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Original Research Article

Role of Mean Platelet Volume (MPV), Platelet Distribution Width (PDW) and Total Leucocyte Count (TLC) in Acute Appendicitis: A Prospective Study

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Abstract

Background: Acute appendicitis is one of the most common surgical emergencies worldwide, and prompt diagnosis significantly reduces morbidity and mortality. Delay in the diagnosis and surgical intervention may lead to complications and increased morbidity and mortality. The severity of acute appendicitis is associated with inflammation, and platelets play prominent roles in inflammatory processes. This study aims to evaluate the role of platelet indices, including mean platelet volume (MPV) and platelet distribution width (PDW), in the diagnosis of acute appendicitis.

Materials and Methods: A prospective cross-sectional study was conducted over two years among 198 patients undergoing appendicectomy, selected by purposive sampling at the Department of General Surgery, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal. Patients' demographic characteristics, imaging findings, preoperative laboratory markers (MPV, PDW, TLC), and postoperative histopathology results were recorded. Descriptive statistics such as means, medians, frequencies, and percentages were used. Chi-square test and independent t-test were used to compare proportions and means respectively. Spearman correlation was used to examine the relationship. P-Values of <0.05 were considered statistically significant.

Results: Among 198 patients who participated in the study, the majority (70.2%, n=139) had acute appendicitis. The mean MPV was highest in the acute appendicitis with periappendicitis group (9.54±2.18), followed by the acute appendicitis group (9.23±1.84). The mean TLC (15112.97 ± 2693.68) was highest in the gangrenous group. A statistically significant association was observed between MPV and TLC value with the degree of appendicitis. (P-value<0.05)

Conclusion: Elevated leucocyte count and platelet indices (MPV and PDW) levels support the diagnosis of acute appendicitis. The levels of the MPV, PDW, and leucocyte count are significantly correlated with pathological findings.

Keywords: Acute Appendicitis; Mean Platelet Volume; Platelet Distribution Width; Total Leucocyte Count; Inflammation.

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Introduction

Acute appendicitis is one of the most common surgical emergencies worldwide, and prompt diagnosis significantly reduces morbidity and mortality. [1] The first description of the structure of the appendix was given by Jacopo Berengario da Carpi in 1522. The first successful appendectomy was performed in 1735 by Claudius Amyand. In 1880, Robert Lawson Tait made the first diagnosis of appendicitis and surgically removed the appendix. Later, in 1886, Reginald Heber Fitz published a study on appendicitis, introduced the term "appendicitis," and named the surgical

procedure "appendectomy." [2] Charles McBurney described the area of maximal tenderness in appendicitis. Kurt Semm introduced laparoscopic appendicectomy in 1988. [3] Classically, the diagnosis of acute appendicitis is based on a brief history of abdominal pain, nausea, migration of pain to the right iliac fossa, and signs of localised peritonitis. The diagnostic accuracy based on these symptoms ranges from 70% to 80%. [4] However, diagnostic errors are common, and as a result, clinical scoring systems have been developed to diagnose acute appendicitis, but they are insufficient to predict the complication.

The progression from acute inflammation to perforation generally occurs within a few days. [5] Delay in the diagnosis and surgical intervention for AA may lead to perforation of the appendix, peritonitis, and systemic septic complications with an increase in morbidity and mortality rates. [6] The introduction of ultrasonography and computed tomography has considerably decreased negative appendectomy rates; however, higher perforation rates still remain. [7,8]

Therefore, an early and accurate diagnosis of acute appendicitis may contribute to reducing the perforation rates, risk of peritonitis or sepsis, and the number of unnecessary operations. The severity of acute appendicitis is associated with the extent of inflammation. [9] In addition, platelet indices (PDW, MPV) and TLC play prominent roles in inflammatory processes. [10]

Recently, MPV, PDW, and TLC have been evaluated as inflammatory markers in several inflammatory diseases, including cardiovascular and cerebrovascular disorders, endometriosis, pulmonary disease, and acute appendicitis. [11-16] Accordingly, a study was conducted to evaluate the pre-operative diagnostic value of MPV, PDW, and TLC in acute appendicitis and to compare these parameters with post-operative histopathological findings in patients undergoing appendectomy, in order to determine whether these indices can serve as reliable non-invasive biomarkers for the pre-operative diagnosis of acute appendicitis.

Materials and Methods

Study design and Setting: This was a prospective cross-sectional study conducted in the Department of General Surgery, Jawaharlal Nehru Institute of Medical Science (JNIMS), Porompat, Imphal, Manipur, over a 2-year period from 1st August 2022 to 31st July 2024. The study aimed to evaluate the pre-operative diagnostic value of MPV, PDW, and TLC in acute appendicitis and to compare these parameters with post-operative histopathological findings in patients undergoing appendectomy to determine whether these indices can serve as reliable non-invasive biomarkers for the pre-operative diagnosis of acute appendicitis.

Study population: Patients undergoing appendicectomy in the General Surgery department were selected purposively until the sample size of 198 was reached. The sample size was calculated using n = Zα2PQ/e2 where, P=84.8% (ME Günes et al. [29])

Eligible Criteria: Patients aged 18-60 years attending the hospital with a clinical diagnosis of acute appendicitis and undergoing appendectomy. Pregnant females, patients on steroids, immunocompromised patients, patients on chemotherapy for malignancy, Patients with hematologic disorders and severe comorbidities such as liver disease, heart failure, and peripheral vascular disease, and who did not give consent were excluded from the study.

Data collection: A total of 198 patients who underwent appendectomy were included in this study. Patients' demographic characteristics, imaging findings, pre-operative laboratory markers (MPV, PDW, TLC), and post-operative histopathology results were recorded using the tool attached in Annexure. The patients were divided into three groups based on histopathologic findings: acute appendicitis, acute appendicitis with peri-appendicitis, and gangrenous appendicitis. Cell blood count analysis was performed on patients' venous blood samples. Blood samples were obtained at the patient's admission or within 24 hrs of diagnosis of acute appendicitis and drawn into tubes containing EDTA to analyze complete blood count and platelet indices using an automated hematologic analyzer. Normal values were defined as follows: TLC 4.0 to 11.0 × 103/µL, MPV 8 to 12 fL, PDW 9 to 14 fL. The correlation between laboratory markers and histopathology outcomes was examined.

Surgical Procedure: Under spinal anaesthesia, the patient was placed in the supine position. Scrubbing was performed with cetrimide, followed by painting with 10% povidone-iodine, then draping. A gridiron incision was made. Two layers of superficial fascia were cut. The external oblique aponeurosis was opened in the line of incision. Internal oblique and transverse muscles are to be split in the line of fibres. The peritoneum is to be opened in the line of incision. The caecum is identified by the taenia and the ileocaecal valve junction. Omentum, when adherent, was separated. The appendix was held with Babcock's forceps. Mesoappendix with appendicular artery was ligated. The base of the appendix was transfixed. The appendix was cut distal to the suture ligature and removed. Stump was cleaned with 10% povidone-iodine. An appendix specimen was

collected in formalin and sent for Histopathological examination.

Statistical Analysis: All the data was analysed with SPSS version 23. Continuous data were expressed as mean ± standard deviations or medians, while categorical data were expressed as frequency and percentages. Normality of data distribution was verified using the Kolmogorov-Smirnov test.

Comparison between variables was performed using Student t-test for continuous variables and Chi-Square test for categorical variables. Spearman correlation was used to examine the relationship between laboratory markers and histopathology results. P-Values of <0.05 were considered statistically significant.

Ethical Issues: The study protocol was approved by the Institutional Ethics Committee prior to commencement. Informed written consent was obtained from all participants, and confidentiality of patients' information was strictly maintained throughout the study.

Results

A total of 198 patients who had undergone appendectomy with acute appendicitis were included in the study. The mean age of the participants was 33.30 ± 12.10.

The majority of the participants were female (59.1%). We found that the mean age of female patients (34.72 ± 12.52) was significantly higher than that of male patients (31.26 ± 11.23). (Table 1)

Table 1: Distribution of Mean age according to their sex (N=198)

Sex	Mean age (Mean ± SD)	t-value	P-Value
Male	31.26 ±11.23	-1.993	0.048*
Female	34.72 ±12.52		
Total	33.30 ± 12.10		

*p<0.05, Significant

There is no significant association in mean platelet volume between males and females (Table 2)

Table 2: Distribution of Mean platelet volume according to sex (N=198)

Sex	Mean MPV (Mean ± SD)	t-value	P-Value
Male (n=81)	9.06 ± 2.02	0.162	0.872
Female (n= 117)	9.02 ± 1.80		
Total	9.04 ±1.89		

The mean platelet distribution width in male patients was 14.75 ± 2.44 (mean ± SD), which was significantly higher than that in female patients (14.00 ± 2.33; mean ± SD). (Table 3)

Table 3: Distribution of Mean platelet distribution width according to their sex (N=198)

Sex	Mean PDW (Mean ± SD)	t-value	P-Value
Male (n=81)	14.75 ± 2.44	2.179	0.031*
Female (n= 117)	14.00 ± 2.33		
Total	14.31 ± 2.40		

***p<0.05, Significant**

The mean total leucocyte count of male patients (12728.80 ± 4041.70) was significantly higher than the mean total leucocyte count of female patients (11280.51 ± 3981.39). (Table 4)

Table 4: Distribution of Total leucocyte count according to sex. (N=198)

Sex	Mean TLC (Mean ± SD)	t-value	P-Value
Male (n=81)	12728.80 ± 4041.70	2.552	0.011*
Female (n= 117)	11280.51 ± 3845.65		
Total	11872.99 ± 3981.39		

***p<0.05, Significant**

Histopathological report: Among 198 patients who participated in the study, histopathology showed that the majority, 70.2% (n=139), had acute appendicitis, and 18.7% (n=37) had gangrenous appendicitis. Only 11.1% (n=22) have acute appendicitis with peri-appendicitis. (Table 5)

Table 5: Distribution of acute appendicitis patients according to their histopathology (N=198)

Characteristics	Frequency(n)	Percentage (%)
Acute appendicitis	139	70.2
Acute appendicitis with peri-appendicitis	22	11.1
Gangrenous appendicitis	37	18.7
Total	198	100

There was a 24.5% positive correlation between MPV and PDW. (r=0.245;). MPV and PDW were significantly correlated (p<0.05). The correlation between MPV and TLC was only 23.0%. MPV and TLC were significantly correlated (p<0.05). Only 3.0% of the variance between PDW and TLC is negatively correlated. (Table 6)

Table 6: Correlation between MPV, PDW, and Total Leucocyte count in acute appendicitis patients. (N=198)

Characters	Pearson Correlation (r)	95% Confidence Interval		p-value
		Lower	Upper	
MPV-PDW	0.245	0.109	0.372	0.001*
MPV-TLC	-0.230	-0.358	-0.094	0.001*
PDW-TLC	-0.030	-0.168	0.110	0.680

***p<0.05, Significant**

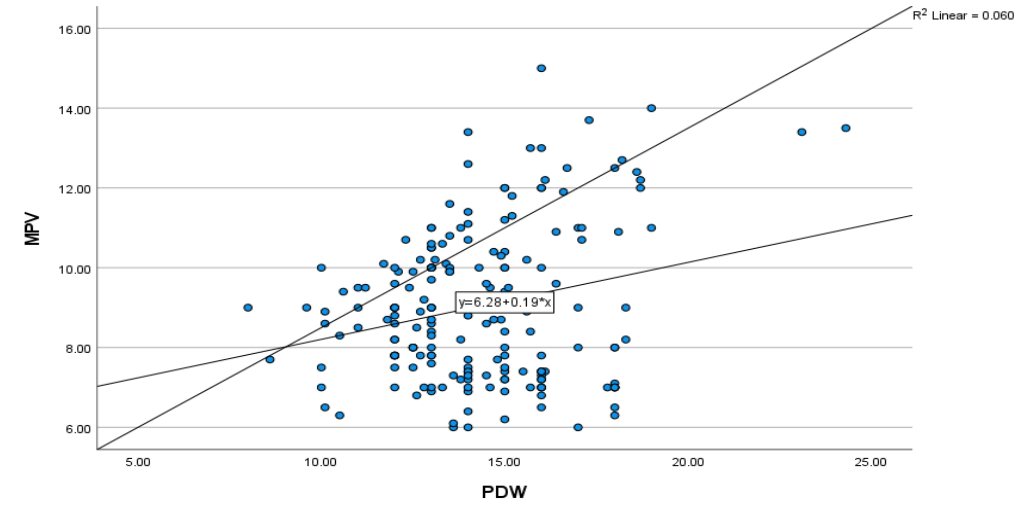

Figure 1: Shows a scatter plot between MPV and PDW

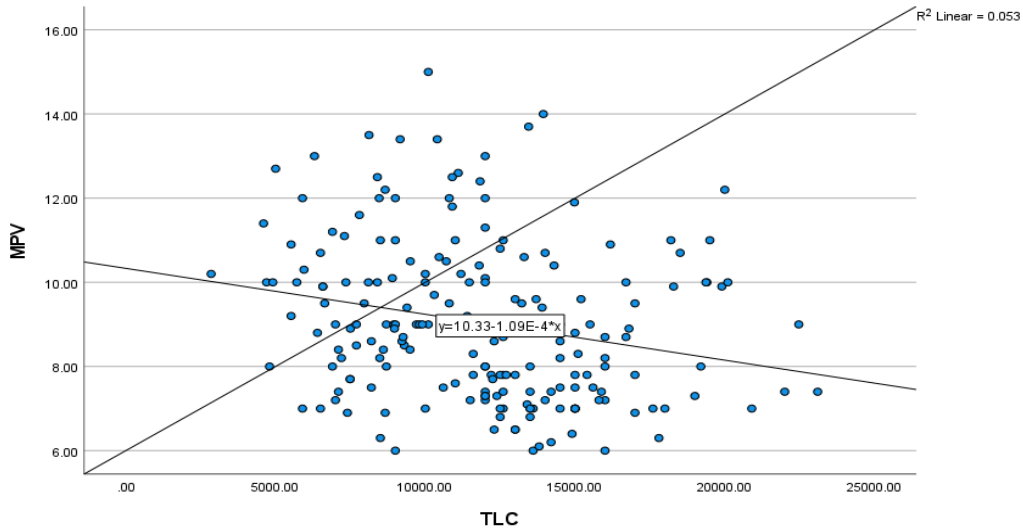

Figure 2: Shows a scattered plot between MPV and TLC

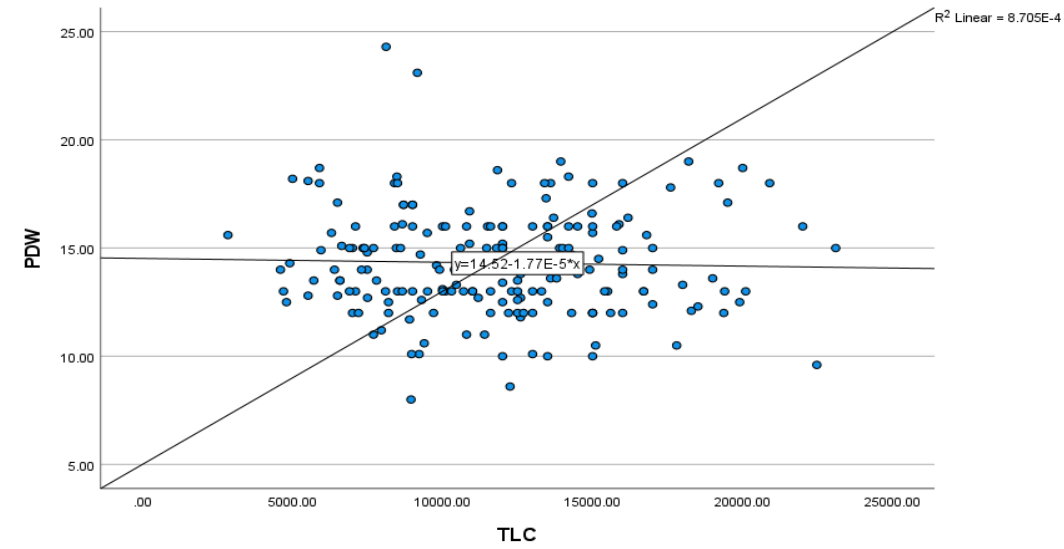

Figure 3: shows a scatter plot between PDW and TLC

The mean MPV was highest in the acute appendicitis with peri-appendicitis group (9.54 ± 2.18), followed by the acute appendicitis group (9.23 ± 1.84). The mean TLC (15112.97 ± 2693.68) was highest in the gangrenous group, followed by acute appendicitis with peri-appendicitis group (11749.09 ± 4628.58). There was a significant association between MPV and TLC value with the degree of appendicitis. (Table 8)

Table 8: Comparison of cases according to HPE

Role of characteristics		Mean ± SD	F-test	p-value
Age	Acute appendicitis (n=139)	33.16±11.41	0.551	0.557
	Acute appendicitis with peri-appendicitis (n=22)	35.73±13.42		
	Gangrenous appendicitis(n=37)	32.41±13.84		
MPV	Acute appendicitis	9.23±1.84	7.255	0.001*
	Acute appendicitis with peri-appendicitis	9.54±2.18		
	Gangrenous appendicitis	8.02±1.55		
PDW	Acute appendicitis	14.23±2.56	0.292	0.747
	Acute appendicitis with peri-appendicitis	14.48±2.16		
	Gangrenous appendicitis	14.53±1.88		
TLC	Acute appendicitis	11030.17±3734.05	2.364	0.001*
	Acute appendicitis with peri-appendicitis	11749.09±4628.58		
	Gangrenous appendicitis	15112.97±2693.68		

***p<0.05, Significant**

Discussion

Acute appendicitis is generally classified histopathologically into acute appendicitis, acute appendicitis with peri-appendicitis, and gangrenous appendicitis. In some Eastern countries, acute appendicitis is mostly classified as catarrhal, phlegmonous, or gangrenous types based on the inflammatory characteristics. [9] Although recent series recommend a negative appendectomy rate of up to 15 percent is acceptable, and new approaches in antibiotic therapy are currently being developed, surgery still remains the treatment of choice for acute appendicitis, particularly in gangrenous appendicitis [.9,18] Therefore, inflammatory markers such as platelet indices and leucocyte count may have potential clinical benefits for the diagnosis of acute appendicitis. Xharra et al. reported a mean age of 19.7±10.5 years among 148 patients with acute appendicitis, of which 52.02%. Additionally, researchers reported that 83.5% of patients were under 30 years old. [19] Aren et al. also reported male gender and age between 15 - 30 years as potential risk factors for acute appendicitis in their study. [20] In contrast, in the present study of the 198 patients with acute appendicitis, 59.1% were female, and 40.9% were male, with a mean age of 33.30 ± 12.10 years. A statistically significant difference according to age was observed. ($p<0.05$).

Guler K et al. evaluated the 101 patients and found no significant differences in age or gender between perforated and non-perforated appendicitis groups. [21] Similarly, in the present study, patients were divided into gangrenous appendicitis, acute appendicitis, and acute appendicitis with peri-

appendicitis, and no significant age differences were found between the groups.

Inflammation increases platelet production, which may lead to changes in platelet volume. Finally, this process results in increased MPV and PDW levels. [22] In addition, a reduction of platelet and PCT levels occurs during excessive consumption of platelets. Increased platelet volume has been widely examined; conversely, MPV might decrease in high-grade inflammation due to excessive consumption. [23]

Numerous studies have demonstrated the diagnostic value of platelet indices in certain inflammatory diseases. Narci et al. reported higher MPV values in patients with acute appendicitis, with 66% sensitivity and 51% specificity, [24] whereas Kılıç et al. found no significant difference in MPV between patients with acute appendicitis and other patient groups. [25] In the present study, there was a statistically significant correlation between MPV and acute appendicitis ($p<0.05$), and it was correlated with the degree of appendicitis. Gangrenous appendicitis has the lowest MPV (mean 8.02 ± 1.55) compared to appendicitis and acute appendicitis with peri-appendicitis.

Ceylan et al. reported that MPV was lower in 363 patients with acute appendicitis than in control groups, and that there was no significant difference between groups in PDW levels[26]. In the present study, PDW was statistically correlated with appendicitis ($p<0.05$), but no statistically significant correlation was found between PDW and the degree of appendicitis ($p> 0.05$). However, male patients had a higher value of PDW, and the gangrenous appendicitis group had the highest PDW level, i.e., 14.53 ± 1.88 (Mean ± SD). MPV and PDW were significantly correlated ($p<0.05$), with a positive Pearson correlation (24.5%).

The relationship between the rise in leukocyte count and the diagnosis of appendicitis has been examined and demonstrated in numerous published studies. Aren A et al. designed three groups to assess leukocyte counts in patients with acute appendicitis: <10 x103/μL, 10 to 15 x103/μL, and > 15 x103/μL. Researchers observed a 2.5-fold higher risk ($p=0.042$) of developing acute appendicitis in the>15x103/μL leukocyte group. [20] Narcı H et al. also noted the increase in leukocyte count in the acute appendicitis group. [24] Yang HR et al. showed a relationship between higher leukocyte count and histological inflammation in acute appendicitis. [27]

Andersson RE et al. and Guraya SY et al. suggested that leukocyte count is a reliable indicator of acute appendicitis. [28,29] Xharra et al. reported elevated TLC in 126 (85.1%) cases with positive histopathology (mean 12.6 and 15.6 x109/l in acute appendicitis and perforated appendix groups, respectively. Moreover, researchers demonstrated a positive correlation between TLC and the severity of inflammation. [19] Bates MF et al. concluded that the absence of an increased TLC count is a risk factor for negative appendectomy. [30] In the present study, total leucocyte count was statistically correlated with appendicitis and the degree of appendicitis ($p<0.05$). TLC count was higher in the male sex, with a mean of 12728.80 ± 4041.70 (Mean ± SD). MPV was negatively correlated with TLC (Pearson correlation -23%) and statistically significant ($p<0.05$); however, no statistically significant correlation was found between PDW and TLC ($p>0.05$). The TLC count was significantly correlated with the degree of appendicitis. Gangrenous appendicitis group has the highest leucocyte counts of 15112.97 ± 2693.68 (Mean ± SD), followed by acute appendicitis with periappendicitis group 11749.09 ± 4628.58 (Mean ± SD), while acute appendicitis group has a mean TLC of 11030.17 ± 3734.05 (Mean ± SD).

Conclusion:

In conclusion, the findings of the present study suggest that elevated leucocyte count and platelet indices (MPV & PDW) levels support the diagnosis of acute appendicitis. The levels of the MPV, PDW, and leucocyte count are significantly correlated with pathological findings. The most common histopathological findings observed were simple acute appendicitis, followed by gangrenous appendicitis and acute appendicitis with peri-appendicitis.

Furthermore, the preoperative leukocyte count showed the highest sensitivity in the present study. Thus,combining inflammatory markers with positive clinical findings would improve diagnostic accuracy in acute appendicitis. Since delayed treatment can lead to gangrenous or perforated appendicitis, early surgical intervention still remains the treatment of choice as soon as the diagnosis is made. Consequently, further research should be performed with larger study groups to achieve more assured results.

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