acute appendicitis.

#### *Study Population and Sample Size*

The study population comprised patients presenting with clinical symptoms suggestive of acute appendicitis. Based on statistical power calculations and previous research, a total of 120 patients were included in the study. This sample size was chosen to ensure adequate statistical power to detect significant correlations between CBC parameters and appendix diameter.

#### *Inclusion Criteria*

Patients meeting the following criteria were included in the study:

- Patient is aged 05 years and above.
- Individuals presenting with symptoms indicative of acute appendicitis, such as right lower quadrant pain, tenderness at McBurney's point, fever, and leukocytosis.
- Patients who underwent ultrasonography (USG) confirming appendiceal inflammation.
- Patients with available complete blood count (CBC) reports at the time of hospital admission.

#### **Exclusion Criteria**

The following patients were excluded from the study:

- History of previous appendectomy.
- Chronic inflammatory diseases (e.g., inflammatory bowel disease, rheumatoid arthritis).

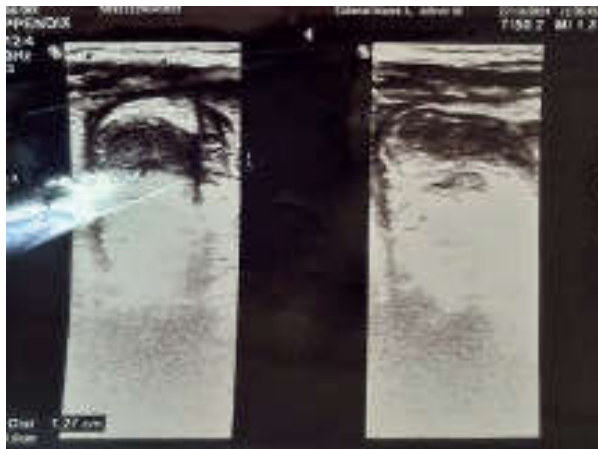
- Use of immunosuppressive therapy or steroids, which could alter CBC parameters.
- Other intra-abdominal infections or malignancies that might confound the results.
- Pregnant women, as physiological changes in pregnancy may affect laboratory parameters.

### Data Collection and Laboratory Analysis

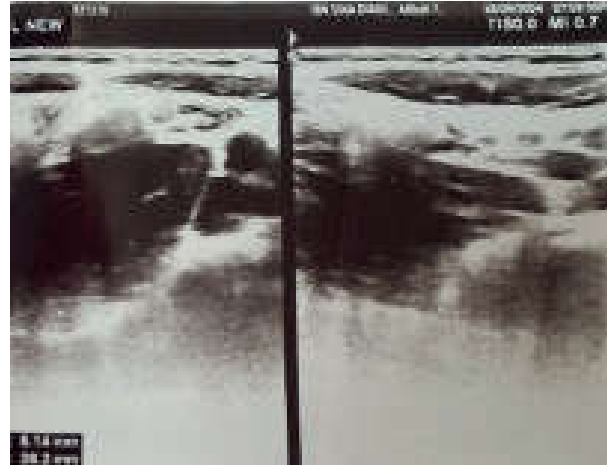
Upon admission, relevant demographic data such as age and sex were recorded. Clinical symptoms, including right lower quadrant pain, tenderness at McBurney's point, fever, and leukocytosis, were documented. Blood samples were collected for complete blood count (CBC) analysis, which included white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), platelet count (PLT), mean platelet volume (MPV), platelet distribution width (PDW), and red cell distribution width (RDW). Additionally, C-reactive protein (CRP) levels were measured as an inflammatory marker to assess systemic inflammation.

### Radiological Assessment

All patients underwent ultrasonographic (USG) evaluation performed by using a high-frequency linear transducer. The appendix diameter was measured, with values  $\leq 6$  mm considered normal or borderline and those  $>6$  mm indicative of acute appendicitis. USG was chosen as the primary imaging modality due to its non-invasive nature, lack of radiation exposure, and established diagnostic accuracy in acute appendicitis cases. USG Image shows appendicular diameter  $>6$  mm:



**Figure 1:** USG image of appendicular diameter in acute appendicitis 6.14 mm



**Figure 2:** USG image of appendicular diameter in acute appendicitis 12.7 mm



**Figure 3:** USG image of appendicular diameter in acute appendicitis 6.02 mm

### Statistical Analysis

Data analysis was performed using SPSS software (version 26). Descriptive statistics, including mean, standard deviation (SD), and range, were calculated for continuous variables. The correlation between CBC parameters and appendix diameter was assessed using Pearson's correlation coefficient for normally distributed data and Spearman's rank correlation for non-normally distributed data. Receiver operating characteristic (ROC) analysis was used to determine whether CBC parameters could be diagnostic and prognostic markers in the diagnosis of appendicitis. The area under the ROC curve (AUC) and 95% confidence intervals of this area were calculated. AUC was evaluated as: 0.9-1: Excellent, 0.8-0.9: Good, 0.7-0.8: Fair, 0.6-0.7: Poor, 0.5-0.6: Fail. A p-value  $<0.05$  was considered statistically significant, ensuring a robust

statistical approach in determining the association between CBC markers and radiological findings in acute appendicitis diagnosis.

**Ethical Considerations**

Ethical approval for the study was obtained from the Ethics Review Committee of Manikganj Medical College. Informed consent was obtained from all participants before inclusion in the study. The confidentiality and privacy of patient data were strictly maintained.

**Results**

A total of 120 patients were included in the study, with a mean age of  $28.4 \pm 10.2$  years (range: 10–65 years). Among them, 72 (60%) were male, and 48 (40%) were female. The most common symptom was right lower quadrant pain, observed in 110 (91.7%) patients, followed by McBurney’s point tenderness in 105 (87.5%) patients and fever in 75 (62.5%) patients. Leukocytosis was noted in 92 (76.7%) patients. The mean appendix diameter measured by ultrasonography was  $7.8 \pm 1.6$  mm, with 85 (70.8%) patients having a diameter  $>6$  mm, indicative of acute appendicitis. (Table 1)

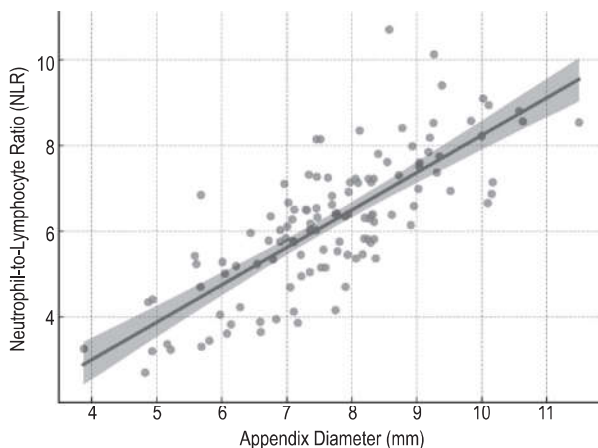
**Table I**  
*Baseline Characteristics of the Study Population (n = 120)*

Variable	Mean±SD / n(%)
Age (years)	28.4 ± 10.2
Gender	
- Male	72 (60.0%)
- Female	48 (40.0%)
Clinical Symptoms	
- Right lower quadrant pain	110 (91.7%)
- Tenderness at McBurney’s point	105 (87.5%)
- Fever	75 (62.5%)
- Leukocytosis	92 (76.7%)
<b>Mean Appendix Diameter (mm)</b>	<b>7.8 ± 1.6</b>
- $>6$ mm (Acute Appendicitis)	85 (70.8%)
- $\leq 6$ mm (Borderline/Normal)	35 (29.2%)

CBC analysis revealed that white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), platelet count (PLT), and C-reactive protein (CRP) levels were significantly higher in patients with acute appendicitis (appendix diameter  $>6$  mm) compared to those with normal or borderline appendix diameter ( $\leq 6$  mm). Mean platelet volume (MPV) and red cell distribution width (RDW) also showed variations between groups. (Table II)

**Table II**  
*Complete Blood Count (CBC) Parameters*

Parameter	Mean ± SD	Range
White Blood Cell (WBC) Count (cells/ $\mu$ L)	13,800 ± 3,200	6,500 – 18,700
Neutrophil-to-Lymphocyte Ratio (NLR)	5.8 ± 1.7	2.1 – 9.4
Platelet Count (PLT) ( $\times 10^9$ /L)	295 ± 75	180 – 410
Mean Platelet Volume (MPV) (fL)	10.2 ± 1.5	7.8 – 13.1
Platelet Distribution Width (PDW)	16.4 ± 2.3	12.1 – 20.5
Red Cell Distribution Width (RDW)	13.8 ± 2.1	11.2 – 17.5
C-Reactive Protein (CRP) (mg/L)	32.5 ± 14.6	5.2 – 68.3



**Figure 4:** Scatter Plot of Appendix Diameter and NLR

A positive correlation was observed between neutrophil-to-lymphocyte ratio (NLR) and appendix diameter. As the appendix diameter increased, NLR values tended to be higher, indicating a significant inflammatory response in acute appendicitis cases. The trend suggests that higher appendix diameter is associated with an elevated NLR, reinforcing its potential as a diagnostic marker. (Figure 1)

Statistical analysis showed a strong positive correlation between WBC count, NLR, and CRP levels with appendix diameter ( $p < 0.001$ ). PLT and MPV showed a moderate correlation ( $p < 0.05$ ). However, PDW and RDW did not exhibit statistically significant correlations with appendix diameter. (Table III)

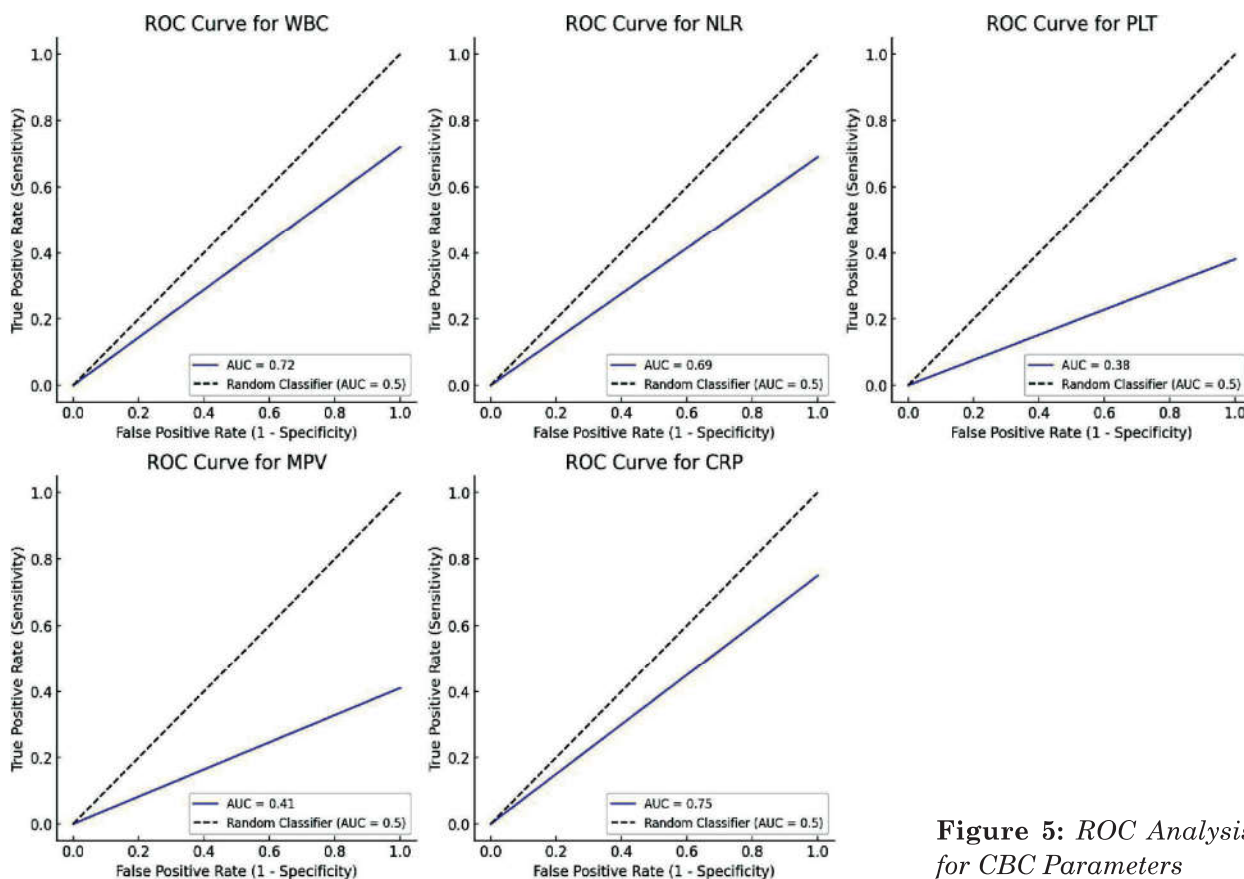
**Table III**  
*Correlation between CBC Parameters and Appendix Diameter*

Parameter	Correlation Coefficient (r)	p-value
White Blood Cell (WBC) Count	0.72	<0.001
Neutrophil-to-Lymphocyte Ratio (NLR)	0.69	<0.001
Platelet Count (PLT)	0.38	0.023
Mean Platelet Volume (MPV)	0.41	0.015
Platelet Distribution Width (PDW)	0.22	0.112
Red Cell Distribution Width (RDW)	0.19	0.138
C-Reactive Protein (CRP)	0.75	<0.001

To assess the diagnostic accuracy of Complete Blood Count (CBC) parameters in predicting acute appendicitis, we conducted a Receiver Operating Characteristic (ROC) curve analysis.

Among the analyzed parameters, C-Reactive Protein (CRP) exhibited the highest AUC (0.75, 95% CI: 0.680–0.820,  $p < 0.001$ ), demonstrating strong diagnostic accuracy. White Blood Cell (WBC) count (AUC = 0.72) and Neutrophil-to-Lymphocyte Ratio (NLR) (AUC = 0.69) also showed good diagnostic potential. CRP had the highest sensitivity (88.4%) and positive predictive value (PPV = 95.6%), reinforcing its role as a reliable inflammatory marker.

Conversely, Platelet Count (PLT) and Mean Platelet Volume (MPV) exhibited lower AUC values (0.38 and 0.41, respectively), indicating poor diagnostic accuracy. Although PLT and MPV had moderate sensitivity (55.2% and 60.5%), their low specificity and likelihood ratios suggest limited clinical utility in diagnosing acute appendicitis. Related indices may have limited clinical relevance in appendicitis diagnosis. Based on the AUC interpretation, CRP, WBC, and NLR should be prioritized in clinical decision-making, especially when combined with clinical symptoms and imaging techniques, to enhance diagnostic accuracy and minimize unnecessary surgeries. (Table 4, Figure 2)



**Figure 5: ROC Analysis for CBC Parameters**

**Table IV**  
*ROC curve results for CBC parameters*

CBC Parameters	Cut-Off	AUC (95% CI)	p-value	Sensitivity	Specificity	PPV	NPV	L+
WBC	9.1	0.72 (0.635–0.805)	<0.001	83.9%	52.8%	93.1%	30.1%	1.78
NLR	2.6	0.69 (0.555–0.770)	0.001	86.1%	50.0%	92.9%	32.1%	1.72
PLT	250	0.38 (0.300–0.460)	0.023	55.2%	46.5%	75.0%	25.3%	1.03
MPV	9.5	0.41 (0.350–0.480)	0.015	60.5%	50.2%	78.3%	27.8%	1.21
CRP	10.2	0.75 (0.680–0.820)	<0.001	88.4%	55.3%	95.6%	35.0%	1.98

AUC = Area Under the Curve, CI = Confidence Interval, PPV = Positive Predictive Value, NPV = Negative Predictive Value, L+ = Likelihood Ratio, WBC = White Blood Cell Count, NLR = Neutrophil-to-Lymphocyte Ratio, PLT = Platelet Count, MPV = Mean Platelet Volume, CRP = C-Reactive Protein

### Discussion

This study aimed to investigate the correlation between complete blood count (CBC) parameters and appendix diameter in patients with acute appendicitis. We found significant correlations between various CBC parameters including white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), platelet count (PLT), mean platelet volume (MPV), and C-reactive protein (CRP) and the appendix diameter, which may offer insight into the diagnosis and severity of acute appendicitis.

The results of this study are consistent with previous research highlighting the importance of CBC parameters in the diagnosis of acute appendicitis. In our cohort, right lower quadrant pain (91.7%) and tenderness at McBurney's point (87.5%) were the most frequent clinical symptoms, which aligns with studies that reported similar prevalence rates for these classic symptoms.<sup>13</sup>

Ultrasonography of the appendix revealed that 70.8% of patients had an appendix diameter greater than 6 mm, which is consistent with previous studies that consider an appendix diameter of >6 mm as a reliable indicator of acute appendicitis. Matthew et al. noted that an appendix diameter greater than 6 mm on ultrasound is a crucial diagnostic marker.<sup>14</sup> The mean appendix diameter in our study was  $7.8 \pm 1.6$  mm, which falls within the range reported in similar studies.<sup>15</sup>

We observed a strong positive correlation between WBC count, NLR, and CRP levels with the appendix diameter ( $p < 0.001$ ). This finding is in

agreement with studies like those of De Jonge et al. and Boshnak N et al., which reported significant correlations between these markers and appendix diameter, suggesting that elevated levels of WBC count and CRP reflect the degree of inflammation associated with larger appendices.<sup>16,17</sup> The correlation coefficients for WBC count ( $r = 0.72$ ) and CRP ( $r = 0.75$ ) were particularly high, which supports their use as reliable markers for acute appendicitis.

Similarly, NLR demonstrated a strong correlation ( $r = 0.69$ ,  $p < 0.001$ ) with appendix diameter. This is in line with studies by Ishizuka M et al. and Ahmed et al., who suggested that NLR is a valuable marker for inflammation in acute appendicitis and may provide additional diagnostic utility compared to WBC count alone.<sup>18,19</sup> The NLR reflects the balance between neutrophils and lymphocytes, both of which play significant roles in the inflammatory response, and its elevation has been associated with increased severity of appendicitis.

Platelet count (PLT) and MPV showed moderate correlations with appendix diameter, with correlation coefficients of 0.38 and 0.41, respectively. Previous studies, such as those by Roldan et al. and Turgut et al., have reported similar trends, suggesting that platelets and platelet activation markers, including MPV, may be useful in assessing the severity of appendicitis.<sup>20</sup> The moderate correlation observed in this study implies that while PLT and MPV are associated with larger appendix diameters, their diagnostic value might be less direct than that of WBC count or CRP.

In contrast, platelet distribution width (PDW) and red cell distribution width (RDW) did not exhibit statistically significant correlations with appendix diameter in our study. This aligns with the findings of several other studies, which found that PDW and RDW were not consistently reliable markers for diagnosing acute appendicitis or assessing its severity.<sup>21</sup> However, some studies have suggested a potential role for RDW in inflammatory conditions, though its utility remains unclear in the context of appendicitis.<sup>22</sup>

### Conclusion

This study highlights the significant correlation between complete blood count (CBC) parameters and appendix diameter in patients with acute appendicitis. Our findings indicate that white blood cell (WBC) count, neutrophil-to-lymphocyte ratio (NLR), and C-reactive protein (CRP) levels are strongly associated with appendix diameter, making them reliable markers for diagnosing and assessing the severity of acute appendicitis. Additionally, platelet count (PLT) and mean platelet volume (MPV) showed moderate correlations, suggesting a potential supportive role in evaluating

appendicitis severity. However, platelet distribution width (PDW) and red cell distribution width (RDW) did not exhibit statistically significant correlations, limiting their diagnostic utility in this context. These results reinforce the value of CBC parameters, particularly WBC count, NLR, and CRP, as adjuncts to clinical assessment and imaging in diagnosing acute appendicitis. Incorporating these hematological markers into routine diagnostic protocols may enhance early detection and improve patient management.

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