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Use of Mean Platelet Volume and Neutrophil-To-Lymphocyte Ratio as Predictors of Postoperative Transfusion Needs and Morbidity in Total Knee and Hip Arthroplasties

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Abstract

Objective: This study aimed to evaluate the diagnostic value of the neutrophil-to-lymphocyte ratio (NLR) as a predictor of postoperative blood transfusion requirements, intensive care unit (ICU) admission, and prolonged hospital stay in patients undergoing total knee arthroplasty (TKA) and total hip arthroplasty (THA).

Methods: A total of 229 patients who underwent TKA and 201 patients who underwent THA between January 2016 and December 2023 were retrospectively analyzed. The predictive utility of NLR, mean platelet volume (MPV), platelet count, and other hematological markers was assessed. Inclusion criteria focused on patients aged 45-80, while those with significant comorbidities, such as cancer or hematological disorders, were excluded. The primary outcomes measured were postoperative blood transfusion need, ICU admission, and hospital stay duration.

Results: The neutrophil-to-lymphocyte ratio demonstrated a statistically significant association with the need for postoperative blood transfusion in both TKA and THA patients ($P < .05$). However, other markers, including the MPV/platelet count ratio, did not show a significant correlation with postoperative ICU admission or prolonged hospital stays. No significant predictive value was identified for other hematological parameters.

Conclusion: Neutrophil-to-lymphocyte ratio may be a useful, cost-effective marker for predicting the need for blood transfusion in arthroplasty patients. However, the MPV/platelet count ratio did not show predictive value in this context. Further large-scale, prospective studies are necessary to confirm the utility of NLR and explore other potential predictive markers for postoperative outcomes in TKA and THA patients.

Keywords: Arthroplasty, blood transfusion, mean platelet volume, neutrophil-to-lymphocyte ratio

Introduction

With the aging society, the risk of developing osteoarthritis in the knee or hip joint throughout life has increased. The annual number of arthroplasty surgeries has been increasing recently.[1] With the increase in life expectancy and the increase in the need for arthroplasty, which is a relatively elective surgery, determining postoperative mortality and morbidity and taking precautions constitutes a new trend. Complications that develop after arthroplasty, which aims to improve the quality of life, are challenging for both the patient and the orthopedic surgeon.[2]

In a study conducted among Turkish orthopedists, it was shown that malpractice issues negatively affect surgeons emotionally, cause them to request excessive and unnecessary workup studies, and cause them to avoid elective surgeries.[3] There is no routinely used objective and universal scale that helps to predict postoperative mortality and morbidity during the preoperative preparation period in arthroplasty surgery. Predicting postoperative mortality and morbidity using tests already requested during preoperative preparation is considered a highly cost-effective approach, as it does not lead to a substantial rise in healthcare spending.

Various blood parameters have been extensively studied for prognostic purposes across diverse medical fields such as oncology, cardiovascular surgery, infectious diseases, and orthopedic surgery[4] Human platelets are cells that have been proven to play roles in numerous pathophysiological processes. Hemostasis, thrombosis, inflammation, immune reaction, and even osteoarthritis are among the most important ones.[5,6] It has been shown that markers such as red blood cell distribution width, mean platelet volume (MPV), platelet-to-lymphocyte ratio (PLR), and neutrophil–lymphocyte ratio (NLR), which are considered inflammatory markers, may impact on mortality and morbidity.[7-9]

Recently, there has been interest in the use of low-cost laboratory biomarkers for risk stratification prior to arthroplasty surgery. So far, studies have been conducted examining the neutrophil/lymphocyte ratio on issues such as cancer survival, sepsis mortality, and cardiovascular disease risk. Studies in the field of orthopedics have investigated its use as a mortality indicator in hip fractures. There are studies investigating its usefulness as a marker of deep vein thrombosis and periprosthetic joint infection after elective surgeries, especially arthroplasty. However, the utility of these markers in evaluating the need for blood replacement, intensive care unit admission, total hospitalization duration, and their impact on functional scores after elective hip and knee arthroplasty remains underexplored.

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Given the increasing interest in using hematological markers to predict postoperative outcomes, we hypothesized that the NLR and other blood parameters, MPV and PLR, could serve as predictive markers for postoperative morbidity, including the need for blood transfusion and intensive care unit (ICU) admission, in patients undergoing TKA and THA. The objective of this study was to evaluate the diagnostic value of these markers, with a particular focus on NLR, in predicting postoperative transfusion requirements, ICU admissions, and length of hospital stay, aiming to improve preoperative risk assessment and perioperative management in elective arthroplasty procedures.

Methods

Ethics committee approval was received for this study from the İstanbul University-Cerrahpaşa, Faculty of Medicine, Clinical Research Ethical Committee (Approval no: 982691 Date: May 9, 2024). Informed consent was not required as patient data were anonymized and retrospectively analyzed according to the ethical committee's guidelines. All procedures adhered to the Declaration of Helsinki, and patient confidentiality and data protection were maintained in accordance with current standards. This retrospective cohort study evaluated adult patients (aged 45-80) who underwent total knee arthroplasty (TKA) or total hip arthroplasty (THA) between January 2016 and December 2023 at a single orthopedic clinic. A total of 229 TKA patients and 201 THA patients were included in the analysis.

The inclusion criteria for the study required participants to be between the ages of 45 and 80, undergoing primary elective TKA or THA, and to have preoperative and postoperative blood tests available. Individuals with a history of malignancy, chronic inflammatory conditions such as rheumatoid arthritis, hematological disorders, and vascular pathologies were excluded. Patients with acute fractures prior to arthroplasty were also excluded. Additionally, patients with American Society of Anesthesiologists (ASA) scores greater than 3 were not included in the study. Exclusion criteria were carefully implemented to minimize the effect of other comorbidities that could potentially skew biomarker levels. All patients underwent surgery under general anesthesia, which was provided by the same team. The postoperative management, including analgesia, mobilization, and antibiotic prophylaxis, was standardized across both cohorts.

Patients were compared in terms of the change in the hemogram between preoperative and postoperative 24 hours, the need for preoperative and postoperative blood transfusion, the need for postoperative ICU, and the total hospital stay, by means of complete blood count parameters. Mean platelet volume/Platelet Count (/PC) ratio was calculated as MPV divided by PC on preoperative 7 days and postoperative 24 hours. Neutrophil-to-lymphocyte ratio, monocyte-to-lymphocyte ratio (MLR), and PLR were also evaluated.

Power analysis was conducted using a moderate effect size (Cohen's $w = 0.3$) and the desired power of 80%. The sample size for this study was adequately powered (>99% power) to detect significant associations.

For statistical analysis, SPSS version 21.0 (IBM Corporation, Armonk, New York) was employed. The assessment of normal distribution using the Shapiro–Wilk test guided the utilization of the *t*-test for variables exhibiting a normal distribution, while the Mann–Whitney *U* test was applied for non-normally distributed continuous variables. For categorical data, univariate analysis was performed using the χ^2 test.

Results

A total of 229 patients who underwent TKA were included, with 41 male and 188 female patients. The mean age of the TKA patients was 66.7 ± 7.8 years. Sixty-nine knees (30.1%) were operated on without tourniquet and 160 knees were operated on with tourniquet. The mean duration of stay at the hospital was 5.6 ± 1.8 days, with 172 (75.5%) of the patients requiring admission for over 4 days. Eleven (4.9%) patients required intensive care postoperatively. The average age of these patients was 67.9 years. Fifty-five percent of patients who needed intensive care also needed transfusion. Transfusion was deemed necessary for 95 patients (41.5%), and 1.3 ± 0.7 units of erythrocyte suspensions were used per patient. Nine patients required more than 2 units of erythrocyte suspensions. There were 106 patients with preoperative hemoglobin values below 12 mg/dL. Ten of these patients were male (46.2%). Forty-two patients (39.6%) received a mean of 1.4 units of erythrocyte suspensions.

A total of 201 patients who underwent THA were included. The mean age of THA patients was 58 years. Fifty-six patients were male, and 145 were female. For total hip replacement patients, the mean duration of stay at the hospital was 6.1 ± 2.2 days, with 156 (77.6%) of the patients requiring admission over 4 days. Twelve (5.9%) patients required intensive care postoperatively. Transfusion was deemed necessary for 87 patients (43.3%), and an average of 1.7 ± 1 units of erythrocyte suspensions were used per patient. Fifteen patients required more than 2 units of erythrocyte suspensions.

In both TKA and THA patients, NLR values showed a statistically significant relationship with the need for transfusion ($P = .026$ and $P = .021$, respectively). In addition, the number of transfused products was statistically significantly correlated with NLR for TKA patients ($P = .017$) but not THA patients ($P = .08$). Monocyte-to-lymphocyte ratio showed a statistically significant relationship with the transfusion need in only TKA patients ($P = .034$) but not in THA patients ($P = .322$). Mean platelet volume, platelet (Plt), Platelet/Mean Platelet Volume Ratio (PMR), and PLR levels were not statistically significantly associated with a higher need for postoperative intensive care, a longer duration of admission, or a higher need for blood transfusion (Table 1).

Discussion

Our study evaluated the predictive value of several hematological markers, including the NLR, MPV, and PLR, for postoperative transfusion requirements and intensive care unit admissions in TKA and THA patients. The results demonstrated that NLR was the only marker significantly associated with the need for postoperative blood transfusion in both TKA and THA groups, while MPV and PLR showed no statistically significant correlations with transfusion, ICU admission, or length of hospital stay. This suggests that NLR may be a valuable marker for predicting postoperative transfusion needs, while other markers, such as MPV and PLR, may be less useful in this context.

In the field of orthopedic surgery, particularly in the context of TKA and THA, the optimization of postoperative care and outcomes remains a critical pursuit. Various hematological parameters have been investigated as potential predictors of postoperative complications and recovery trajectories in both other fields of medicine and also orthopedics.[4] The role of these parameters was previously investigated in both traumatic and elective orthopedic surgery[2,5] and both pre- and postoperative evaluations.[10,11] Among these parameters, the NLR, MPV, Plt, PMR, PLR, and MLR have garnered attention for their potential utility in prognostication.

Most of the studies focusing on these parameters investigate their associations with periprosthetic joint infections.[12-15] In our study, low infection rates preclude the investigation of these

Table 1. Statistical Analysis of the Hemogram Parameters and Outcomes in Both TKA and THA Groups

	Intensive Care	Transfusion Need	Transfusion Count	Length of Stay
Total Knee Arthroplasty				
NLR	0.285	0.026*	0.017*(*=A p-value of .05 or lower)	0.122
MPV	0.810	0.348	0.204	0.206
Plt	0.065	0.563	0.312	0.099
PMR	0.184	0.364	0.2	0.839
PLR	0.369	0.875	0.475	0.654
MLR	0.056	0.034*	0.008*	0.839
Total hip arthroplasty				
NLR	0.693	0.021	0.08	0.244
MPV	0.401	0.502	0.831	0.772
Plt	0.051	0.506	0.078	0.599
PMR	0.076	0.524	0.09	0.938
PLR	0.388	0.137	0.577	0.514
MLR	0.875	0.322	0.675	0.531

parameters' value in periprosthetic wound infections; however, understanding the associations between these hematological markers and postoperative outcomes such as intensive care requirements, length of hospital stay, need for blood transfusion, and rates of reoperation is crucial for refining perioperative management strategies and enhancing patient care, since all these markers can be obtained or calculated from a simple blood count, which is readily available and almost always ordered during preoperative assessment.

The availability of these parameters resulted in a large numbers of studies focusing on the relationships between them and many outcomes. In a study by Akcal et al, only an increase in red cell distribution width was associated with mortality, while MPV, PLR, and NLR changes were not relevant.[7] In another study performed by Yao et al, only NLR was associated with a higher rate of postoperative pneumonia and sepsis.[16] Similarly, Wang et al demonstrated poor survival associated with a high PLR,[17] yet Balta et al found that only the MPV/PC ratio provided enough significance.[18] In a comparison based on the platelet/mean platelet volume ratio, which was found to be significant in the study by Tirumala et al, it was observed that patients undergoing both hip and knee arthroplasty with a platelet/MPV ratio below this value had shorter hospital stays and less need for blood transfusion in patients undergoing hip arthroplasty.

In our study, we found that in 2 different groups of patients undergoing elective orthopedic surgery, none of the parameters evaluated previously provided a statistically significant effect on the need for transfusion and intensive care or duration of admission, except for a statistically significant relationship between NLR and the need for transfusion in both cohorts.

The clinical relevance of our findings lies in the potential use of NLR as a preoperative risk stratification tool. By identifying patients with elevated NLR levels preoperatively, surgeons and anesthesiologists could better anticipate the likelihood of blood transfusion and plan accordingly. This could involve optimizing preoperative hemoglobin levels, implementing blood conservation strategies, or ensuring the adequate availability of blood products in high-risk cases. Furthermore, the inclusion of NLR in routine preoperative assessments could lead to more personalized surgical care, with the potential to reduce perioperative morbidity associated with transfusion.

On the other hand, given that MPV and PLR did not show predictive value in this study, their routine measurement in the preoperative assessment for arthroplasty patients may not be justified. Clinicians should focus on markers with proven predictive utility, such as NLR, to streamline preoperative testing and improve patient outcomes. Future research should focus on validating these findings in prospective studies and exploring the role of other inflammatory biomarkers in predicting outcomes in orthopedic surgery.

Although our study was well-powered, several limitations need to be addressed. The retrospective nature of the study introduces the potential for selection bias, as patients were selected based on the availability of complete blood count data. Additionally, the lack of strict transfusion protocols may have introduced bias in our results, particularly in comparing transfusion rates between the TKA and THA groups.

This study demonstrated that the NLR is a significant predictor of postoperative transfusion requirements in TKA and THA patients, suggesting its potential as a useful and cost-effective marker for preoperative risk assessment. In contrast, MPV and PLR did not show significant associations with postoperative outcomes. While our findings support the clinical utility of NLR, further prospective studies with a larger patient population are warranted to validate its role in optimizing perioperative management in arthroplasty.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: Ethics committee approval was received for this study from the İstanbul University-Cerrahpaşa, Faculty of Medicine, Clinical Research Ethical Committee (Approval no: 982691 Date: May 9, 2024).

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