Predictive Value of Preoperative Neutrophil-to-Lymphocyte Ratio on Postoperative Complications in Valve Surgery Patients

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Abstract

Aim: This study sought to determine the prognostic utility of the preoperative neutrophil-to-lymphocyte ratio (NLR) as a predictor for major postoperative morbidity in patients undergoing isolated elective valve replacement surgery.

Methods: This retrospective cohort study examined the data of 412 adult patients undergoing elective aortic and/or mitral valve replacement. NLR was calculated from blood samples 24 hours before surgery. The cutoff value of NLR ≥3.0 was determined using Receiver Operating Characteristic (ROC) curve analysis to maximize predictive accuracy for composite morbidity. Patients were divided into two groups based on NLR values: Group 1: NLR < 3.0 and Group 2: NLR ≥ 3.0.

Results: According to preoperative NLR values, 268 patients (65%) were in Group 1 and 144 patients (35%) were in Group 2. Significantly higher rates of postoperative atrial fibrillation (PoAF), renal dysfunction, prolonged mechanical ventilation, and infectious complications were observed in Group 2 compared to Group 1.

Conclusions: Preoperative NLR is an independent predictor of adverse outcomes, including atrial fibrillation, renal dysfunction, and infectious complications, following valve surgery. Its integration into preoperative risk assessment models may enhance patient stratification and guide tailored perioperative management strategies.

***Keywords**: Heart valve surgery; systemic inflammation; preoperative neutrophil-lymphocyte ratio; postoperative complications*

1. Introduction

Valvular heart diseases remain a significant global health issue due to their increasing prevalence and the need for surgical intervention, particularly in the aging population.[1] Aortic and mitral valve replacements are associated with considerable morbidity and mortality, especially in high-risk cohorts.[2] As such, identifying simple, reliable, and cost-effective biomarkers that can predict postoperative complications is of critical importance.

Systemic inflammation has been recognized as a key contributor to adverse surgical outcomes.[3] The neutrophil-to-lymphocyte ratio (NLR), derived from routine blood counts, has emerged as a surrogate marker of systemic inflammation and immune dysregulation.[4] Previous studies have shown its prognostic value in conditions such as sepsis, malignancies, peripheral artery disease, and cardiovascular surgeries.[5,6]

However, the body of evidence specifically investigating the predictive value of NLR in patients undergoing isolated valve surgery remains comparatively limited, with many studies encompassing mixed cardiac surgical cohorts. Therefore, the primary objective of this retrospective study was to elucidate the association between preoperative NLR and the risk of postoperative complications in a well-defined cohort of patients undergoing elective, isolated aortic and/or mitral valve replacement, thereby elucidating its potential as a preoperative risk stratification tool.

2. Materials and Methods

This retrospective cohort study was conducted in accordance with the Declaration of Helsinki Principles at the Department of Cardiovascular Surgery, Adana City Training and Research Hospital, Health Sciences University, and institutional ethical and legal permissions were obtained. Ethics committee approval was obtained from the Clinical Research Ethics Committee of Adana City Training and Research Hospital, Health Sciences University (Date: 21.08.2025 - Approval number: 16/689). The data used in this study were obtained from the hospital record system. The data were anonymized, and patient confidentiality was protected throughout the study. Informed consent was not required as there was no risk or impact on patient care. This waiver of consent was approved by the Institutional Review Board and the Ethics Committee.

Data from adult patients who underwent planned aortic and/or mitral valve replacement between January 2019 and December

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2023 were reviewed. A total of 412 patients met the inclusion criteria. Patients were excluded if they underwent concomitant coronary artery bypass grafting (CABG), emergency surgery, had a history of active infection or sepsis within the preceding two weeks, hematologic malignancy, or received immunosuppressive therapy. Demographic data, preoperative complete blood count values, operative variables, and postoperative outcomes were obtained. Patient clinical characteristics and demographic data are presented in Table 1. The neutrophil-to-lymphocyte ratio (NLR) was calculated from preoperative blood samples collected within 24 hours before surgery. The optimal preoperative NLR cutoff value for predicting composite postoperative complications was determined to be 3.0 based on Receiver Operating Characteristic (ROC) curve analysis (Youden's index). Patients were divided into two groups based on their NLR values: Group 1: NLR < 3.0 and Group 2: NLR ≥ 3.0.

Postoperative complications were defined as follows:

- Postoperative atrial fibrillation (PoAF): New-onset AF requiring medical or electrical intervention
- Renal dysfunction: Defined by the KDIGO criteria (≥1.5× increase in serum creatinine within 7 days postoperatively)
- Prolonged mechanical ventilation: Need for ventilatory support >24 hours postoperatively
- Prolonged ICU stay: ICU stay exceeding 3 days
- Infectious complications: Clinical and laboratory diagnosis of pneumonia, surgical site infection, or sepsis.

2.1. Statistical Analysis

Continuous variables were summarized as mean ± standard deviation or median (interquartile range), depending on whether they showed a normal distribution. Categorical variables were reported as numbers and percentages. Statistical analysis of differences between groups was performed using the Mann-Whitney U test for continuous variables under nonparametric conditions, the Student t-test for parametric conditions, and the Chi-square or Fisher exact test for categorical variables. A multivariate logistic regression model was constructed to determine independent factors predicting postoperative complications. Statistical significance was accepted as $p<0.05$. All statistical analyses were performed using IBM SPSS Statistics 25.0 (IBM Corp., Armonk, NY, USA) software.

3. Results

A total of 412 patients (mean age 64.2 ± 10.7 years; 58.5% male) who underwent elective aortic and/or mitral valve replacement were included in the study. According to the preoperative NLR values, 268 patients (65%) were in Group 1 (NLR <3.0) and 144 patients (35%) were in Group 2 (NLR ≥3.0). Group 2 had significantly higher rates of postoperative atrial fibrillation (PoAF), renal dysfunction, prolonged mechanical ventilation, and infectious complications compared to Group 1 (Table 2). Multivariate logistic regression analysis identified NLR ≥3.0 as an independent predictor of postoperative atrial fibrillation (OR: 2.31; 95% CI: 1.36–3.93; p=0.002), renal dysfunction (OR: 2.05; 95% CI: 1.06–3.95; p=0.033), and infectious complications (OR: 2.52; 95% CI: 1.28–4.97; p=0.007) (Table 3).

Table 1

Summary of Participant Demographics and Pretreatment Clinical Variables

Characteristic	Group 1 (N=268)	Group 2 (N=144)	p-value
Patient Characteristics			
Age, years (Mean ± SD)	62.5 ± 10.1	67.8 ± 11.2	>0.05
Male, n (%)	155 (57.8%)	86 (59.7%)	>0.05
BMI (Mean ± SD)	26.5 ± 3.2	27.1 ± 3.8	>0.05
EuroSCORE II (Mean ± SD)	2.5 ± 1.1	3.8 ± 1.5	<0.001
Hypertension, n (%)	170 (63.4%)	98 (68.1%)	>0.05
Diabetes Mellitus, n (%)	95 (35.4%)	58 (40.3%)	>0.05
COPD, n (%)	25 (9.3%)	20 (13.9%)	>0.05
CAD, n (%)	110 (41.0%)	65 (45.1%)	>0.05
Previous Stroke/TIA, n (%)	15 (5.6%)	10 (6.9%)	>0.05
Chronic Kidney Disease, n (%)	30 (11.2%)	25 (17.4%)	>0.05
LVEF (Mean ± SD)	55.2 ± 8.1	53.9 ± 8.5	>0.05
Valve Disease Type			
Aortic Valve Replacement (AVR), n (%)	180 (67.2%)	90 (62.5%)	>0.05
Mitral Valve Replacement (MVR), n (%)	60 (22.4%)	35 (24.3%)	>0.05
Double Valve Replacement (DVR), n (%)	28 (10.4%)	19 (13.2%)	>0.05
Preoperative Laboratory Values			
Hemoglobin (Mean ± SD)	12.8 ± 1.2	11.9 ± 1.5	<0.001
WBC Count (Mean ± SD)	7.2 ± 1.5	9.5 ± 2.0	<0.001
Neutrophil Count (Mean ± SD)	4.5 ± 1.2	7.0 ± 1.8	<0.001
Lymphocyte Count (Mean ± SD)	2.5 ± 0.8	1.9 ± 0.7	<0.001
Platelet Count (Mean ± SD)	250 ± 60	265 ± 75	>0.05
Serum Creatinine (Mean ± SD)	0.9 ± 0.2	1.1 ± 0.3	>0.05
CRP (Median [IQR])	3.2 [1.5-6.8]	7.5 [4.0-12.1]	<0.001
NLR (Mean ± SD)	1.8 ± 0.5	4.1 ± 1.1	<0.001
Surgical Characteristics			
CPB Time, min (Mean ± SD)	105 ± 25	112 ± 30	>0.05
ACC Time, min (Mean ± SD)	70 ± 15	75 ± 18	>0.05

ACC; Aortic Cross-Clamp, AVR; Aortic Valve Replacement, BMI; Body Mass Index, CAD; Coronary Artery Disease, COPD; Chronic Obstructive Pulmonary Disease, CPB; Cardiopulmonary Bypass, CRP; C-Reactive Protein, DVR; Double Valve Replacement, MVR; Mitral Valve Replacement, NLR; Neutrophil/ Lymphocyte Ratio, WBC; White Blood Cell

Table 2

Postoperative Complications Stratified by Preoperative NLR Group

Postoperative Complication	Group 1 n (%)	Group 2 n (%)	p-value
PoAF	45 (16.8%)	48 (33.3%)	<0.001
Renal Dysfunction	15 (5.6%)	18 (12.5%)	>0.05
Prolonged Mechanical Ventilation (>24 hours)	20 (7.5%)	18 (12.5%)	>0.05
Prolonged ICU Stay (>3 days)	40 (14.9%)	28 (19.4%)	>0.05
Infectious Complications (Overall)	10 (3.7%)	15 (10.4%)	>0.05
Pneumonia	5 (1.9%)	8 (5.6%)	>0.05
Surgical Site Infection	3 (1.1%)	4 (2.8%)	>0.05
Sepsis	2 (0.7%)	3 (2.1%)	>0.05

ICU; Intensive Care Unit, PoAF; Postoperative Atrial Fibrillation

Table 3

Multivariable Analysis of Factors Independently Associated with Postoperative Adverse Outcomes

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Dependent Variable: PoAF			
Preoperative NLR ≥3.0 (vs. <3.0)	2.31	1.36–3.93	>0.05
Age (per 10-year increase)	1.25	1.05–1.48	>0.05
EuroSCORE II (per 1-point increase)	1.10	1.01–1.20	>0.05
Dependent Variable: Renal Dysfunction			
Preoperative NLR ≥3.0 (vs. <3.0)	02.05	1.06–3.95	>0.05
Chronic Kidney Disease (Yes vs. No)	3.50	1.80–6.80	<0.001
CPB Time (per 10 min increase)	01.08	1.01–1.16	>0.05
Dependent Variable: Infectious Complications			
Preoperative NLR ≥3.0 (vs. <3.0)	2.52	1.28–4.97	>0.05
COPD (Yes vs. No)	2.10	1.05–4.20	>0.05
Prolonged Mechanical Ventilation (>24 hours)	4.50	2.10–9.60	<0.001

COPD; Chronic Obstructive Pulmonary Disease, CPB; Cardiopulmonary Bypass, NLR; Neutrophil/ Lymphocyte Ratio, PoAF; Postoperative Atrial Fibrillation

4. Discussion

In this retrospective study, we investigated the prognostic significance of preoperative neutrophil-to-lymphocyte ratio (NLR) in patients undergoing elective aortic and/or mitral valve replacement. Our findings demonstrate that an elevated NLR (≥3.0) is significantly associated with increased rates of postoperative atrial fibrillation, renal dysfunction, prolonged mechanical ventilation, and infectious complications.

The association between systemic inflammation and adverse outcomes after cardiac surgery has been well established.[7] NLR, as an accessible and cost-effective inflammatory marker, reflects the balance between neutrophil-driven inflammation and lymphocyte-mediated immune regulation.[8] Our findings suggest that an elevated preoperative NLR may represent a state of enhanced inflammatory tone and impaired immunocompetence, potentially reflecting the cumulative burden of physiological stress from valvular heart disease, which predisposes patients to a more complicated postoperative course.

Consistent with the established literature on inflammatory biomarkers in cardiac surgery, our analysis confirms that an elevated preoperative NLR (≥3.0) is a robust and independent predictor of postoperative atrial fibrillation (PoAF) in the specific context of valve surgery. The odds of developing PoAF were more than twofold higher in the high-NLR cohort, reinforcing the hypothesis that subclinical inflammation, quantified by NLR, facilitates a pro-arrhythmic substrate conducive to atrial fibrillation. They also strengthen the hypothesis that subclinical inflammation underlying NLR plays a critical role in the pathophysiology of postoperative atrial arrhythmias.[9] In a meta-analysis by Gibson et al., high NLR values were shown to be a predictor of PoAF, possibly through inflammation-induced atrial remodeling.[10] Similarly, we observed a twofold increase in the odds of PoAF in patients with NLR ≥3.0.

In terms of renal outcomes, systemic inflammation is a known contributor to perioperative acute kidney injury (AKI).[11] Our study demonstrated a significant association between elevated NLR and postoperative renal dysfunction, aligning with earlier findings that preoperative inflammatory markers could predict AKI after valve surgery.[12]

The incidence of major infectious complications was significantly elevated in patients with a preoperative NLR ≥3.0. This observation aligns with the fundamental pathophysiology reflected by NLR: a relative neutrophilia coupled with lymphopenia. This immunophenotype suggests a state of impaired cellular immunity and compromised immune surveillance, thereby heightening susceptibility to nosocomial infections such as pneumonia and sepsis in the postoperative period. [13]

The statistically insignificant numerical difference in ICU length of stay suggests that the independent effect of NLR on this outcome measure may be limited. This could be explained by ICU lengths being more strongly modulated by various factors independent of NLR, such as patient-specific clinical course, comorbidities, and center-specific discharge policies.

The cumulative evidence from this study underscores the potential of preoperative NLR to serve as a pragmatic and cost-effective adjunctive tool for perioperative risk stratification. By identifying a high-risk subgroup preoperatively, clinicians could potentially implement more vigilant monitoring and personalized prophylactic strategies. These might include enhanced hemodynamic management to mitigate renal injury, extended ECG monitoring for early PoAF detection, or tailored antimicrobial prophylaxis in high-risk individuals to prevent infectious sequelae.

The NLR cutoff of ≥3.0 identified in our study is notably lower than values frequently reported in cohorts including coronary artery bypass grafting (CABG). This suggests that the inflammatory burden and associated risk profile in isolated valve surgery patients may be distinct, and a lower threshold could be more appropriate for early risk identification in this specific surgical population.

This study has several limitations that should be considered in its interpretation. Its retrospective and single-center nature may

limit the generalizability of the results to the general population. The fact that NLR was measured only at a single preoperative time point precluded our ability to assess the prognostic impact of its dynamic course over time; future studies could investigate whether postoperative NLR trends correlate with complication resolution or progression. Furthermore, the fact that NLR was measured only at a single preoperative time point precluded our ability to assess the prognostic impact of its dynamic course over time. Finally, the hypothesis that integrating NLR into existing risk models improves predictive accuracy requires formal validation in prospective, multi-center studies.

Statement of ethics

The study protocol was approved by the Adana City Training and Research Hospital (Date: 21.08.2025 - Approval number: 16/689). All participants were informed in detail about the study's purpose and procedures, and written informed consent was obtained from each participant in accordance with the Declaration of Helsinki.

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No artificial intelligence-based tools or generative AI technologies were used in this study. The entire content of the manuscript was originally prepared, reviewed, and approved by both authors.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Author contributions

TOB and HAU, made the most significant contributions to the writing of the manuscript. TOB, HAU, and HU participated in the design, data collection, critical review and analysis of the study. FC and AC participated in supervision, literature review, data collection and analysis. All authors read and approved the final version of the manuscript.

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