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The relationship between preoperative systemic inflammation markers and postoperative complications in patients undergoing abdominal surgery

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ABSTRACT

Objective: This study aimed to evaluate the relationship between preoperative systemic inflammation markers and postoperative complications.

Methods: This study was conducted as a retrospective, single-center observational study. A total of 674 patients undergoing elective abdominal surgery under general anesthesia were included in the study. Data were collected through patient information forms, preoperative and postoperative laboratory values, and calculation of systemic inflammation markers. Independent samples t-test, Mann-Whitney U test, Pearson chi-square test, Wilcoxon test, Spearman correlation analysis, and multivariable logistic regression were used for data analysis.

Results: Data from 674 patients with a mean age of 57.17 ± 16.21 years were analyzed. Clavien-Dindo sınıflandırmasına göre hastaların %39,6'sında en az bir komplikasyon görülmüştür. A significant positive correlation was found between perioperative findings and systemic inflammation markers. Among the parameters evaluated, NLR (AUC=0.995) and SII (AUC=0.957) demonstrated the highest discriminative power, both remaining robust independent predictors in multivariable analysis.

Conclusion: This study demonstrated that measuring systemic inflammation markers preoperatively could be the easiest and most cost-effective method to predict postoperative complications. Therefore, routine assessment of these parameters before surgery may aid in the early identification of patients at risk, allowing for appropriate treatment planning.

Keywords: Abdominal surgery, postoperative complications, CRP, systemic inflammation

INTRODUCTION

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It is reported that approximately 310 million surgical procedures are performed worldwide each year, with elective abdominal surgeries increasing annually by 2-5% in developed countries [1, 2]. Abdominal surgery encompasses the surgical treatment—either emergency or elective—of diseases or injuries affecting organs such as the stomach, pancreas, liver, spleen, gallbladder, small intestine, and colon. Although surgery has therapeutic benefits, various physiological and psychological complications may occur postoperatively [3, 4].

Postoperative complications following abdominal surgery include infections, pulmonary complications, cardiovascular complications, and anastomotic leakage. These complications are associated with high mortality rates and prolonged hospital stays, thereby increasing the economic burden [5]. Early diagnosis and timely intervention to prevent the progression of complications can improve patient prognosis. However, there is currently no reliable biomarker to predict postoperative complications. Therefore, appropriate indicators need to be identified to detect patients at risk of developing complications [6, 7].

Postoperative complications are influenced by the patient's inflammatory status, suggesting that inflammation markers could serve as useful tools for classifying patients at risk of complications. Systemic inflammation markers derived from various combinations of neutrophils, lymphocytes, monocytes, and platelets have been shown to be valuable prognostic tools in several malignant tumors [8, 9]. The significant advantages of these markers include easy calculation from routine complete blood count results, no additional cost, and no requirement for extra blood sampling. Additionally, these markers have been reported to predict prognosis in coronary artery disease, rheumatologic diseases, COVID-19, and inflammatory bowel disease [7, 10, 11].

The aim of this study was to investigate the prognostic value of preoperative systemic inflammation markers in predicting postoperative complications in patients undergoing abdominal surgery.

METHODS

Study design and participants

This study was designed and reported in accordance with the Strengthening Reporting of Observational Studies in Epidemiology (STROBE) guidelines [12]. This retrospective, single-center, observational cohort study was conducted in the General Surgery Department of Bakırköy Dr. Sadi Konuk Hospital. Data were collected from hospital records of patients who underwent abdominal surgery between January 1, 2024, and December 31, 2024. Patients included in the

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study were over 18 years old, had undergone abdominal surgery, and had a hospital stay of at least 24 hours postoperatively. Patients who underwent emergency surgery, those with chronic inflammatory diseases, a history of any malignancy, hematological disorders, bone marrow pathology, or those using anti-inflammatory or immunosuppressive medications were excluded from the study. However, patients with a prior history of gastrointestinal perforation who underwent elective abdominal surgery after successful stabilization of the acute condition were considered eligible for inclusion. Furthermore, the gastrectomy, hepatectomy, and hemicolectomy procedures included in this study were performed only for benign indications; patients who underwent surgery for malignant disease were not included (Figure 1).

Surgical postoperative complications (SPCs) were classified according to the Clavien–Dindo classification [13]. Patients who developed postoperative infections requiring antibiotic therapy and those who required blood transfusion were classified as Grade II complications. Life-threatening complications requiring admission to the neurological, coronary, cardiovascular, or critical care intensive care units were classified as Grade IV. SPCs were prospectively recorded by the study team from the day of surgery until hospital discharge. Complications were identified through daily review of physician notes, nursing records, laboratory findings, imaging reports, microbiological results, medication records, and discharge summaries. Postoperative infections were defined according to the European Society of Anaesthesiology and Intensive Care (ESAIC) criteria and included surgical site infection, pneumonia, bloodstream infection, urinary tract infection, and infection of unknown origin. Patients with documented active infections before surgery were not considered to have postoperative infections unless a new infection developed after surgery [7].

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Data Collection

A patient information form, developed by the researchers based on the literature, was used for data collection [14]. To minimize potential information bias, the process of obtaining and recording data from hospital records was performed by two independent researchers using a standardized data collection form. The form included questions regarding age, gender, body mass index (BMI), presence of chronic diseases, type of surgical procedure, and presence of postoperative complications. Additionally, preoperative and postoperative (24 hours) laboratory values were collected, including glucose, LDL, HDL, total cholesterol, triglycerides, urea, creatinine, eGFR, AST, ALT, GGT, lipase, total protein, albumin, calcium, magnesium, sodium, potassium,

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erythrocyte (RBC), leukocyte (WBC), neutrophil (NEU), lymphocyte (LYM), monocyte (MON), platelet (PLT), hemoglobin, and C-reactive protein (CRP). Using some of these laboratory parameters, calculations of the following systemic inflammation markers were performed [15].

NLR = Neutrophil / Lymphocyte

PLR = Platelet / Lymphocyte

LMR = Lymphocyte / Monocyte

MHR = Monocyte / HDL

PAI (plasma atherogenic index) = log (Triglyceride / HDL)

Systemic immune-inflammation index (SII) = Platelet x Neutrophil / Lymphocyte

Statistical analysis

All statistical analyses were performed using SPSS version 26 (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean, standard deviation, frequency, and percentage values. The distribution of scores for each continuous variable was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Independent samples t-test was used for comparisons of normally distributed continuous variables, while the Mann-Whitney U test was applied for continuous variables that did not show normal distribution. Pearson's chi-square test was used to compare binary categorical variables, and the Wilcoxon test was employed to analyze within-group changes.

To evaluate the independent predictive value of preoperative biochemical parameters and inflammatory indices for postoperative complications, multivariable logistic regression analyses were performed. To avoid potential multicollinearity arising from the mathematical and biological correlations among the five inflammatory indices (NLR, PLR, SII, Glucose, and LMR), five separate multivariable logistic regression models were constructed, with each model evaluating a single inflammatory index as the primary independent variable. To control for baseline imbalances and clinical severity, a fixed set of clinically important confounders—including age, ASA score, operation duration, diabetes mellitus, hypertension, and heart failure—was forced into all five models simultaneously, regardless of their significance in univariate analyses. The predictive value of variables included in the multivariable logistic regression for adverse outcomes was evaluated using receiver operating characteristic (ROC) curve analysis. The prediction model was assessed by the area under the curve (AUC). Spearman's rank correlation coefficient test was used to

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examine correlations between variables. Results were evaluated at a 95% confidence interval, with statistical significance set at $p<0.05$.

RESULTS

Among the 674 patients included in this study, 407 (60.4%) had no complications, while 267 (39.6%) experienced at least one complication. Among patients with complications, 159 had grade II complications and 108 had grade IV complications (Table 1).

The mean age of the patients included in the study was 57.17 ± 16.21 years; 383 (56.8%) were male and 291 (43.2%) were female. Fifty-four percent of the patients had no chronic diseases, while 21.2% had hypertension and 17.5% had diabetes. Patients with complications had significantly higher values in preoperative day, postoperative day, hospital stay, ASA score, and operation time compared to those without complications (Table 2).

Patients with complications had significantly higher preoperative levels of glucose, LDL, triglycerides, urea, GGT, sodium, and potassium compared to those without complications. Conversely, HDL, eGFR, total protein, albumin, and calcium levels were significantly lower in patients with complications (Table 3).

When comparing preoperative and postoperative values, statistically significant differences were observed between patients with and without complications in total cholesterol, HDL, LDL, triglycerides, urea, eGFR, total protein, albumin, calcium, and potassium levels (Table 3).

Patients with complications had significantly higher preoperative levels of WBC, NEU, MON, NLR, PLR, MHR, PAI, SII, and CRP compared to those without complications. In contrast, hemoglobin, RBC, LYM, PLT, and LMR levels were significantly lower in patients with complications (Table 4).

When comparing preoperative and postoperative values, statistically significant differences were observed between patients with and without complications in hemoglobin, RBC, WBC, NLR, LMR, MHR, PAI, SII, and CRP levels (Table 4).

As shown in Figure 2, the discriminative ability of various preoperative biochemical parameters to predict postoperative complications in patients undergoing abdominal surgery was evaluated using ROC analysis, followed by calculation of Odds Ratios (OR) based on optimal cutoff values. The optimal cutoff value for each parameter was determined by calculating the Youden index (J = sensitivity + specificity – 1) from the ROC curve. Among the parameters examined, NLR and SII emerged as the variables with the highest discriminative power. According to the ROC analysis,

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the optimal cut-off value for the NLR score with the highest diagnostic accuracy was ≥8.99, and for SII it was ≥2893.88.

To evaluate the independent predictive value of the evaluated biomarkers and prevent potential multicollinearity, separate multivariable logistic regression models were constructed for each inflammatory index, with baseline clinical and operative characteristics adjusted simultaneously (Table 5). After controlling for potential confounders such as age, ASA score, operation duration, diabetes mellitus, hypertension, and heart failure, all five markers remained robust and independent predictors of postoperative complications. Specifically, higher levels of NLR (OR = 24.391, 95% CI: 9,090–65,447, p<0.001), PLR (OR = 1.004, 95% CI: 1,002–1,006, p<0.001), SII (OR = 1.003, 95% CI: 1,003–1,004, p<0.001), and glucose (OR = 1.023, 95% CI: 1,017–1,030, p<0.001) were associated with significantly increased odds of complications. Conversely, higher LMR values exhibited a significant protective effect against postoperative complications (OR = 0.583, 95% CI: 0.510–0.665, p<0.001).

Table 6 presents the correlation relationships between perioperative findings and the parameters identified as potential independent predictors of complication development. Significant positive correlations were found between postoperative day and hospital stay with glucose, NLR, MHR, PAI, and SII. Operation time and ASA score also showed significant positive correlations with glucose, NLR, PAI, and SII.

DISCUSSION

Postoperative complications commonly encountered in abdominal surgery adversely affect patients' overall health status, increasing morbidity and mortality, prolonging hospital stay, raising intensive care requirements, and consequently escalating hospital costs. It is estimated that complications following major surgeries cause approximately eight million deaths annually worldwide. Therefore, early and easy detection of postoperative complications before surgery is of great importance [16].

Length of hospital stay, often used as an indicator of healthcare quality, is generally considered a short-term surgical outcome. Prolonged hospitalization is one of the significant factors associated with postoperative complications and increased healthcare costs. Numerous studies in the literature related to abdominal surgery have shown that patients who develop complications tend to have longer hospital stays [17, 18]. In this study, hospital stay was significantly longer in patients with complications compared to those without. Similarly, Jiao et al. reported that in patients undergoing

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abdominal surgery, the duration of surgery, length of hospital stay, and the percentage of patients with an ASA score greater than two were significantly higher in those with complications [7]. Various studies evaluating the relationship between postoperative length of stay and complications across different surgical types have identified postoperative complications as the most important factor affecting hospital stay [7, 17]. The positive correlation observed in this study between perioperative findings and systemic inflammation markers underscores the importance of infection in prolonging hospital stay.

C-reactive protein (CRP), an acute-phase protein, is widely used in clinical practice as a diagnostic marker in inflammatory conditions, with its concentration increasing proportionally to the severity of inflammation. Leukocytes (WBC) are fundamental components of the immune system, serving as the body's first line of defense, and act as sensitive biomarkers for various conditions such as infection and trauma. In this study, preoperative and postoperative WBC and CRP levels were significantly higher in patients with complications compared to those without. Recent studies on patients undergoing surgical interventions have also reported elevated WBC and CRP levels in those with complications [2, 13, 19, 20]. These findings suggest that WBC and CRP may play a role in the early detection of postoperative complications. Surgical site infection (SSI) is one of the most common postoperative complications following abdominal surgeries, and conditions such as sepsis triggered by this infection cause severe pain and suffering in the patient, as well as prolonging hospital stays, increasing morbidity, mortality, and economic burden [21, 22]. Accordingly, early monitoring of these inflammatory markers is critically important in preventing costly and life-threatening complications such as SSI and sepsis.

To enable early identification of postoperative complications in abdominal surgery, there is a need for simple, commonly used, and cost-effective laboratory tests. Hemogram represent a rapid, inexpensive laboratory analysis routinely performed in nearly all healthcare settings worldwide. These features make hemogram an accessible and time-efficient biochemical test suitable for preoperative risk assessments in surgical clinics [15, 23].

Systemic inflammation indicators are ratio indices calculated from platelets, inflammatory activators (neutrophils/monocytes), and inflammatory regulators (lymphocytes), which are considered effective markers of immune balance and play important roles in diagnosis, prognosis, and therapeutic evaluation in various diseases. Among these, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII) are

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the most commonly used [24, 25]. In this study, preoperative and postoperative levels of NLR, PLR, and SII were significantly higher in patients with complications than in those without. In a similar sample group, Wen et al. found that preoperative SII and NLR values were significantly higher in patients who developed pulmonary complications compared to those who did not [26]. Likewise, Tekeli et al., in their study on patients undergoing acute appendectomy, reported significantly higher SII, NLR, and PLR levels in patients with complications compared to those without [8]. The findings of this study are consistent with the literature. Furthermore, the results of ROC curve analysis revealed that among the examined parameters, preoperative NLR and SII had the highest discriminative power.

CONCLUSION

In conclusion, our findings suggest that certain biochemical biomarkers measured preoperatively may serve as potential predictors of postoperative complications. Complications in patients undergoing abdominal surgery are associated with prolonged hospital stays, increased need for intensive care, higher healthcare costs, and elevated mortality rates. Future studies should investigate individual complications to better evaluate the impact of biochemical parameters on postoperative outcomes in patients undergoing abdominal surgery. In addition to routine hemogram-based indices, emerging research has highlighted the potential of novel enzymatic biomarkers in predicting surgical complications. For instance, perioperative levels of butyrylcholinesterase (BChE)—an enzyme synthesized in the liver—have recently been shown to correlate with the risk and severity of SSIs following abdominal surgeries [27]. Therefore, future clinical trials should investigate the synergistic use of both routine inflammatory ratios and novel biomarkers like BChE to further improve risk stratification in abdominal surgery.

Limitations

This study has several limitations. The first limitation is that the data were obtained from a single center. Secondly, our analyses were conducted retrospectively.

CRediT authorship contribution statement

M.S.T: Writing - original draft, Methodology, Formal analysis, Resources, Conceptualization. **A.Y.G** Data curation, Writing - review & editing, Supervision.

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None declared.

Disclosure

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The Author(s) declare(s) that there is no conflict of interest.

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Ethics Statement

The present study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from Istanbul Kent University Ethics Committee (dated 18.11.2024, approval number: 2024-08).

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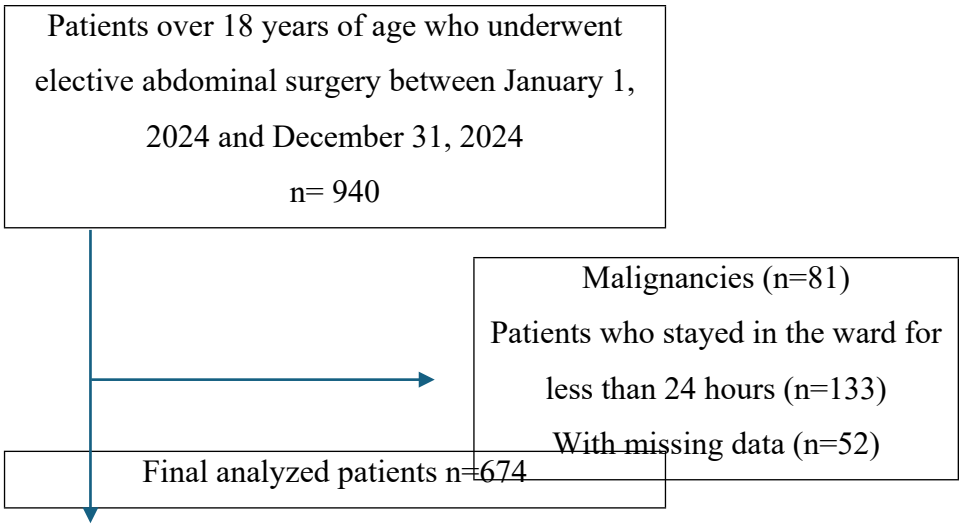


Figure 1: The flow chart diagram for the patient enrollment.

Table 1: Types of surgeries and complications in patients

	Without SPCs n=407	With SPCs n=267		Total n=674
		Grade II	Grade IV	
Appendectomy	73	20	11	104
Cholecystectomy	81	12	16	109
Gastrectomy	46	23	17	86
Perforation	71	34	15	120
Hepatectomy	30	20	7	57
Ileostomy	51	29	23	103
Hemicolectomy	55	21	19	95

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Table 2: Demographic and surgical information of patients

	Without SPCs n=407			With SPCs n=267			
	Mean	**±**	**SD**	**Mean**	**±**	**SD**	**p value**
Age (years)	54,33	±	16,64	61,49	±	14,54	***<0,001[t]***
BMI (kg/m²)	25,84	±	5,32	25,44	±	5,35	0,335[t]
Preoperative day	1,98	±	2,27	2,94	±	3,58	***<0,001[m]***
Postoperative day	4,02	±	2,81	7,88	±	4,95	***<0,001[t]***
Hospital stay	6,00	±	3,95	10,82	±	6,07	***<0,001[t]***
ASA	2,39	±	0,66	2,66	±	0,75	***<0,001[m]***
Operation time (minutes)	157,86	±	114,81	186,31	±	114,25	***<0,001[m]***
	n(%)			**n(%)**			
Male sex	236 (58%)			147 (55%)			0,453[x²]
History of smoking	145 (35,6%)			85 (31,8%)			0,310[x²]

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Alcohol intake	32 (7,9%)	16 (6%)	0,356[x²]
Chronic disease			
Diabetes mellitus	61 (15%)	57 (21,3%)	***0,034***[x²]
Hypertension	66 (16,2%)	77 (28,8%)	***<0,001***[x²]
Heart failure	22 (5,4%)	27 (10,1%)	***0,021***[x²]

BMI: Body Mass Index, [m] / Mann-Witney U test, [t] / Independent samples t-test, [x²] / Pearson's chi-square test

Table 3: Preoperative and postoperative biochemical parameter levels

	Without SPCs n=407	**With SPCs n=267**	
	Mean ± SD	**Mean ± SD**	**p**
Preoperative glucose (mg/dL)	107,62 ± 27,05	132,78 ± 38,10	***<0,001***[m]
Postoperative glucose (mg/dL)	104,69 ± 27,07	126,38 ± 41,98	***<0,001***[m]
	0,129[w]	0,265[w]	
Preoperative total cholesterol (mg/dL)	188,53 ± 33,05	182,17 ± 22,12	0,233[m]
Postoperative total cholesterol (mg/dL)	198,42 ± 34,96	188,41 ± 21,31	***0,008***[m]
	<0,001[w]	***<0,001***[w]	
Preoperative HDL (mg/dL)	61,56 ± 10,14	38,61 ± 9,61	***<0,001***[m]
Postoperative HDL (mg/dL)	57,76 ± 9,66	35,75 ± 8,41	***<0,001***[m]
	<0,001[w]	***<0,001***[w]	
Preoperative LDL (mg/dL)	98,35 ± 24,56	112,95 ± 19,63	***<0,001***[t]
Postoperative LDL (mg/dL)	110,41 ± 26,74	120,29 ± 18,20	***<0,001***[t]
	<0,001[a]	***<0,001***[a]	
Preoperative triglyceride (mg/dL)	143,24 ± 48,52	153,45 ± 38,29	***0,002***[t]
Postoperative triglyceride (mg/dL)	151,20 ± 51,66	161,98 ± 33,59	***0,001***[t]
	0,027[a]	***0,005***[a]	
Preoperative urea (mg/dL)	32,58 ± 15,64	39,53 ± 22,04	***<0,001***[m]
Postoperative urea (mg/dL)	28,77 ± 17,02	35,32 ± 25,99	***0,006***[m]
	<0,001[w]	***<0,001***[w]	
Preoperative creatinine (mg/dL)	0,89 ± 0,25	1,05 ± 0,63	0,132[m]
Postoperative creatinine (mg/dL)	0,93 ± 0,50	1,01 ± 0,79	0,556[m]
	0,147[w]	***<0,001***[w]	
Preoperative eGFR (mL/min/1,73 m²)	92,04 ± 24,55	76,11 ± 29,27	***<0,001***[m]
Postoperative eGFR (mL/min/1,73 m²)	95,78 ± 24,49	82,17 ± 30,39	***<0,001***[m]
	<0,001[w]	***<0,001***[w]	
Preoperative AST (U/L)	28,24 ± 16,39	32,32 ± 28,46	0,218[m]
Postoperative AST (U/L)	30,63 ± 23,28	29,99 ± 23,10	0,861[m]
	0,416[w]	0,621[w]	
Preoperative ALT (IU/L)	25,13 ± 15,19	32,26 ± 30,66	0,908[m]
Postoperative ALT (IU/L)	25,89 ± 22,89	26,41 ± 24,20	0,242[m]

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	0,283[w]	***0,031[w]***	
Preoperative GGT (U/L)	31,06 ± 23,31	46,15 ± 39,27	***<0,001[t]***
Postoperative GGT (U/L)	35,11 ± 29,78	47,70 ± 36,42	***<0,001[t]***
	0,009[a]	0,580[a]	
Preoperative lipase (U/L)	33,53 ± 21,73	39,84 ± 29,55	0,110[m]
Postoperative lipase (U/L)	34,00 ± 23,19	41,06 ± 31,99	0,062[m]
	0,737[w]	0,712[w]	
Preoperative total protein (g/L)	66,08 ± 8,95	59,17 ± 9,74	***<0,001[t]***
Postoperative total protein (g/L)	60,51 ± 9,20	54,98 ± 8,90	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative albumin (g/L)	38,92 ± 7,66	32,92 ± 7,34	***<0,001[t]***
Postoperative albumin (g/L)	34,85 ± 7,15	29,62 ± 6,08	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative calcium (mg/dL)	8,96 ± 0,87	8,56 ± 0,92	***<0,001[t]***
Postoperative calcium (mg/dL)	8,68 ± 0,74	8,21 ± 0,68	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative magnesium (mg/dL)	1,98 ± 0,26	2,03 ± 0,44	0,064[t]
Postoperative magnesium (mg/dL)	1,95 ± 0,29	1,93 ± 0,41	0,544[t]
	0,138[a]	***<0,001[a]***	
Preoperative sodium (mmol/L)	137,52 ± 3,65	139,43 ± 5,30	***<0,001[t]***
Postoperative sodium (mmol/L)	137,62 ± 3,53	138,58 ± 7,90	0,062[t]
	0,631[a]	0,102[a]	
Preoperative potassium (mmol/L)	4,17 ± 0,61	4,31 ± 0,66	***0,005[t]***
Postoperative potassium (mmol/L)	4,02 ± 0,66	4,08 ± 0,74	0,251[t]
	<0,001[a]	***<0,001[a]***	

[m] / Mann-Witney U test, [t] / Independent samples t-test, [w] / Wilcoxon test, [a] / Paired samples t-test

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Table 4: Preoperative and postoperative blood parameters and inflammation markers

	Without SPCs n=407	**With SPCs n=267**	
	Mean ± SD	**Mean ± SD**	**p**
Preoperative hemoglobin (g/dL)	12,32 ± 2,29	11,02 ± 2,31	***<0,001[t]***
Postoperative hemoglobin (g/dL)	11,28 ± 2,06	10,02 ± 1,85	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative RBC (10^{-6}/µl)	4,38 ± 0,77	3,98 ± 0,74	***<0,001[t]***
Postoperative RBC (10^{-6}/µl)	4,12 ± 0,71	3,63 ± 0,66	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative WBC (10^{-3}/µl)	6,11 ± 1,73	10,81 ± 3,13	***<0,001[t]***
Postoperative WBC (10^{-3}/µl)	6,89 ± 1,90	12,06 ± 3,60	***<0,001[t]***
	<0,001[a]	***<0,001[a]***	
Preoperative NEU	7,67 ± 3,60	14,61 ± 3,79	***<0,001[t]***
Postoperative NEU	7,70 ± 5,53	9,73 ± 4,66	***<0,001[t]***

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	0,936[a]	***<0,001[a]***
Preoperative LYM	1,64 ± 1,31	1,30 ± 0,60 ***<0,001[t]***
Postoperative LYM	1,63 ± 1,32	1,25 ± 0,64 ***<0,001[t]***
	0,703[a]	***<0,001[a]***
Preoperative MON	0,52 ± 0,26	0,64 ± 0,40 ***<0,001[t]***
Postoperative MON	0,57 ± 0,25	0,61 ± 0,29 0,055[t]
	<0,001[a]	0,410[a]
Preoperative PLT (10^{-3}/µl)	281,22 ± 80,90	249,54 ± 76,89 ***<0,001[t]***
Postoperative PLT (10^{-3}/µl)	267,42 ± 84,80	255,86 ± 107,06 ***0,046[t]***
	0,002[a]	0,719[a]
Preoperative NLR	5,05 ± 2,34	13,35 ± 2,84 ***<0,001[m]***
Postoperative NLR	6,17 ± 5,32	9,20 ± 6,80 ***<0,001[m]***
	0,049[w]	***<0,001[w]***
Preoperative PLR	196,34 ± 107,33	240,07 ± 107,96 ***<0,001[m]***
Postoperative PLR	207,89 ± 130,69	230, 60 ± 141,14 ***0,004[m]***
	0,364[w]	***0,028[w]***
Preoperative LMR	3,86 ± 2,71	2,31 ± 1,36 ***<0,001[t]***
Postoperative LMR	3,26 ± 2,12	2,59 ± 1,73 ***<0,001[t]***
	<0,001[a]	***0,011[a]***
Preoperative MHR	0,009 ± 0,004	0,018 ± 0,012 ***<0,001[m]***
Postoperative MHR	0,010 ± 0,005	0,018 ± 0,010 ***<0,001[m]***
	<0,001[w]	***0,008[w]***
Preoperative PAI	0,35 ± 0,16	0,60 ± 0,20 ***<0,001[t]***
Postoperative PAI	0,40 ± 0,16	0,66 ± 0,17 ***<0,001[t]***
	<0,001[a]	***<0,001[a]***
Preoperative SII	1378,47 ± 679,92	3230,29 ± 960,40 ***<0,001[t]***
Postoperative SIi	1565,80 ± 1303,25	2023,36 ± 1324,37 ***<0,001[t]***
	0,006[a]	***<0,001[a]***
Preoperative CRP (mg/dL)	19,00 ± 18,99	74,07 ± 71,22 ***<0,001[t]***
Postoperative CRP (mg/dL)	50,10 ± 42,67	83,83 ± 62,02 ***<0,001[t]***
	<0,001[a]	***<0,001[a]***

[m] / Mann-Witney U test, [t] / Independent samples t-test, [w] / Wilcoxon test, [a] / Paired samples t-test

Table 5: Confounder-adjusted multivariable logistic regression models (Models 1–5) for the independent association between individual inflammatory indices and postoperative complications.

Independent Variables	Model 1 (NLR) OR (95% CI) / p	Model 2 (PLR) OR (95% CI) / p	Model 3 (SII) OR (95% CI) / p	Model 4 (Glucose) OR (95% CI) / p	Model 5 (LMR) OR (95% CI) / p
Age	1,017 (0,981-1,053) / p=0,365	1,014 (1,001-1,026) / p=0,028	1,016 (0,995-1,037) / p=0,143	1,009 (0,996-1,022) / p=0,182	1,016 (1,003-1,030) / p=0,014
ASA	1,874 (0,800-4,394) / p=0,148	1,492 (1,170-1,904) / p=0,001	1,172 (0,773-1,776) / p=0,455	1,466 (1,140-1,884) / p=0,003	1,592 (1,228-2,065) / p<0,001
Operation time	1,002 (0,998-1,006) / p=0,355	1,002 (1,000-1,003) / p=0,013	1,002 (0,999-1,004) / p=0,147	1,002 (1,000-1,003) / p=0,040	1,002 (1,000-1,003) / p=0,024
Diabetes mellitus	0,337 (0,084-1,353) / p=0,125	1,283 (0,838-1,965) / p=0,252	1,569 (0,772-3,191) / p=0,213	0,661 (0,409-1,067) / p=0,090	1,199 (0,760-1,890) p=0,435

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Hypertension	2,467 (0,747-8,147) / p=0,139	1,806 (1,202-2,714) / p=0,004	1,934 (0,981-3,815) / p=0,057	1,626 (1,064-2,486) / p=0,025	1,757 (1,140-2,706) / p=0,011
Heart failure	0,759 (0,104-5,553) / p=0,786	1,215 (0,644-2,293) / p=0,548	0,847 (0,305-2,350) / p=0,750	1,278 (0,659-2,477) / p=0,468	1,220 (0,620-2,401) / p=0,565
NLR	24,391 (9,090-65,447) / ***p<0,001***	-	-	-	-
PLR	-	1,004 (1,002-1,006) / ***p<0,001***	-	-	-
SII	-	-	1,003 (1,003-1,004) / ***p<0,001***	-	-
Glucose	-	-	-	1,023 (1,017-1,030) / ***p<0,001***	-
LMR	-	-	-	-	0,583 (0,510-0,665) / ***p<0,001***

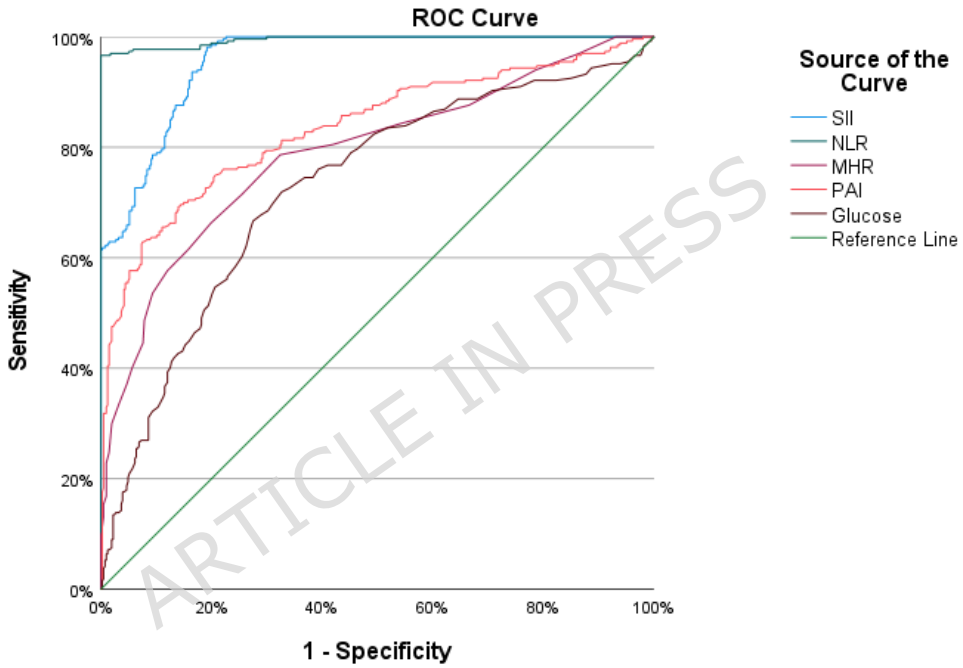


Figure 2: ROC curves for preoperative laboratory parameters in predicting postoperative complications

Table 6: Spearman correlation table showing the relationships between perioperative period findings and preoperative biochemical variables.

		Preoperative day	Postoperative day	Hospital stay	Operation time	ASA	Glucose	NLR	MHR	PAI	SII
Preoperative day	r	1,000	0,333	0,632	0,271	***0,035***	0,055	0,118	0,098	0,158	0,144
	p		***<0,001***	***<0,001***	***<0,001***	0,360	0,155	***0,002***	***0,011***	***<0,001***	***<0,001***
Postoperative day	r		1,000	0,910	0,488	0,110	0,275	0,360	0,208	0,269	0,353
	p			***<0,001***	***<0,001***	***0,004***	***<0,001***	***<0,001***	***<0,001***	***<0,001***	***<0,001***
Hospital stay	r			1,000	0,499	0,101	0,248	0,334	0,207	0,267	0,341
	p				***<0,001***	***0,009***	***<0,001***	***<0,001***	***<0,001***	***<0,001***	***<0,001***
Operation time	r				1,000	0,109	0,177	0,139	0,069	0,143	0,130
	p					***0,005***	***<0,001***	***<0,001***	0,071	***<0,001***	***0,001***
ASA	r					1,000	0,155	0,193	0,068	0,080	0,191
	p						***<0,001***	***<0,001***	0,078	***0,037***	***<0,001***

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Glucose	r	1,000	0,371	0,197	0,194	0,321
	p		***<0,001***	***<0,001***	***<0,001***	***<0,001***
NLR	r		1,000	0,461	0,481	0,875
	p			***<0,001***	***<0,001***	***<0,001***
MHR	r			1,000	0,449	0,489
	p				***<0,001***	***<0,001***
PAI	r				1,000	0,432
	p					***<0,001***
SII	r					1,000
	p					

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