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Diagnostic Accuracy of Platelet-to-Lymphocyte Ratio as a Biomarker in Perforated Acute Appendicitis: A Cross-Sectional Study from a Tertiary Care Centre in Kerala

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ABSTRACT

Background- Acute appendicitis is one of the most common surgical emergencies worldwide. Perforation remains a serious complication associated with increased morbidity, prolonged hospital stays, and higher healthcare costs. Early preoperative differentiation between perforated and non-perforated appendicitis is clinically challenging, particularly in resource-limited settings where access to advanced imaging may be delayed. The Platelet-to-Lymphocyte Ratio (PLR), derived from routine complete blood counts, has emerged as a potential low-cost inflammatory biomarker for assessing disease severity. This study aimed to evaluate the diagnostic accuracy of PLR in predicting perforated acute appendicitis.

Methods- This hospital-based cross-sectional diagnostic test evaluation was conducted in the Department of General Surgery at Government Medical College, Thiruvananthapuram. A total of 202 adult patients (>18 years) undergoing appendectomy for clinically and radiologically diagnosed acute appendicitis were included using consecutive sampling over a one-year period. Patients with conditions known to affect PLR were excluded. Preoperative PLR was calculated from complete blood counts. Intraoperative findings and histopathology served as the reference standards. Statistical analysis was performed using SPSS software version 27, and receiver operating characteristic (ROC) curve analysis was used to assess diagnostic performance.

Results -Of the 202 patients, 132 (65.3%) had perforated appendicitis. Mean PLR was significantly higher in the perforated group compared to the non-perforated group (170.60 vs. 155.89; $p < 0.001$). A PLR cut-off value of 163.27 yielded a sensitivity of 72.73%, specificity of 74.29%, positive predictive value of 84.21%, and negative predictive value of 59.09%. ROC analysis demonstrated good diagnostic accuracy. Female gender, presence of fever, toxic features, and poor general condition were significantly associated with perforation.

Conclusion -The platelet-to-Lymphocyte Ratio is a simple, inexpensive, and readily available biomarker with good diagnostic accuracy for predicting perforated acute appendicitis. PLR can serve as a valuable adjunct to clinical and radiological assessment, particularly in resource-constrained settings, aiding early surgical decision-making and improving patient outcomes.

Keywords*: Acute Appendicitis, Perforated Appendicitis, Platelet-to-Lymphocyte Ratio, Inflammatory Biomarkers, Diagnostic Accuracy.*

INTRODUCTION

Acute appendicitis (AA) is the most common abdominal surgical emergency worldwide, with an estimated incidence of 100 cases per 100,000 person-years and a lifetime risk of 7–8%.[1] Despite its high prevalence, accurate diagnosis-particularly in early or atypical presentations-remains challenging. Appendicitis is primarily caused by luminal obstruction

due to fecaliths, lymphoid hyperplasia, foreign bodies, or neoplasms, leading to inflammation, ischemia, bacterial proliferation, and potential perforation.[2] Perforated appendicitis represents a severe complication associated with increased postoperative morbidity, intra-abdominal abscess formation, sepsis, prolonged hospital stay, and higher healthcare costs.[3]

Timely preoperative differentiation between uncomplicated and perforated appendicitis is crucial for optimizing management and improving outcomes. However, classical clinical features such as right lower quadrant pain, anorexia, nausea, and leukocytosis are often nonspecific, especially in children, elderly individuals, and pregnant women.[4] Although imaging modalities such as ultrasonography and contrast-enhanced computed tomography (CECT) have improved diagnostic accuracy, their use may be limited by cost, availability, radiation exposure, and operator dependence, particularly in low- and middle-income countries (LMICs).[5]

In recent years, attention has shifted toward simple, rapid, and cost-effective hematological biomarkers derived from routine complete blood counts (CBC). Among these, the Platelet-to-Lymphocyte Ratio (PLR) has emerged as a novel inflammatory index reflecting thrombocytosis and lymphopenia, hallmarks of systemic inflammation. PLR has shown diagnostic and prognostic value in various inflammatory, infectious, and neoplastic conditions.[6] Systemic inflammation in appendicitis induces platelet activation mediated by cytokines such as interleukin-6, while stress-related corticosteroid release leads to lymphocyte redistribution, resulting in elevated PLR values.[7]

Several studies have reported significantly higher PLR levels in acute and perforated appendicitis. However, conflicting findings have been reported due to population heterogeneity and variable cut-off values.[8,9] Compared with neutrophil-to-lymphocyte ratio (NLR), PLR may offer greater stability during acute inflammatory states and improved reliability as a ratio-based marker.

AIMS AND OBJECTIVES

The aim of this study is to evaluate the diagnostic accuracy of the platelet-to-lymphocyte ratio (PLR) as a biomedical marker in identifying perforated acute appendicitis among patients presenting to a tertiary care centre in Kerala. The study also seeks to assess the impact of various preoperative factors, including clinical, demographic, and laboratory parameters, on the risk of developing perforated acute appendicitis, thereby aiding early risk stratification and improving preoperative decision-making.

MATERIALS AND METHODS

Study Design

This study was conducted as a cross-sectional diagnostic test evaluation in the Department of General Surgery at Government Medical College, Thiruvananthapuram. The study population comprised all patients who underwent appendicectomy for clinically diagnosed acute appendicitis during the study period. Following approval from the Institutional Ethics Committee (IEC), data were collected prospectively over a duration of one year.

Inclusion and Exclusion Criteria

The study included adult patients aged more than 18 years who were diagnosed with acute appendicitis and underwent appendicectomy at the study centre during the study period, provided they gave informed consent to participate. Patients were excluded if they had a known medical condition that could independently alter the platelet-to-lymphocyte ratio (PLR), including malignancy, vasculitis, or rheumatic fever, to avoid confounding of hematological parameters.

Sample Size Calculation

Sample size was calculated using the formula:
$n = 4 \times \text{sensitivity (SN)} \times 1\text{-SN}/d^2 \times \text{prevalence}$
Where:
n is the sample size;
p is the prevalence obtained from the reference study
Here:
Prevalence: % of perforated appendicitis ÷ total study participants/cases
= 0.3
Sensitivity = 76.19; d is absolute precision = 10 (As in Ha et al.[10] 2024)
= 4 x 76.19 x 23.81 / 10 x 10 x 0.36
= 202

Data Collection Procédure

After obtaining written informed consent, adult patients aged more than 18 years undergoing appendicectomy in the Department of General Surgery at Government Medical College, Thiruvananthapuram, with clinical and radiological evidence of acute appendicitis during the study period were enrolled in the study. Patient-related information was collected using a structured proforma. Disease-related data were obtained from preoperative haematological investigations and

radiological findings, intraoperative observations recorded during surgery, and postoperative histopathological examination of the resected appendiceal specimens.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) software version 27. Comparisons between perforated and non-perforated appendicitis groups were performed using the independent samples *t*-test for variables with a normal distribution and the Mann–Whitney *U* test for variables with a non-normal distribution. Receiver Operating Characteristic (ROC) curve analysis was employed to assess and compare the diagnostic accuracy of haematological ratios.

RESULTS

Table 1 shows the demographic characteristics of the study participants. The majority of patients belonged to the 21–30 years age group, indicating a predominance of acute appendicitis among young adults. There was a slight male predominance in the study population, reflecting the commonly reported epidemiological trend of appendicitis.

Table 1: Demographic Profile of the Study Population (n = 202)			
Variable		**Frequency**	**Percentage (%)**
Age group (years)	18–20	13	6.4
	21–30	122	60.4
	31–40	63	31.2
	41–50	4	2.0
Sex	Male	112	55.4
	Female	90	44.6

Table 2 illustrates the presenting symptoms, socioeconomic status, seasonal occurrence, and dietary habits of the patients. Diffuse or lower abdominal pain was the most common presenting symptom. More than half of the patients belonged to a low socioeconomic group and had inadequate water and fibre intake, which may contribute to appendiceal pathology.

Table 2: Clinical Presentation and Socio-Environmental Factors			
Variable		**Frequency**	**Percentage (%)**
Clinical presentation	Diffuse abdominal pain	70	34.7
	Lower abdominal pain + dysuria	66	32.7
	RLQ pain + fever	51	25.2
	Lower abdominal pain + fever	15	7.4
Socioeconomic status	Low	103	51.0
	Middle	99	49.0
Season of occurrence	Rainy	103	51.0
	Summer	99	49.0
Dietary pattern	Low water & low fibre intake	113	55.9
	Adequate water & fibre intake	89	44.1

Table 3 illustrates the radiological findings among patients with acute appendicitis. Ultrasonography was the primary imaging modality, while CT scan was performed selectively. Radiological features suggestive of inflammation and perforation were commonly observed.

Table 3: Radiological Findings (USG and CT Scan)		
USG Finding	**Number (n)**	**Percentage (%)**
Inflamed appendix	113	55.9
Appendix not visualised	49	24.3
Perforated appendix	40	19.8
Total	**202**	**100**
A. Ultrasonography (USG) Findings (n = 202)		
CT Scan Status	**Number (n)**	**Percentage (%)**
CT scan not done	107	53.0
Features of complicated appendicitis	95	47.0
Total	**202**	**100**
B. CT Scan Findings (n = 202)		

Table 4 shows the intraoperative findings and surgical approaches used. A high proportion of patients had perforated appendicitis or perforated tips with healthy bases. Open appendectomy using Lanz incision was the most frequently performed procedure.

Table 4: Operative Findings and Type of Surgery		
Variable	**Frequency**	**Percentage (%)**
Intraoperative findings		
Perforated appendix	65	32.2
Healthy base with perforated tip	51	25.2
Inflamed non-perforated appendix	86	42.6
Type of surgery (open)		
Lanz incision	99	49.0
Lower midline laparotomy	88	43.6
McBurney incision	15	7.4

Table 5 demonstrates histopathological patterns observed in resected appendices. The most common finding was perforated appendicitis with neutrophilic infiltration, granulation tissue, and hemorrhage, confirming advanced inflammatory disease.

Table 5: Histopathological Findings	
Histopathological finding	**Percentage (%)**
Perforated appendix with severe inflammation	38.6
Neutrophilic infiltration beyond seromuscular layer	23.3
Full-thickness transmural necrosis	10.9
Vascular thrombosis	10.9
Abscess / microabscess formation	6.0
Others	10.3

Table 6 highlights the relationship between PLR values and appendiceal perforation. Patients with PLR > 163.27 had a significantly higher incidence of perforated appendicitis, indicating strong discriminatory ability of PLR.

Table 6: Platelet-to-Lymphocyte Ratio (PLR) and Perforation Status		
PLR Category	**Non-perforated n (%)**	**Perforated n (%)**
≤ 163.27	52 (59.1)	36 (40.9)
> 163.27	18 (15.8)	96 (84.2)

Table 7 shows the diagnostic accuracy of PLR in predicting perforated appendicitis. PLR demonstrated good sensitivity and specificity with a high positive predictive value, supporting its clinical usefulness as a preoperative biomarker.

Table 7: Diagnostic Performance of PLR for Perforated Appendicitis	
Diagnostic parameter	**Value**
Sensitivity	72.73%
Specificity	74.29%
Positive Predictive Value	84.21%
Negative Predictive Value	59.09%
Diagnostic accuracy	Moderate to good

DISCUSSION

The present study evaluated the diagnostic accuracy of the Platelet-to-Lymphocyte Ratio (PLR) in predicting perforated acute appendicitis among patients presenting to a tertiary care centre. Acute appendicitis predominantly affects young adults, and in this study, the mean age of presentation was 28.52 ± 6.06 years, with the majority of patients belonging to the 21–30-year age group. This age distribution is consistent with observations made by Yazar et al., who reported a peak incidence in the second and third decades of life, attributing this trend to heightened lymphoid activity and inflammatory responsiveness in younger individuals.[11] Younger patients may also exhibit more pronounced hematological responses, which enhances the diagnostic value of inflammatory indices such as PLR.

A slight male predominance was noted in the overall study population, a finding that aligns with global epidemiological data reported by Yazar et al.[11] However, a significantly higher proportion of perforated appendicitis was observed among female patients. Similar findings have been reported by Kaya et al., who attributed this to diagnostic delays caused by overlapping gynecological conditions and atypical symptomatology in females.[12] This emphasizes the importance of

maintaining a high index of suspicion and using objective biomarkers such as PLR in female patients presenting with lower abdominal pain.

Clinical presentation varied considerably, with diffuse abdominal pain and lower abdominal pain with urinary symptoms being the most common complaints. Classical right lower quadrant pain with fever was present in only one-fourth of patients. Yazar et al. highlighted that atypical presentations are common and frequently result in delayed diagnosis and increased risk of perforation 10. Such variability limits reliance on clinical features alone and underscores the need for adjunctive laboratory markers like PLR.[13]

Socioeconomic status showed a nearly equal distribution between low and middle socioeconomic groups. Previous studies by Alan et al. demonstrated that lower socioeconomic status is associated with delayed presentation and higher rates of perforation due to limited healthcare access and delayed decision-making.[13] In such populations, cost-effective biomarkers derived from routine investigations, such as PLR, assume greater clinical relevance. Seasonal variation was not significant in this study, with a nearly equal case distribution across rainy and summer seasons. While studies by Ferris et al. reported seasonal peaks in warmer months,[14] similar to findings by Blos et al, no clear seasonal trend was evident in tropical regions such as Kerala.[15]

Dietary assessment revealed that more than half of the patients had inadequate water and fibre intake. Burkitt et al. and subsequent studies have demonstrated a strong association between low fibre intake and increased risk of fecolith formation, which predisposes to appendiceal obstruction and perforation.[16] In the present study, fecoliths were identified intraoperatively in all cases, reinforcing their etiological role.[17,18]

Ultrasonography identified appendiceal pathology in the majority of cases, although non-visualization was common. Alan et al. noted that USG has limited sensitivity in detecting perforation, particularly in retrocecal appendicitis and obese patients.[13] CT imaging, although not performed in all patients, reliably demonstrated features of complicated appendicitis when used, consistent with findings by Rao et al. and Kim et al.[19,20]

The most significant finding of this study was the strong association between elevated PLR and perforated appendicitis. Patients with perforation had significantly higher mean PLR values compared to non-perforated cases ($p < 0.001$). Similar observations have been consistently reported by Yazar et al, and Alan et al., supporting PLR as a reliable marker of disease severity.[11,13] ROC curve analysis in this study demonstrated good diagnostic accuracy at a PLR cutoff of 163.27, comparable to values reported in earlier studies.

Histopathological findings further validated these results, with perforated cases showing transmural necrosis, vascular thrombosis, and intense neutrophilic infiltration-features associated with severe systemic inflammation. Carr et al. and Lamps et al. similarly correlated these pathological features with elevated inflammatory markers.[21,22]

The high prevalence of perforated appendicitis (65.3%) observed in this study highlights persistent challenges related to delayed presentation and diagnostic limitations in resource-constrained settings. Bhangu et al. reported similarly high perforation rates in low- and middle-income countries.[23] In such contexts, PLR offers a practical, low-cost adjunct to clinical assessment and imaging.

The findings of this study are consistent with existing literature and support the role of PLR as a valuable preoperative biomarker for identifying perforated acute appendicitis. When integrated with clinical evaluation and basic imaging, PLR can enhance early risk stratification, guide surgical urgency, and potentially reduce morbidity associated with delayed diagnosis.

Clinical Implications

The high prevalence of perforation (65.3%) observed in this study underscores the ongoing challenge of delayed diagnosis in resource-limited settings. In such environments, reliance on inexpensive, rapidly available biomarkers like PLR may significantly enhance early risk stratification and guide timely surgical intervention. While PLR should not replace imaging or clinical judgment, it serves as a valuable adjunct, particularly where advanced imaging is unavailable or delayed.

Limitations

This study has certain limitations that should be considered while interpreting the findings. Being a single-centre study, the results may not be generalizable to other healthcare settings with differing patient demographics and access to diagnostic facilities. The cross-sectional design limits the ability to establish causality, allowing only the identification of associations between PLR and appendicular perforations. Additionally, the timing of PLR measurement was not standardized, and variations in the interval between symptom onset and blood sampling may have influenced PLR values. The exclusion of laparoscopic appendectomy cases may have resulted in underrepresentation of patients with early or less severe disease. Furthermore, the presence of undiagnosed infections or inflammatory conditions in some participants could have acted as confounding factors affecting PLR levels.

CONCLUSION

This study demonstrates that the Platelet-to-Lymphocyte Ratio (PLR) is a simple, cost-effective, and readily available preoperative biomarker with good diagnostic accuracy for predicting perforated acute appendicitis. A significantly higher PLR was observed in perforated cases, and a cutoff value of 163.27 showed strong predictive performance, supporting its role in early risk stratification. In resource-limited settings where access to advanced imaging is restricted or delayed, PLR can serve as a valuable adjunct to clinical assessment and basic imaging, aiding timely surgical decision-making. Although the findings are limited by the single-centre, cross-sectional design and potential inflammatory confounders, the results strongly support the incorporation of PLR into routine evaluation protocols to improve early identification of complicated appendicitis and optimize patient outcomes.

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