

High Cumulative Step Count after Total Knee Arthroplasty is Associated with Reduced Risk of Venous Thromboembolism

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INTRODUCTION: The incidence of venous thromboembolism (VTE) following total knee arthroplasty (TKA) has been reported at 1.19%. Prior research has demonstrated that early mobilization on the first post-operative day, significantly reduced the incidence of thromboembolic complications. There is a lack of objective research investigating the relationship between activity in the immediate post-operative recovery period (day 1-14) and the risk of VTE. The purpose of this study was to compare the cumulative step count at post-operative week 2, 4, 8, and 12 between patients without VTE complication (control) versus patients with VTE (deep vein thrombosis or pulmonary embolism). Relative risk was calculated to determine if cumulative step count at day 14 is a risk factor for developing VTE after day 14.

METHODS: Insurance claims data from patients who received a smart implantable device (SID) TKA between October 2021, and November 2024, were analyzed to identify patients with VTE or without (controls) within 90-days after surgery based on ICD-10 diagnosis codes. Tokenized deidentified claims data was matched to deidentified SID step count data via a tokenization algorithm. Cumulative step count was calculated as the cumulative sum of daily step count since the day of surgery and summarized as median and interquartile range from day 0 to 90. Univariable tests were used to assess any baseline differences between complication groups (VTE vs. None). T-tests were used for age and BMI, and a chi-square test was used for gender. Factors found to be univariably statistically significant were then used in a multivariable model to adjust out baseline differences while comparing complication groups on cumulative step counts at various times throughout follow-up. Freidman's non-parametric repeated measures techniques were used. Bonferroni adjustment for multiple comparisons was used with Wilcoxon rank sum tests to compare the complication groups at each timepoint. If the p-value was less than $\alpha = 0.05/4 = 0.0125$ (i.e., 4 pairwise comparisons) then the result was considered statistically significant. Finally, the total number of cumulative steps by day 14 was categorized into low and high activity groups (low < 1,565 steps vs. high \geq 1,565 steps). Relative risk was calculated and statistical significance determined via the Fisher's Exact method (two-sided).

RESULTS: The analysis of 617 patients (653 TKAs) determined VTE occurred in 8.9% (58/653) TKAs. There were slightly more males in the VTE group, $p=0.0454$ but similar in age and BMI (Table 1). A significant interaction between complication groups and time on the cumulative step counts was found. No difference was found at week 2 ($p=0.0254$), but a statistically significant difference between groups was found at weeks 4, 8, and 12 ($p<0.0125$) with those in the VTE group having significantly fewer cumulative steps compared to those without complications (Figure 1, Table 2). The total number of cumulative steps by day 14 was categorized into low and high activity groups (low < 1,565 steps vs. high \geq 1,565 steps). The risk of VTE between day 14 and 90 was 7.4% (23/312) in the low activity group compared to 2.9% (9/312) in the high activity group with a relative risk of 2.6 (23/312 \div 9/312) which indicates that those in the low activity group were 2.6 times more likely to develop VTE than those in the high activity group (Figure 1).

DISCUSSION AND CONCLUSION: We found that low cumulative step count at post-operative day 14 (i.e. post-operative inactivity) was associated with higher risk of developing VTE between day 14 and 90 (relative risk 2.6). The presumed mechanism by which mobilization during the first 14 days reduces VTE risk relates to mitigating venous stasis, a key component of Virchow's triad. Physical activity such as leg exercise and walking promotes venous return from the lower extremities, reducing blood pooling, and the likelihood of thrombus formation. It also helps counteract the systemic hypercoagulable state associated with surgery and immobility.