

The effect of total knee arthroplasty surgery on mean platelet volume, platelet count, and mean platelet volume/platelet count ratio

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Abstract

Objective: This study aims to investigate the effects of total knee arthroplasty (TKA) surgery on mean platelet volume (MPV), platelet count (Plt), and the MPV/Plt ratio.

Methods: This retrospective study examined the data of 379 patients who underwent total knee arthroplasty at Konya City Hospital between January 1, 2023, and January 1, 2024. Preoperative and postoperative blood tests were analyzed at 12-24 hours (postop1) and 24-48 hours (postop2) intervals. MPV, Plt, and MPV/Plt ratio were recorded and compared. Repeated measures ANOVA test was used for statistical analysis.

Results: A significant increase in MPV and MPV/Plt ratio and a significant decrease in Plt were observed in the postoperative period ($p < 0.001$).

Conclusion: The increase in MPV and the decrease in Plt after total knee arthroplasty may indicate an elevated risk of thromboembolic complications. Routine monitoring of MPV, Plt, and the MPV/Plt ratio could be necessary for the early detection and management of these complications.

Keywords: Total knee arthroplasty, mean platelet volume, platelet count, mean platelet

INTRODUCTION

In aging societies, the number of elderly patients suffering from degenerative knee joint disease is increasing. This condition can cause pain and a decrease or loss in the ability to walk (1). Total knee arthroplasty (TKA) is a proven and effective treatment for relieving arthritic knee pain. (2, 3). While attempting to achieve pain relief with knee arthroplasty surgery, another goal is to minimize complications.

Orthopedic surgery, particularly total knee and total hip arthroplasty, is considered a significant risk factor for perioperative venous thromboembolism. During surgical intervention, the tendency for blood to coagulate increases. Surgical trauma raises the concentrations of coagulation factors in the plasma while lowering the levels of coagulation inhibitors. Additionally, it enhances platelet activity at the site of vascular injury, triggering the release of cytokines,

catecholamines, and serotonin, which induce platelet aggregation and increase the propensity for thrombosis. Surgical stress also suppresses fibrinolytic responses (4-6).

Platelets are small, anucleate cells that are vital in the hemostasis process (7). Abnormalities in platelet count (Plt) are critically important in the diagnosis and management of various clinical conditions. Monitoring Plt, especially after major surgical interventions such as knee prosthesis surgery, is crucial for preventing postoperative complications.

Mean platelet volume (MPV), which indicates the average size of platelets, is an important laboratory marker associated with platelet function and activity. Increased MPV is considered a significant risk factor in thromboembolic diseases (4, 5). Larger platelets are more reactive than normal-sized platelets because they have a higher granule content (6, 8). These larger platelets produce more prothrombotic factors, exhibit greater

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aggregation in response to adenosine diphosphate (ADP), collagen, or adrenaline, and secrete more thromboxane A₂ (TxA₂) (9, 10). An increase in MPV is the initial indicator of platelet activation and rises when platelet production and destruction are enhanced by cytokines such as interleukin-3, interleukin-6, and thrombopoietin (11). The thrombotic potential and the effectiveness of hemostatic, vasomotor, and pro-inflammatory functions of larger platelets are greater than those of smaller platelets (12).

The MPV/Plt ratio is considered an important indicator among hematological parameters. This ratio is particularly used in the evaluation of various clinical conditions such as cardiovascular diseases, inflammatory states, and cancer (9, 13-15). In this context, the MPV/Plt ratio emerges as a valuable biomarker in clinical applications.

In this study, it was aimed to investigate the effects of total knee arthroplasty surgery on MPV, Plt, and the MPV/Plt ratio.

METHOD

Ethics approval and registration

This study was conducted through a retrospective review of patients who underwent TKA in the operating rooms of Konya City Hospital between January 1, 2023, and January 1, 2024. Ethical approval for the study was obtained from the KTO Karatay University Ethics Committee on October 14, 2024 (Decision No: E-41901325-200-95694). The Declaration of Helsinki and relevant ethical principles were followed in the research. Patient data were accessed through the Konya City Hospital Electronic Patient Information Management System (HBYS).

Patient population and inclusion/exclusion criteria

The study included patients aged 18 years and older with an American Society of Anesthesiologists (ASA) physical status classification of 1 to 3, who underwent elective knee replacement surgery. Patients were excluded if they had a history of stroke (SVO) and/or transient ischemic attack (TIA), a history of myocardial infarction (MI), coronary artery disease, hematological disorders, thrombophilic conditions, a history of pulmonary thromboembolism (PTE) and/or deep vein thrombosis (DVT), a history of thromboembolic disease, active infections, or elevated infection markers.

Outcome measures

The primary outcome involved a retrospective review of routine blood tests at three different time points. These tests were conducted during the preoperative preparation phase, between 12-24 hours postoperatively and between 24-48 hours postoperatively. MPV, Plt, and the MPV/Plt ratio were recorded from these blood tests. The values measured before surgery were labeled as preoperative

(preop), while the postoperative values were categorized as postoperative 1 (postop1) and postoperative 2 (postop2), respectively. Additionally, patient demographics, including age, gender, and ASA score, were recorded for all participants.

Statistical analysis

The data obtained in this study were analyzed using IBM SPSS Statistics 20.0 (IBM-SPSS Inc., Chicago, IL, USA). A total of 379 patients meeting the inclusion criteria were included in the analysis. Continuous variables were expressed as mean and standard deviation or median (25th-75th percentile) based on their distribution, while categorical variables were expressed as frequency and percentage. The normality of the data distribution was assessed using skewness and kurtosis values within the range of -1.5 to +1.5, histogram shapes, and Q-Q plots. For comparisons between measurements, repeated measures ANOVA was used. A p-value of less than 0.05 was considered statistically significant. Additionally, Bonferroni correction was applied for pairwise comparisons, and a p-value of less than 0.05 was deemed statistically significant.

RESULTS

Patients who underwent TKA between January 1, 2023, and January 1, 2024, were retrospectively reviewed. A total of 379 patients meeting the study criteria were included. The patients' demographic characteristics (age, ASA score, and gender) were evaluated (Table 1).

The recorded values of the patients were presented as mean $\pm$ standard deviation. Preoperative values were as follows: MPV 10.389 ± 0.868 , Plt 283.6 ± 66.3 , and MPV/Plt ratio 0.039 ± 0.01 (Table 2).

Table 1. Patient demographic characteristics

Characteristics		n: 379
Age, (year)		65 $\pm$ 8
ASA score, n (%)	1	6 (1.6%)
	2	240 (63.3%)
	3	133 (35.1%)
Gender, n(%)	Man	47 (12.4%)
	Woman	332 (87.6%)
ASA: American Society of Anesthesiologists		
Continuous variables are presented as Mean $\pm$ SD, while categorical variables are shown as n.(%).		

Table 2. MPV, Plt, and MPV/Plt ratio values

	Preop	Postop1	Postop 2	P
MPV	10.389 $\pm$ 0.868	10.587 $\pm$ 0.870	10.774 $\pm$ 0.868	<0.001
Plt	283.6 $\pm$ 66.3	244.3 $\pm$ 57.1	214.9 $\pm$ 51.8	<0.001
MPV/Plt ratio	0.039 $\pm$ 0.01	0.046 $\pm$ 0.012	0.053 $\pm$ 0.015	<0.001
Continuous variables are presented as Mean $\pm$ SD. MPV, Mean platelet volume; Plt, platelet count				

Postoperatively, at 12-24 hours, MPV1 was 10.587 ± 0.870 , Plt1 was 244.3 ± 57.1 , and MPV/Plt1 ratio was 0.046 ± 0.012 (Table 2). At 24-48 hours postoperatively, MPV2 was 10.774 ± 0.868 , Plt2 was 214.9 ± 51.8 , and MPV/Plt2 ratio was 0.053 ± 0.015 (Table 2).

When comparing the preoperative MPV, Plt, and MPV/Plt ratio with the postoperative values at both time points, a statistically significant difference was observed over time ($p < 0.001$) (Table 2). Postop MPV1 and MPV2 values were significantly higher compared to preop MPV values ($p < 0.001$ for both comparisons). However, the Plt measured at both postop time points was significantly lower than the preop Plt ($p < 0.001$ for both comparisons). Additionally, the MPV/Plt1 and MPV/Plt2 ratios were significantly higher than the preop MPV/Plt ratio ($p < 0.001$ for both comparisons).

In the first 48 hours following surgery, there was an increase in MPV and the MPV/Plt ratio ($p < 0.001$ for both), while the Plt showed a significant decrease ($p < 0.001$) when comparing postop values with preop measurements.

DISCUSSION

As a result of the research, it was found that after TKA surgery, patients' MPV and MPV/Plt values increased significantly, while their Plt decreased significantly.

The risk of complications following TKA increases due to the heightened tendency of blood coagulation during surgery and the surgical trauma enhancing coagulation factors and platelet activity (16). MPV is a parameter of routine blood tests. It is low-cost and provides results quickly (17). Additionally, MPV is a commonly used laboratory marker associated with platelet function and activity (4, 5). Studies have found higher MPV values in patients who experienced stroke (18) and acute MI (19, 20) compared to the control group. Additionally, P. Bath and colleagues demonstrated that MPV is a predictor of stroke in patients with a history of cerebrovascular events, and it can predict stroke risk even in the 3.9-year period preceding the event (21). Increased MPV is associated with higher mortality in cardiovascular diseases and is considered an important risk factor. (6, 8) Cameron HA and colleagues also found that MPV was higher in acute MI patients compared to the control group in their study (19). Similarly, there are various studies indicating a relationship between increased MPV and DVT (22, 23).

Both retrospective and prospective studies have shown that large platelets and high MPV are predictors of thrombotic events in predominantly arterial diseases (4). Additionally, the literature indicates that high MPV is associated with various diseases such as MI (24), cerebrovascular thromboembolism (25), portal vein thrombosis (17) and cancer-related

thrombosis (26).

İçli et al. (27) reported that MPV values were significantly higher in DVT patients, whether or not they had pulmonary embolism, and that high MPV in DVT patients was associated with pulmonary embolism. Similarly, Gulcan et al. (28) demonstrated that MPV was significantly higher in DVT patients compared to the control group. Aliosmanoglu et al. (17) showed that MPV levels were significantly higher in patients with unexplained portal vein thrombosis compared to control participants.

In this study, it was found that MPV increased significantly following TKA surgery. High MPV is thought to elevate the risk of thrombotic complications, such as DVT and pulmonary embolism. Therefore, regular monitoring of MPV values in patients after TKA may be important for the early detection and management of potential complications. Furthermore, studies in the literature support an association between elevated MPV values and various thrombotic events. High MPV is recognized as a significant risk factor in cardiovascular diseases, cerebrovascular events, and pulmonary hypertension. These findings align with the results of this study suggest that elevated MPV is an essential marker to consider when assessing thrombotic risks.

It has been reported that the Plt decreases by approximately 30% to 60% after major surgical procedures (29, 30). This decrease has been suggested to be related to increased platelet consumption due to the effects of surgery, as well as hemodilution (31).

Plt was also examined in a study conducted by D'Erasmus and colleagues. In this study, it was found that stroke patients with high mortality had low Plt (32). Similarly, in a study conducted by Jin Soo Han and colleagues, it was shown that a low platelet count can activate the coagulation system (33). In various studies, it has been found that patients who have experienced an acute MI have lower Plt compared to the control group (19, 34, 35).

In this study, a significant decrease was found in Plt following TKA surgery, consistent with findings of existing literature. This result reaffirms the impact of major surgical interventions on the reduction of Plt and underscores the necessity of closely monitoring Plt levels in the postop period. Furthermore, the results of this study are aligned with previous research indicating that lower Plt is associated with higher mortality risk in stroke patients and the activation of the coagulation system. This underscores that Plt is an essential parameter in evaluating thrombotic risks in the postop period.

A high MPV/Plt ratio is considered a risk factor for various

diseases and has been found to be associated with MI, anemia, and hepatocellular carcinoma (9, 36).

In the study conducted by Jin Soo Han and colleagues, the MPV/Plt ratio was also found to be significantly high in patients with DVT (33). Additionally, MPV and Plt are generally inversely related, and similar results were obtained in this study as well (37-39). Therefore, an increased MPV/Plt ratio can be considered indicative of both elevated MPV and low Plt. In the study by Elsayed et al., it was found that patients presenting with cerebrovascular stroke had significantly higher MPV and MPV/Plt ratios compared to the control group (40).

Findings from various studies underscore the importance of monitoring the MPV/Plt ratio in the postop period. Given the elevated thrombotic risks during this time, an increasing MPV/Plt ratio can provide clinicians with critical information regarding a patient's predisposition to thrombotic complications. Regular monitoring of the MPV/Plt ratio not only assists in assessing thrombosis risk but also enables timely intervention to mitigate this risk. For instance, in patients with a high MPV/Plt ratio, it may be necessary to initiate antithrombotic treatments earlier or to review and adjust current treatment plans.

Furthermore, monitoring the MPV/Plt ratio can contribute to developing more personalized treatment approaches based on individual patient risk profiles, potentially improving postop outcomes and helping prevent serious complications. In conclusion, evaluating MPV, Plt, and the MPV/Plt ratio in patients following TKA provides valuable information for preventing and managing postop complications. Incorporating these parameters into routine clinical practice may significantly enhance patient monitoring by more accurately assessing risk profiles and optimizing treatment strategies. This enables early detection of thrombotic risks and timely intervention during the postoperative period, thereby improving patient safety and helping to prevent serious complications. Such an approach could be a critical advancement in optimizing patient follow-up and identifying potential complications early in the period following TKA.

Limitations of the Study

This study has several significant limitations. First, due to its retrospective design, the collection process may need to include more accurate data. Second, the research was conducted at a single center, which may limit the generalizability of the findings. More comprehensive results could be obtained with data from different centers and populations. Third, the patients were only monitored during the short-term postoperative period. There is a lack

of information on long-term thrombotic complications or other postoperative outcomes, which poses a limitation in evaluating the long-term effects of the findings.

CONCLUSION

This study demonstrates an increase in MPV and MPV/Plt ratio and a decrease in Plt following TKA. These changes may be indicative of an elevated thrombotic risk. Therefore, regularly monitoring these parameters after TKA is crucial for the early detection and management of potential complications. However, these findings need to be validated through more extensive research involving a larger patient cohort and long-term follow-up.

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