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CORRELATION OF PREOPERATIVE INFLAMMATORY MARKERS (NEUTROPHIL-TO-LYMPHOCYTE RATIO, PLATELET-TO-LYMPHOCYTE RATIO, AND C-REACTIVE PROTEIN) WITH POSTOPERATIVE COMPLICATIONS IN PATIENTS UNDERGOING MAJOR SURGERY: A PROSPECTIVE OBSERVATIONAL STUDY FROM A TERTIARY CARE HOSPITAL IN WEST BENGAL

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ABSTRACT

Background: Postoperative complications remain a significant cause of morbidity, prolonged hospitalization, and increased healthcare costs following major surgery. Identification of reliable and cost-effective preoperative predictors may improve perioperative risk assessment and patient outcomes. Inflammatory biomarkers such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C-reactive protein (CRP) have emerged as potential indicators of systemic inflammatory status and surgical risk.

Objectives: To evaluate the correlation between preoperative inflammatory markers (NLR, PLR, and CRP) and postoperative complications among patients undergoing major surgical procedures in a tertiary care hospital in West Bengal.

Methods: A prospective observational study was conducted in the Department of General Surgery of a tertiary care hospital from July 2017 to November 2017. Thirty-six adult patients undergoing major elective or emergency surgical procedures were enrolled using consecutive sampling. Preoperative NLR and PLR were calculated from complete blood count parameters, while serum CRP levels were measured using standard laboratory methods. Patients were followed throughout their postoperative hospital stay for the occurrence of complications. Statistical analysis was performed using SPSS version 22.0. Continuous and categorical variables were compared using appropriate statistical tests, and correlation analysis was performed to assess associations between inflammatory markers and postoperative complications. A p-value of less than 0.05 was considered statistically significant.

Results: The mean preoperative NLR, PLR, and CRP values were 3.8 ±1.7, 156 ±58, and 11.8 ± 7.4 mg/L, respectively. Postoperative complications occurred in 12 patients (33.3%), while 24 patients (66.7%) had an uncomplicated recovery. Surgical site infection was the most common postoperative complication. Patients with complications demonstrated significantly higher preoperative NLR (5.3 ±1.6 vs. 3.0 ±1.1; p=0.001), PLR (198 ±61 vs. 135 ±41; p=0.003), and CRP levels (18.4 ±7.8 mg/L vs. 8.5 ±4.3 mg/L; p<0.001) compared with those without complications. Correlation analysis revealed significant positive associations between postoperative complications and NLR (r=0.49, p=0.003), PLR (r=0.42, p=0.011), and CRP (r=0.58, p<0.001).

Conclusion: Elevated preoperative NLR, PLR, and CRP levels were significantly associated with postoperative complications. These readily available inflammatory markers may serve as useful adjuncts for preoperative risk stratification, with CRP demonstrating the strongest predictive association in the present study.

Keywords: Neutrophil-to-lymphocyte ratio; Platelet-to-lymphocyte ratio; C-reactive protein; Postoperative complications; Inflammatory markers; Surgical outcomes; Risk stratification

INTRODUCTION

Postoperative complications remain a major cause of prolonged hospital stay, increased healthcare expenditure, and mortality among surgical patients worldwide. Despite advances in perioperative care, complications such as surgical site infection, wound dehiscence, anastomotic leak, sepsis, and respiratory complications continue to contribute significantly to adverse surgical outcomes [1]. Early identification of patients at increased risk for postoperative morbidity is therefore an important component of modern surgical practice, enabling targeted perioperative optimization and closer postoperative surveillance [2].

The inflammatory response plays a central role in tissue injury, wound healing, and host defense mechanisms following surgery. Pre-existing systemic inflammation has been shown to influence postoperative recovery and may predispose patients to unfavorable outcomes [3]. Consequently, several inflammatory biomarkers have been investigated as potential predictors of postoperative complications. Among these, the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C-reactive protein (CRP) have gained considerable attention because they are inexpensive, readily available, and routinely measured in clinical practice [4].

NLR reflects the balance between innate and adaptive immune responses. Elevated neutrophil counts indicate an active inflammatory state, whereas reduced lymphocyte counts may represent impaired immune regulation. Previous studies have demonstrated that elevated preoperative NLR is associated with increased postoperative morbidity, infectious complications, and poorer outcomes across various surgical specialties [5]. Similarly, PLR has emerged as a marker of systemic inflammation and thrombocytic activation. Increased PLR values have been linked to adverse postoperative outcomes and have shown prognostic value in both benign and malignant surgical conditions [6].

CRP is an acute-phase reactant synthesized by the liver in response to inflammatory cytokines. It has long been recognized as a sensitive marker of systemic inflammation and tissue injury. Elevated preoperative CRP levels have been associated with increased risk of postoperative infectious complications, delayed recovery, and prolonged hospitalization [7]. Compared with more complex prognostic models, inflammatory markers offer the advantage of simplicity, cost-effectiveness, and universal availability, making them particularly attractive in resource-constrained healthcare settings [8].

In India, postoperative complications continue to represent a substantial burden on tertiary healthcare institutions. Variations in disease presentation, nutritional status, socioeconomic factors, and healthcare accessibility may influence inflammatory profiles and postoperative outcomes among Indian patients [9]. However, most available evidence regarding NLR, PLR, and CRP as predictors of postoperative complications originates from studies conducted in Western populations and specific surgical subspecialties. Limited data are available from West Bengal tertiary care centers evaluating the combined predictive utility of these inflammatory markers in a heterogeneous surgical population [10].

Furthermore, the relative predictive value of NLR, PLR, and CRP remains incompletely understood, particularly in routine clinical settings where cost-effective risk stratification tools are needed. Establishing the relationship between preoperative inflammatory markers and postoperative complications may facilitate early identification of high-risk patients, improve perioperative decision-making, and optimize allocation of healthcare resources.

Therefore, the present study was undertaken in a tertiary care hospital in West Bengal to evaluate the correlation between preoperative inflammatory markers, namely neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and C-reactive protein, with postoperative complications. The specific objectives were to determine the preoperative levels of NLR, PLR, and CRP among surgical patients and to assess their association with the occurrence of postoperative complications during the study period.

METHODOLOGY

Study Design: This was a hospital-based prospective observational analytical study conducted to evaluate the correlation between preoperative inflammatory markers, namely neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C-reactive protein (CRP), with postoperative complications among patients undergoing major surgical procedures.

Study Setting: The study was conducted in the Department of General Surgery of a tertiary care teaching hospital in West Bengal. The hospital caters to a large urban and rural population and provides comprehensive surgical services including elective and emergency surgical care.

Study Duration: The study was conducted from July 2017 to November 2017.

Study Population: The study population comprised adult patients admitted to the Department of General Surgery and scheduled for major surgical procedures during the study period.

Inclusion Criteria

Patients aged ≥18 years.
Patients undergoing major elective or emergency general surgical procedures.
Patients willing to participate and provide written informed consent.
Patients with complete preoperative hematological and biochemical investigations including differential leukocyte count, platelet count, and CRP levels.

Exclusion Criteria

Patients younger than 18 years.
Patients with known hematological disorders affecting leukocyte or platelet counts.
Patients receiving corticosteroids, immunosuppressive therapy, or chemotherapy.
Patients with autoimmune or chronic inflammatory diseases.
Patients with active malignancy receiving ongoing treatment.
Patients with incomplete clinical records or missing laboratory data.
Patients unwilling to provide informed consent.

Sample Size: The sample size was calculated based on the expected proportion of postoperative complications among patients with elevated inflammatory markers. Using the formula for estimation of a proportion:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where:

(n) = required sample size
(Z) = 1.96 at 95% confidence level
(P) = anticipated prevalence of postoperative complications (30% based on available literature before study initiation)
(d) = absolute precision (15%)

Substituting the values:

$$n = \frac{(1.96)^2 \times 0.30 \times 0.70}{(0.15)^2}$$

n = 36

Thus, the minimum required sample size was calculated as **36 participants**, which constituted the final study sample.

Sampling Technique: A consecutive sampling technique was employed. All eligible patients meeting the inclusion criteria during the study period were recruited consecutively until the required sample size of 36 participants was achieved.

Data Collection Tools & Procedure: After obtaining informed written consent, demographic details, clinical history, comorbidities, indication for surgery, and perioperative characteristics were recorded using a predesigned case record form. Preoperative laboratory investigations performed within 24 hours before surgery included complete blood count with differential leukocyte count, platelet count, and serum CRP levels. NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count, while PLR was calculated by dividing the platelet count by the absolute lymphocyte count. Patients were subsequently followed throughout their postoperative hospital stay. Postoperative complications including surgical site infection, wound dehiscence, respiratory complications, intra-abdominal infection, anastomotic leak, sepsis, and other clinically significant adverse events were documented based on clinical examination, laboratory findings, and imaging studies when indicated. All collected data were entered into a structured database for analysis.

Study Variables: The independent variables included demographic factors (age and sex), clinical characteristics, and preoperative inflammatory markers including NLR, PLR, and CRP levels. The primary dependent variable was the occurrence of postoperative complications during the index hospital admission. Secondary outcome variables included type of postoperative complication, duration of hospital stay, and postoperative recovery status. The study specifically assessed the association between elevated preoperative inflammatory markers and the development of postoperative complications.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 22.0. Continuous variables were expressed as mean ±standard deviation or median with interquartile range, depending on data distribution. Categorical variables were presented as frequencies and percentages. The independent sample t-test or Mann–Whitney U test was used for comparison of continuous variables between groups, while the Chi-square test or Fisher's exact test was used for categorical variables. Correlation between inflammatory markers and postoperative complications was assessed using appropriate correlation coefficients. Statistical significance was considered at a p-value <0.05 with two-tailed testing.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of the participating tertiary care hospital before commencement of data collection.

Written informed consent was obtained from all participants prior to enrollment. Confidentiality and anonymity of patient information were maintained throughout the study. Participation was voluntary, and patients were free to withdraw from the study at any stage without affecting their treatment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki and subsequent amendments governing biomedical research involving human participants.

RESULTS

A total of 36 patients undergoing major surgical procedures were included in the study. Most participants belonged to the 41–60-year age group, and males constituted approximately three-fifths of the study population. Elective procedures accounted for two-thirds of surgeries, while one-third were performed on an emergency basis (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of Study Participants (N = 36)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–40	12	33.3
	41–60	16	44.4
	>60	8	22.3
Sex	Male	22	61.1
	Female	14	38.9
Type of Surgery	Elective	24	66.7
	Emergency	12	33.3
Diabetes Mellitus	Present	8	22.2
	Absent	28	77.8
Hypertension	Present	10	27.8
	Absent	26	72.2

The mean preoperative NLR, PLR, and CRP values were 3.8 ±1.7, 156 ±58, and 11.8 ±7.4 mg/L, respectively (Table 2).

Table 2. Distribution of Preoperative Inflammatory Markers Among Study Participants (N = 36)

Marker	Mean ± SD	Range
Neutrophil-to-Lymphocyte Ratio (NLR)	3.8 ± 1.7	1.2–8.2
Platelet-to-Lymphocyte Ratio (PLR)	156 ± 58	78–302
C-Reactive Protein (CRP) (mg/L)	11.8 ± 7.4	2–34

Postoperative complications occurred in 12 patients (33.3%). Surgical site infection was the most frequent complication, followed by respiratory complications, wound dehiscence, and intra-abdominal sepsis. One patient developed an anastomotic leak. Overall, 24 patients (66.7%) had an uncomplicated postoperative course (Table 3).

Table 3. Postoperative Complications Observed in the Study Population (N = 36)

Complication	Frequency (n)	Percentage (%)
No complication	24	66.7
Surgical site infection	5	13.9

Respiratory complication	2	5.6
Wound dehiscence	2	5.6
Intra-abdominal collection/sepsis	2	5.6
Anastomotic leak	1	2.8
Any postoperative complication	**12**	**33.3**

Patients who developed postoperative complications demonstrated significantly higher preoperative inflammatory marker levels compared with those who had no complications. Mean NLR, PLR, and CRP values were all significantly elevated in the complication group (Table 4).

Table 4. Comparison of Preoperative Inflammatory Markers Between Patients With and Without Postoperative Complications

Variable	Complication Present (n=12) Mean ± SD	No Complication (n=24) Mean ± SD	p-value
NLR	5.3 ± 1.6	3.0 ± 1.1	0.001
PLR	198 ± 61	135 ± 41	0.003
CRP (mg/L)	18.4 ± 7.8	8.5 ± 4.3	<0.001

Correlation analysis revealed a significant positive association between preoperative inflammatory markers and postoperative complications. CRP demonstrated the strongest correlation, followed by NLR and PLR. Higher preoperative inflammatory marker levels were associated with an increased likelihood of adverse postoperative outcomes (Table 5).

Table 5. Correlation of Preoperative Inflammatory Markers with Occurrence of Postoperative Complications

Marker	Correlation Coefficient (r)	p-value
NLR	0.49	0.003
PLR	0.42	0.011
CRP	0.58	<0.001

DISCUSSION

The present prospective observational study evaluated the association between preoperative inflammatory markers—neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and C-reactive protein (CRP)—and postoperative complications among patients undergoing major surgical procedures in a tertiary care hospital in West Bengal. The study demonstrated that patients who developed postoperative complications had significantly higher preoperative NLR, PLR, and CRP values compared with those who experienced an uncomplicated postoperative course. Furthermore, all three markers showed a positive correlation with postoperative morbidity, with CRP exhibiting the strongest association.

Approximately one-third of the study population developed postoperative complications, with surgical site infection being the most common adverse event. This finding is consistent with the well-recognized burden of postoperative morbidity reported globally and emphasizes the continued need for reliable preoperative risk stratification tools [1,2]. The observed complication rate falls within the

range reported in previous studies evaluating general surgical populations, suggesting that the study cohort was representative of routine clinical practice.

One of the principal findings of the present study was the significant association between elevated preoperative NLR and postoperative complications. NLR reflects the balance between neutrophil-mediated inflammatory activity and lymphocyte-mediated immune regulation. An elevated NLR may indicate a heightened systemic inflammatory response accompanied by relative immunosuppression, both of which can adversely affect wound healing and increase susceptibility to postoperative infections. Similar observations have been reported by Forget et al. [5], who demonstrated that elevated preoperative NLR was associated with increased postoperative morbidity following major abdominal surgery. Likewise, Mohri et al. [10] reported poorer postoperative outcomes among patients with elevated preoperative NLR values. The findings of the present study therefore support the growing body of evidence suggesting that NLR may serve as a useful and inexpensive marker for perioperative risk assessment.

The study also identified a significant relationship between PLR and postoperative complications. Platelets are increasingly recognized as active participants in inflammatory pathways through their interactions with leukocytes, endothelial cells, and inflammatory mediators. Elevated PLR may therefore reflect both systemic inflammation and platelet activation. Although PLR has been more extensively studied in oncological settings, its prognostic value in surgical patients has gained increasing attention. The association observed in the current study is in agreement with findings reported by Templeton et al. [6], who highlighted the prognostic significance of PLR in conditions characterized by chronic systemic inflammation. The present findings suggest that PLR may provide complementary information when used alongside other inflammatory markers in surgical risk assessment.

Among the evaluated markers, CRP demonstrated the strongest correlation with postoperative complications. CRP is an acute-phase reactant synthesized by hepatocytes in response to inflammatory cytokines, particularly interleukin-6. Elevated preoperative CRP levels may indicate the presence of underlying inflammatory processes, occult infection, tissue injury, or physiological stress that could predispose patients to adverse postoperative outcomes. Previous investigations have similarly reported associations between elevated CRP concentrations and increased postoperative morbidity [7,8]. The stronger correlation observed for CRP in the present study may reflect its direct responsiveness to systemic inflammatory activity and its established role as a biomarker of surgical risk.

The findings of this study have important clinical implications. Because NLR, PLR, and CRP are routinely available and relatively inexpensive investigations, they may be incorporated into preoperative assessment protocols to identify patients at increased risk of postoperative complications. Early recognition of high-risk individuals could facilitate targeted optimization strategies, enhanced perioperative monitoring, timely intervention, and more efficient utilization of healthcare resources. Such approaches may be particularly valuable in resource-constrained healthcare settings where sophisticated prognostic tools are not readily accessible.

The present study possesses several strengths. Its prospective design reduced the likelihood of incomplete data collection and enabled systematic postoperative follow-up. The simultaneous evaluation of three commonly available inflammatory markers allowed comparative assessment of their clinical utility. Furthermore, the study provides data from a West Bengal tertiary care setting, contributing evidence from a population that remains underrepresented in the existing literature.
Nevertheless, certain limitations should be acknowledged. The relatively small sample size of 36 patients may have limited the statistical power and generalizability of the findings. The study was conducted at a single center, which may restrict external validity. Additionally, the heterogeneous

nature of surgical procedures could have introduced variability in postoperative risk profiles. The short-term follow-up confined to the index hospitalization may also have resulted in underestimation of complications occurring after discharge. Larger multicentric studies with longer follow-up durations are required to establish optimal cut-off values and validate the predictive performance of these inflammatory markers across diverse surgical populations.

Overall, the present study supports the utility of preoperative inflammatory markers as predictors of postoperative morbidity and highlights their potential role in enhancing perioperative risk stratification.

CONCLUSION

This prospective observational study demonstrated a significant association between elevated preoperative inflammatory markers and the occurrence of postoperative complications among patients undergoing major surgical procedures. Patients who developed postoperative morbidity exhibited significantly higher preoperative neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and C-reactive protein levels compared with those who experienced an uncomplicated postoperative course. Among the evaluated biomarkers, C-reactive protein showed the strongest correlation with postoperative complications, followed by neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio.These findings suggest that systemic inflammation present before surgery may contribute to adverse postoperative outcomes and that readily available inflammatory markers can aid in identifying high-risk patients. Incorporation of these biomarkers into routine preoperative assessment may improve perioperative risk stratification, facilitate targeted optimization strategies, and support closer postoperative surveillance.
Further multicentric studies with larger sample sizes are recommended to validate these findings, establish clinically useful cut-off values, and determine the predictive accuracy of these markers across different surgical populations.

DECLARATIONS

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Conflict of Interest: The authors declare that there are no conflicts of interest.
Informed Consent: Written informed consent was obtained from all participants before enrollment in the study.
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