Original Article

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Surgery Section

Predictive Value of Platelet Parameters MPV and PDW in Diagnosing Acute Appendicitis and its Complications: A Prospective Observational Study at a Tertiary Care Centre in Belagavi, Karnataka, India

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ABSTRACT

Introduction: Acute appendicitis is one of the most common surgical emergencies encountered in clinical practice. Early diagnosis and prompt intervention significantly improve outcomes. Various quick, low-cost and accessible laboratory markers such as C-reactive Protein (CRP), serum bilirubin and total leukocyte count are being explored to assist in diagnosis and assess complications. Among these, platelet parameters like Mean Platelet Volume (MPV) and Platelet Distribution Width (PDW) have recently garnered interest.

Aim: To evaluate the predictive value of MPV and PDW in diagnosing acute appendicitis and its complications.

Materials and Methods: The present prospective observational study was conducted in the Department of General Surgery at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi, Karnataka, India. Seventy patients diagnosed with acute appendicitis and undergoing appendectomy between January 2021 and December 2021 were included. Preoperative MPV and PDW values were analysed and compared with standard laboratory reference values and correlated with histopathological findings.

Results: Out of 59 patients with confirmed acute appendicitis, 34 had MPV values >8.1 fL and 36 had PDW values <12.2%. However, these differences were not statistically significant. Notably, both MPV and PDW values were significantly elevated in patients with complicated appendicitis compared to those with uncomplicated cases (p<0.001).

Conclusion: MPV and PDW may not be reliable standalone markers for diagnosing acute appendicitis. However, they hold potential as cost-effective, supplementary tools for assessing the severity and complications of the disease, particularly in resource-limited settings.

Keywords: Acute appendicitis, Diagnostic markers, Mean platelet volume, Platelet distribution width, Platelet indices

INTRODUCTION

Acute appendicitis remains one of the most common causes of acute abdominal pain requiring emergency surgical intervention. Despite advancements in diagnostic imaging and laboratory tools, the timely and accurate diagnosis of appendicitis, especially in atypical presentations continues to be a clinical challenge. Early diagnosis is crucial to avoid complications such as perforation, abscess formation and peritonitis, which significantly increase morbidity and healthcare burden [1]. Traditionally, the diagnosis of acute appendicitis relies on clinical evaluation supported by laboratory parameters such as leukocytosis and elevated CRP and imaging studies including ultrasonography and Computed Tomography (CT). However, imaging techniques, although highly sensitive and specific, are not always readily accessible and are limited by cost, operator dependency and exposure to radiation [2-4]. Therefore, interest in simple, cost-effective biomarkers has grown substantially.

Among these, MPV and PDW parameters routinely available in a Complete Blood Count (CBC) have emerged as potential adjunctive markers in the diagnosis of acute appendicitis. MPV reflects platelet activation and is influenced by inflammatory states. PDW, an indicator of variability in platelet size, has also been studied as a marker of inflammation and disease severity [1,4,5].

Recent studies have demonstrated mixed results regarding the diagnostic utility of these indices. Shashirekha CA and Vincent A emphasised MPV as a promising biomarker, reporting its significant elevation in patients with histologically confirmed appendicitis [1]. Al-Jawdah K and Kamal Z and Peksöz R et al., supported the role of CBC parameters, including MPV and PDW, in both diagnosis and assessment of severity [3,5]. Conversely, other investigations have reported limited sensitivity and specificity of MPV and PDW when used in isolation, particularly in paediatric or atypical cases [4,6].

Furthermore, advanced indices such as the Delta Neutrophil Index (DNI), immature granulocyte percentage and Neutrophil To Lymphocyte Ratio (NLR) have been explored as complementary tools in improving diagnostic accuracy. Gedik MS and Hakkoymaz H (2023) found haematological markers, including DNI, useful particularly in paediatric appendicitis, highlighting their potential in stratifying disease severity [2].

In pregnant patients, where imaging is limited and diagnosis is often delayed, haematologic parameters offer valuable non-invasive clues. Guler I et al., demonstrated that CBC parameters could provide important diagnostic support in such high-risk groups [7].

Though there are different methods to diagnose acute appendicitis like clinical scoring systems, imaging methods, biomarkers, etc., each method when used alone may not be very reliable. Platelet parameters (MPV and PDW) are biomarkers of platelet activation that are inexpensive, comfortable and can be rapidly measured by automated haematology analyser [8]. However, though there are several studies who have reported the usefulness of platelet parameters in the diagnosis of acute appendicitis, there has been greater degree of inconsistency in the findings of these studies [1,3-6]. Thus, the present study aimed to evaluate the predictive value of MPV and PDW in diagnosing acute appendicitis and its

complications. Study also compared these markers with imaging modalities and traditional inflammatory indices, TLC to assess their potential as adjunctive diagnostic tools, particularly in resource-limited settings.

MATERIALS AND METHODS

The present prospective observational study was conducted in the Department of General Surgery at KLE's Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre, Nehru Nagar, Belagavi, Karnataka, India. The study was carried out over a period of one year, from January 2021 to December 2021. Ethical clearance was obtained from the JNMC Institutional Ethics Committee on Human Subjects Research via letter MDC/DOME/105 dated 25th Jan 2021 prior to the conduct of the study.

Inclusion and Exclusion criteria: The study included patients admitted with a clinical diagnosis of acute appendicitis who subsequently underwent appendectomy. The study included adult patients aged between 18 and 70 years who were admitted with a clinical diagnosis of acute appendicitis and underwent surgical appendectomy at KLE's Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre. Only those who provided written informed consent were eligible and enrolled. Patients were excluded if they were immunocompromised, receiving corticosteroids or chemotherapy, pregnant, had received a blood transfusion in the past year, or had severe anaemia or any acute or chronic infectious diseases.

Sample size calculation: The sample size was calculated using the standard formula for estimating proportions, considering an estimated prevalence (P) of 50%, with an allowable margin of error (d) set at 25% of the prevalence (i.e., 12.5%) and a Z-value of 1.96 corresponding to a 95% confidence level. Based on these parameters, the minimum required sample size was determined to be 61. To improve the robustness and validity of the results, the sample size was increased to 70. A universal sampling method was adopted, whereby all eligible patients presenting during the study period were included [9].

Study Procedure

After obtaining written informed consent, demographic and clinical data were recorded in a structured proforma. Preoperative investigations included CBC, platelet count, reticulocyte count and platelet indices (MPV and PDW). Imaging studies such as ultrasonography and CT were used to support the clinical diagnosis. MPV and PDW values were interpreted using standard laboratory reference ranges (MPV: 7.2–11.7 fL; PDW: 10-18%) [10]. All patients underwent appendectomy and resected specimens were subjected to histopathological examination. Histopathology was considered the definitive diagnosis. All pathology reports were reviewed and verified by an independent expert Pathologist. The primary outcomes included the diagnostic accuracy of MPV and PDW in identifying acute appendicitis and its complications. Sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) were calculated for MPV and PDW against histopathological findings.

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) Statistics software 28, IBM. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means with standard deviation or medians with interquartile ranges, depending on the distribution. Group comparisons were made using the Student's t-test or Chi-square test, as appropriate. The diagnostic performance of MPV and PDW was evaluated using Receiver Operating Characteristic (ROC) curve analysis. The Area Under the Curve (AUC) was calculated to determine the predictive accuracy of these markers. Sensitivity, specificity, PPV and NPV were reported with corresponding 95% confidence intervals.

RESULTS

A total of 70 patients were included in the study, with a mean age of 34.5±14.25 years. Of these, 59 (84.3%) had histopathologically confirmed acute appendicitis and 11 (15.7%) had chronic appendicitis. The gender distribution included 34 males (48.6%) and 36 females (51.4%). Out of 59 subjects pathologically diagnosed with acute appendicitis, 26 (44.1%) were males and the remaining 33 (55.9%) were females. However, this difference in gender distribution was not found to be statistically significant (p-value=0.179). A total of 64 patients presented with right lower quadrant pain (91.4%), three patients with generalised tenderness (4.29%) and three others with lower abdominal tenderness (4.29%). Median symptom duration of pain in patients clinically diagnosed with acute appendicitis was 4.5 days. A total of 41 patients (58.57%) had pain which was insidious in onset, whereas 29 patients (41.43) presented with sudden onset of pain. Out of 59 patients confirmed with acute appendicitis, physical findings were: 50 had right iliac fossa tenderness, 13 had rebound tenderness, five had guarding, four had rigidity and bowel sounds were absent in two [Table/Fig-1].

Demographic profile	Values
Age in years (Mean±SD)	34.50±14.25
Gender	
Males	34 (48.6%)
Females	36 (51.4%)
Clinical Profile	**Values**
Location of pain	
Right lower quadrant pain	64 (91.4%)
Generalised pain	3 (4.29%)
Lower abdominal pain	3 (4.29%)
Median symptom duration of pain	4.5 days
Onset of pain	
Insidious	41(58.57%)
Sudden	29 (41.43)
Physical findings	
Right iliac fossa tenderness	50
Rebound tenderness	13
Guarding	5
Rigidity	4
Bowel sounds absent	2

[Table/Fig-1]: Demographic and clinical profile.

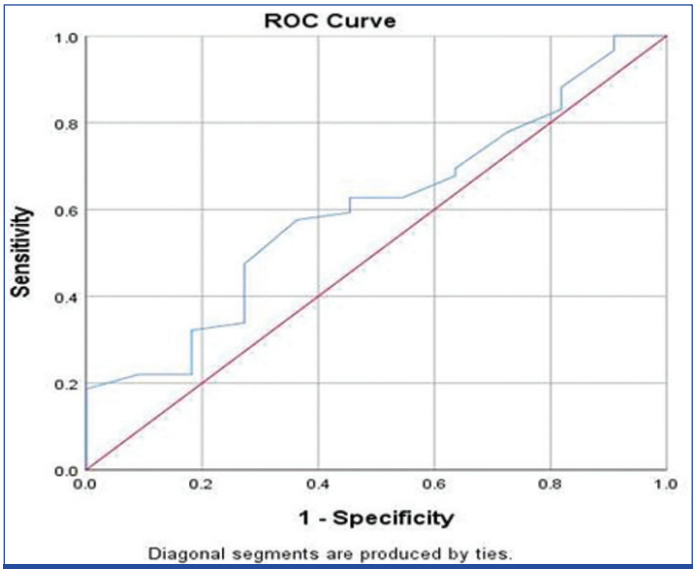
Out of 70 patients with appendicitis, 12 had complications {perforated in eight, ruptured in two, gangrenous in one and abscess in one} as confirmed by ultrasound, Computed Tomography (CT) scan and Histopathology Report (HPR). Significant difference was found between acute and chronic appendicitis patients for MPV, PDW and TLC (p<0.001) [Table/Fig-2].

Parameters	Acute appendicitis (n=59)	Chronic appendicitis (n=11)	p-value
MPV (fL)	8.30±1.56	10.36±3.47	0.001
PDW (%)	0.12±0.03	0.16±0.04	<0.001
TLC (/cu.mm)	13178.33±5293.34	8787.59±2608.33	<0.001

[Table/Fig-2]: Comparison of platelet parameters between patients with and without acute appendicitis.

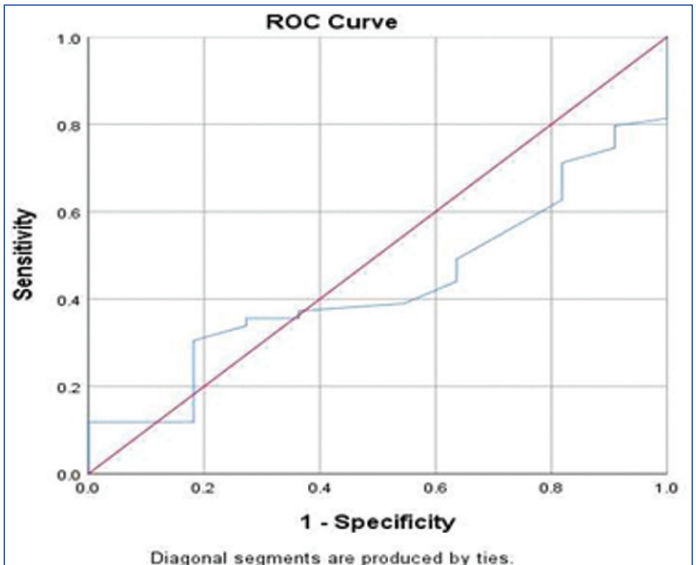
Validity of MPV in predicting acute appendicitis: ROC curve analysis identified a cut-off value of 8.1 fL for MPV, which yielded a sensitivity of 57.63% (95% CI: 44.07, 70.39), specificity of 63.64% (95% CI: 30.79, 89.07), PPV of 89.47% (95% CI: 75.20, 97.06), NPV

of 21.88% (95% CI: 9.28, 39.97) and an overall diagnostic accuracy of 58.57% (95% CI: 46.17,70.23) [Table/Fig-3]. AUC for predictive validity of MPV in predicting Acute appendicitis was 0.601 (95% CI: 0.430, 0.772), standard error of 0.087 and a p-value of 0.291. Hence out of 59 patients with confirmed acute appendicitis, 34 had MPV values >8.1 fL.



[Table/Fig-3]: Receiver Operating Characteristic (ROC) curve showing predictive validity of MPV in predicting acute appendicitis.

Validity of PDW in predicting acute appendicitis (N=59): For PDW, ROC curve analysis identified a cut-off value of 12.20% resulting in a sensitivity of 38.98% (95% CI: 26.55, 52.56), specificity of 45.45% (95% CI: 16.75, 76.62), PPV of 79.31% (95% CI: 60.28, 92.01), NPV of 12.20% (95% CI: 4.08, 26.20) and a diagnostic accuracy of 40.00% (95% CI: 28.47, 52.41) [Table/Fig-4]. ROC curve test results show, area under curve of 0.431 (95% CI: 0.276, 0.587), standard deviation of 0.070 and p-value of 0.473. Out of 59 patients with confirmed acute appendicitis, 36 had PDW values <12.2%.



[Table/Fig-4]: Receiver Operating Characteristic (ROC) curve showing predictive validity of PDW in predicting acute appendicitis.

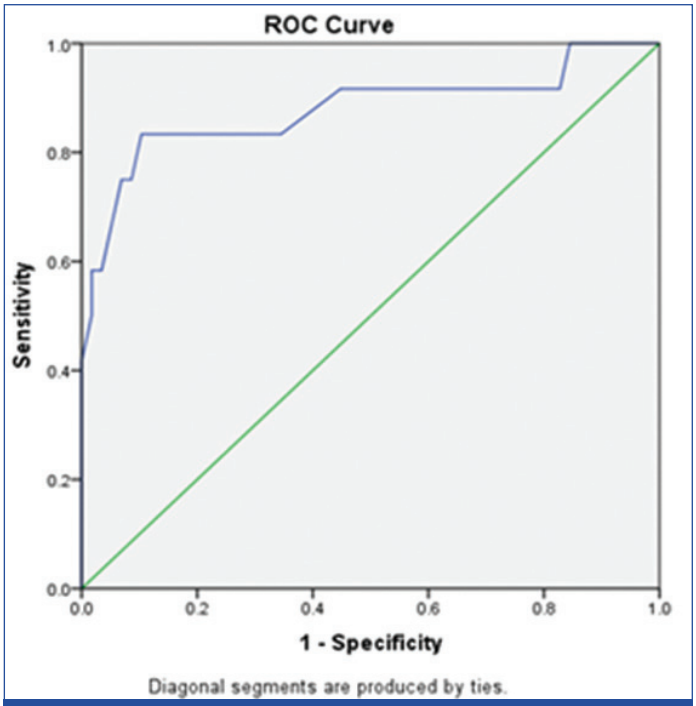
Although the mean MPV and PDW values differed significantly between patients with and without acute appendicitis, neither marker alone demonstrated adequate diagnostic performance [Table/Fig-2].

Mean MPV values among study subjects with complicated appendicitis (12.01±3.25) was comparatively higher than those with non-complicated appendicitis (8.14±1.38) and this difference in MPV was found to be statistically highly significant (p<0.001). Mean PDW values among study subjects with complicated appendicitis (0.18±0.04) was comparatively higher than those with non-complicated appendicitis (0.12±0.02) and this difference in PDW was also found to be statistically highly significant (p<0.001). Mean total leucocyte count (TLC) among study subjects with complicated appendicitis (13178.33±5293.34) was comparatively higher than those with non-complicated appendicitis (8787.59±2608.33) and this difference in mean TLC was found to be statistically highly significant (p<0.001) [Table/Fig-5].

Parameter	Uncomplicated (n=58)	Complicated (n=12)	p-value
MPV (fL)	8.14±1.38	12.01±3.25	<0.001
PDW (%)	0.12±0.02	0.18±0.04	<0.001
TLC (/cu.mm)	8787±2608	13178±5293	<0.001

[Table/Fig-5]: Comparison of haematologic parameters between complicated and uncomplicated appendicitis.

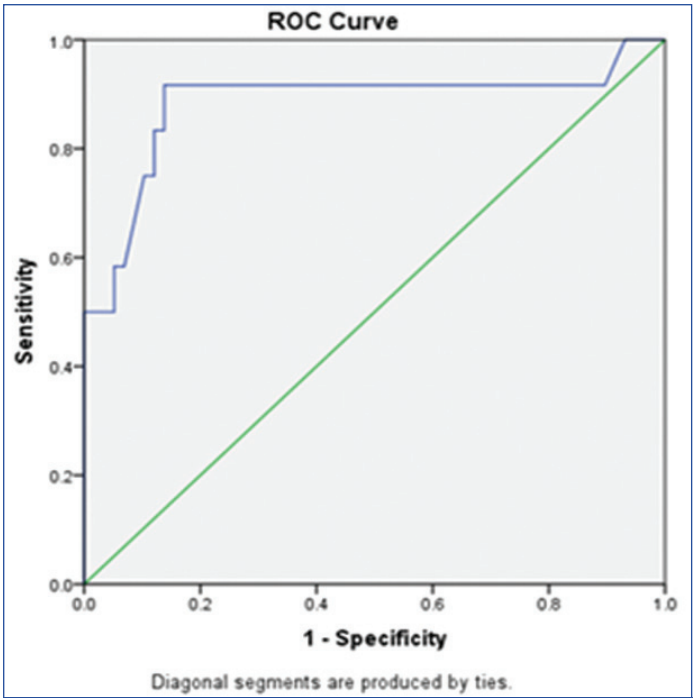
Predictive validity of MPV in predicting complications: ROC analysis for predicting complications revealed that: sensitivity and specificity of MPV to detect complicated appendicitis was found to be 23 .08% (95 % CI: 12.65, 38.34) and 90. 32% (95% CI: 75.1, 96.65). PPV and NPV were 75% (95% CI: 46.77, 91.11) and 48.2% (95% CI: 35.93, 60.84) and diagnostic accuracy was 52.86% (95% CI: 41.32, 64.1) [Table/Fig-6]. AUC for predictive validity of MPV in predicting complications was 0.879 (95% CI: 0.739, 1.000), standard error of 0.071 and a p-value of 0.001.



[Table/Fig-6]: ROC curve showing Predictive validity of MPV in predicting complications.

Sensitivity and specificity of PDW to detect complicated appendicitis was found to be 33.33% (95% CI: 17.19, 54.63) and 89. 8% (95% CI: 78.24, 95.56). PPV and NPV were 58.33% (95% CI: 31.95, 80.67) and 75.86% (95% CI: 63.47, 85.04) and diagnostic accuracy was 72.86% (95% CI: 61.46, 81.88) [Table/Fig-7]. AUC for predictive validity of PDW in predicting complicated appendicitis was 0.884 (95% CI: 0.741, 1.000), standard error of 0.073 and a p-value of 0.001.

Sensitivity and specificity of total leucocyte count to detect complicated appendicitis was found to be 30.77% (95 % CI: 16.5, 49 99) and 90.91% (95% CI: 78.84, 96.41). PPV and NPV were 66.67% (95% CI: 39.06, 86.19) and 68.57% (56.97, 78. 24) and diagnostic accuracy was 68.57% (95% CI: 56.97, 78.24). Although all three markers showed relatively low sensitivity, MPV and PDW were significantly elevated in complicated appendicitis cases and demonstrated specificity comparable to that of TLC.



[Table/Fig-7]: ROC curve showing predictive validity of PDW in predicting complications.

The sensitivity and specificity of ultrasonography to detect acute appendicitis was found to be 67.92% (95% CI: 54.52, 78.91) and 58.82% (95% CI: 36.01, 78.39). PPV and NPV were 83.72% (95% CI: 70.03, 91.88) and 37.04% (95% CI: 21.53, 55.77). Diagnostic Accuracy was 65.71% (95% CI: 54.04, 75.75). The sensitivity and specificity of CT scan to detect acute appendicitis was found to be 11.32% (95% CI: 5.293, 22.58) and 100% (95% CI: 81.57, 100). PPV and NPV were 100% (95% CI: 60.97, 100) and 26.56% (95% CI: 17.3, 38.48). Diagnostic accuracy was 32.86% (95% CI: 23, 44.5).

DISCUSSION

Acute Appendicitis is one of the most common surgical emergencies worldwide [8]. Appropriately diagnosing acute appendicitis is still difficult, even though the topic of diagnosis of appendicitis is not new. It requires a two-stage diagnostic work up with sufficient precision in each stage. In the initial stage, acute appendicitis must be separated from other urgent or non-emergent abdominal illness during the diagnostic stage. Differentiating between complicated and non-complicated appendicitis is necessary in the 2nd diagnostic stage of individuals with acute appendicitis [11].

Traditionally, the diagnosis of acute appendicitis relies on clinical evaluation supported by laboratory parameters such as leukocytosis and elevated CRP and imaging studies including ultrasonography and CT. However, imaging techniques, although highly sensitive and specific, are not always readily accessible and are limited by cost, operator dependency and exposure to radiation [2-4]. Therefore, interest in simple, cost-effective biomarkers has grown substantially.

Among these, MPV and PDW parameters routinely available in a CBC have emerged as potential adjunctive markers in the diagnosis of acute appendicitis. MPV reflects platelet activation and is influenced by inflammatory states. PDW, an indicator of variability in platelet size, has also been studied as a marker of inflammation and disease severity [1,4,5].

Platelets are tiny, disk-shaped components that vary in size, density, age and metabolic capabilities. Megakaryocyte growth is increased together with the formation of MPV in response to thrombopoietic stress. Stress thrombocytes are larger thrombocytes. Interleulin-6 (IL-6) activates bone marrow megakaryocytes and enhances the release of youthful, larger-sized platelets into the bloodstream in disorders accompanied by inflammation; As a result, MPV value rises [8,12]. Increased sequestration and destruction of activated platelets at sites of inflammation results in a decrease in MPV in diseases accompanied by active inflammation, such as early noncomplicated acute appendicitis. It is early platelet activation brought on by inflammation and a late increase in the release of young platelets from the bone marrow into the bloodstream that results in an increase in MPV in diseases like perforated appendicitis in the late stages [13].

Present study evaluated the diagnostic value of platelet indices, MPV and PDW in diagnosing acute appendicitis and predicting its complications. While both MPV and PDW values were significantly different between patients with and without histologically confirmed appendicitis, their standalone diagnostic performance was suboptimal.

Findings of the study align with those of Shashirekha CA and Vincent A, who found that although MPV was significantly lower in acute appendicitis, its diagnostic accuracy was limited, with low sensitivity and specificity [1]. Similarly, another study by Gedik MS and Hakkoymaz H had examined platelet indices in paediatric acute appendicitis and reported statistically significant changes in MPV and PDW, but concluded that these indices alone were not sufficiently reliable for primary diagnosis [2].

However, in the context of disease severity, present study found that both MPV and PDW were significantly elevated in cases of complicated appendicitis, with specificities exceeding 89%. These results are consistent with those of Ceylan B et al., who reported that MPV and PDW levels were significantly higher in patients with perforated or gangrenous appendicitis, suggesting a correlation between elevated platelet indices and the severity of inflammation [13]. Similarly, a study by Guler I et al., in pregnant patients with appendicitis found elevated PDW to be predictive of complications [7].

In contrast, Najd Sepas H et al., reported that MPV was significantly lower in complicated appendicitis compared to uncomplicated cases [14]. This inverse relationship has been hypothesised to result from the sequestration and consumption of larger, more reactive platelets at the site of inflammation, thereby reducing circulating MPV. Xu C et al., offered a supporting pathophysiological explanation, stating that high inflammatory activity leads to platelet activation and subsequent removal of larger platelets from circulation [15].

This study also found that the diagnostic accuracy of platelet indices was inferior to that of imaging modalities. Ultrasonography demonstrated moderate sensitivity (67.92%) and specificity (58.82%), consistent with earlier reports. CT scan had perfect specificity (100%) but poor sensitivity (11.32%) in this cohort, likely due to selective usage in unclear or complicated cases. These findings mirror the finding of earlier studies [15,16], which reported high specificity but variable sensitivity for CT, depending on clinical thresholds for ordering imaging.

Limitation(s)

As this is a single institutional study, the data cannot be generalised to larger groups. Larger, multi-institutional studies must be conducted to validate the results. Also, systematic reviews and meta-analysis must be conducted to further prove the hypothesis.

CONCLUSION(S)

The present study concludes that MPV values were higher in acute appendicitis group in comparison with non-acute appendicitis group but it was not statistically significant. Similar results were seen with PDW as well where more patients with acute appendicitis had low PDW values, but results were not statistically significant. However, statistically significant difference of MPV and PDW values were seen in complicated appendicitis when compared to uncomplicated

appendicitis. Collectively, results of the present study reinforce the notion that while MPV and PDW lack the diagnostic precision to replace imaging or clinical scores or total leucocyte count values, they may serve as useful adjuncts in evaluating disease severity especially in resource-constrained environments where advanced imaging is not always accessible.

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