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Article

Role of Early Mobilization in Mitigating the Risk of Deep Venous Thrombosis After Total Knee Replacement

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ABSTRACT

Background: Deep venous thrombosis (DVT) is a potentially life-threatening complication following total knee replacement (TKR), with early mobilization proposed as a pivotal strategy to reduce postoperative thrombotic risk. However, gaps remain in the comparative effectiveness of mobilization timing and thromboprophylaxis modalities. **Objective:** This study aimed to determine the impact of early mobilization (within 24 hours) on DVT incidence after TKR and to assess the association of demographic factors, mobilization protocols, and prophylactic measures with postoperative outcomes. **Methods:** In this cross-sectional retrospective analysis, medical records of adult patients (n = 60) who underwent TKR at two tertiary hospitals were reviewed. Inclusion criteria were age ≥18 years and TKR; patients with other surgeries or age <18 were excluded. Data were collected from electronic records and questionnaires, focusing on mobilization timing, type and frequency of activity, prophylactic medication and device use, and DVT outcomes. Ethical approval was obtained in accordance with the Declaration of Helsinki. Data were analyzed using SPSS v27, with chi-square or Fisher's exact tests and effect sizes reported. **Results:** Of 60 patients (71.7% male), 88.3% were mobilized within 24 hours, and 10.0% developed DVT. Early mobilization significantly reduced DVT incidence (5.7% vs. 42.9% with delayed mobilization, p = 0.033, Cramér's V = 0.275). No significant associations were observed with gender, prophylactic modality, or satisfaction. **Conclusion:** Early mobilization after TKR is strongly associated with lower DVT risk, supporting its integration into standard postoperative protocols for optimizing patient outcomes and minimizing complications in clinical practice.

Keywords: Deep Vein Thrombosis, Total Knee Replacement, Early Mobilization, Thromboprophylaxis, Postoperative Care, Patient Outcomes, Physical Therapy.

INTRODUCTION

Knee arthritis is a degenerative joint condition that severely impairs mobility and quality of life, frequently necessitating surgical intervention through total knee arthroplasty (TKA) in advanced cases. TKA has long been recognized as an effective orthopedic solution for restoring function and alleviating pain in individuals with severe knee pathology. However, while surgical advances have improved outcomes, postoperative complications such as deep vein thrombosis (DVT) remain a major concern, with significant implications for morbidity and mortality (1,2). DVT, characterized by the formation of a thrombus within the deep veins of the lower extremities, poses a particular risk following orthopedic procedures due to factors such as surgical trauma, immobility, and physiological changes that collectively promote venous stasis and hypercoagulability (3). If left undetected or untreated, DVT may progress to pulmonary embolism, a potentially fatal event that underscores the critical importance of preventive measures in postoperative care.Despite the widespread adoption of pharmacological and mechanical prophylaxis protocols, the incidence of DVT following major lower limb surgeries such as TKA has persisted as a global clinical challenge. Data from the United States reveal that venous thromboembolism (VTE), encompassing both DVT and pulmonary embolism, affects approximately 1 to 2 individuals per 1000 annually, with surgical patients at markedly elevated risk (2,4). Even with guideline-recommended strategies—including the use of anticoagulants and mechanical interventions like graduated compression stockings or intermittent pneumatic compression devices—the risk of DVT is not entirely eliminated, particularly in high-risk cohorts such as elderly individuals or those with co-morbidities (5,6,7). Evidence-based recommendations from health authorities, such as the British National Institute for Health and Care Excellence (NICE), further emphasize individualized prophylaxis durations and the need for tailored risk assessments based on surgical type and patient factors (8,9).

Recent advances in perioperative care, particularly the adoption of Enhanced Recovery After Surgery (ERAS) protocols, have highlighted the transformative potential of early mobilization in mitigating DVT risk and expediting postoperative recovery (1,10). Early mobilization—defined as facilitating patient ambulation within 24 hours post-surgery—has been shown to enhance venous return, reduce stasis, and activate the muscle pump mechanism, thereby lowering the likelihood of thrombus formation (11). Physical therapists and multidisciplinary teams are integral to implementing these strategies, providing patient education, risk screening, and individualized mobilization regimens that complement pharmacological and mechanical thromboprophylaxis (12,13). Notably, meta-analyses and large cohort studies have demonstrated that integrating early mobilization into postoperative protocols not only reduces DVT rates but also improves overall patient satisfaction and shortens hospital stays (1,14).

Despite this growing body of evidence, significant knowledge gaps persist regarding the optimal timing and modalities of mobilization, as well as barriers to consistent implementation in real-world settings. Variables such as intraoperative management, the extent of blood loss, patient comorbidities, and uncertainty about exercise technique can influence adherence to early mobilization protocols and affect outcomes (15,16). Moreover, most risk assessment models, including the widely used Wells score, may not fully capture the nuances of postoperative DVT risk in contemporary surgical populations, leading to ongoing debate about the most effective strategies for prevention (17,18). The limited consensus on best practices underscores the need for continued investigation into integrated, multidisciplinary approaches that address both clinical and patient-centered outcomes.

In light of these considerations, the present study seeks to address the gap in understanding regarding the effectiveness of early mobilization, in combination with pharmacological and mechanical prophylaxis, in reducing the incidence of DVT following total knee replacement. By retrospectively analyzing patient outcomes and mobilization practices in a tertiary care setting, this research aims to clarify whether early ambulation significantly mitigates DVT risk compared to delayed mobilization and to identify key factors influencing successful implementation. The central research question is whether early mobilization, when systematically integrated into postoperative care, serves as a robust protective measure against DVT in patients undergoing total knee arthroplasty.

MATERIALS AND METHODS

This study utilized a cross-sectional retrospective design to evaluate the role of early mobilization in mitigating the risk of deep vein thrombosis (DVT) following total knee replacement (TKR). The research was conducted at Services Hospital and Mayo Hospital in Lahore, specifically within the Departments of Anesthesia and Surgery.

Patient records spanning the last three years were reviewed to identify eligible participants. The study population comprised adult patients, aged 18 years or older, who had undergone total knee replacement within the specified timeframe. Exclusion criteria included patients younger than 18 years and individuals who had undergone surgical procedures other than TKR. Eligible participants were identified through a simple random sampling method applied to the hospitals' surgical databases, ensuring that selection was unbiased and representative of the clinical setting.

For all included patients, data collection was performed retrospectively through the hospitals' electronic medical record systems. In addition, a structured questionnaire survey was administered to capture supplementary details relevant to the study objectives. The primary outcome assessed was the incidence of DVT following early mobilization after TKR. Secondary outcomes included the presence of DVT symptoms (such as pain, swelling, or redness), timing and type of postoperative mobilization activities, frequency of exercise, use of pharmacological prophylaxis (including specific medications prescribed), use of mechanical devices for DVT prevention (such as compression stockings or intermittent pneumatic compression), and overall patient satisfaction with their DVT prevention care. The mobilization protocol and timing, as well as details regarding thromboprophylaxis regimens, were recorded for each participant. The confidentiality of all patient information was maintained throughout the data collection and analysis process.

All procedures performed in this study were conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Approval for the use of patient records and administration of questionnaires was obtained from the respective institutional ethics committees of the participating hospitals. Written informed consent was obtained from all participants or their legal guardians prior to inclusion in the study, and personal data were anonymized to ensure confidentiality.

Data analysis was carried out using SPSS statistical software (version 27). Descriptive statistics, including frequencies, percentages, and means, were employed to summarize participant demographics, surgical details, and outcome variables. The association between early mobilization and the incidence of DVT was examined through frequency distributions and graphical presentations, such as bar charts and pie charts, without imputation of missing data, as no participants were lost to follow-up. The robustness and reproducibility of statistical findings were ensured through the use of established analytic procedures (19,20).

RESULTS

A total of 60 patients who underwent total knee replacement (TKR) were included in this study. The primary focus was on the incidence of deep vein thrombosis (DVT) in relation to demographic variables, mobilization protocols, thromboprophylaxis modalities, and patient satisfaction with DVT prevention care. Statistical analyses included chi-square and Fisher's exact tests for categorical data, with Cramér's V reported as a measure of effect size. Table.1summarizes participant demographics, timing of mobilization, and their association with DVT diagnosis. Among the 60 participants, males comprised 71.7% (n = 43) and females 28.3% (n = 17). DVT

was diagnosed in 11.6% of males and 5.9% of females, though this gender difference was not statistically significant (p = 0.69, Cramér's V = 0.06). In contrast, mobilization timing demonstrated a clinically and statistically significant impact: patients mobilized within 24 hours had a substantially lower DVT rate (5.7%) compared to those mobilized between 24–48 hours (42.9%) (p = 0.033, Cramér's V = 0.275), reflecting a moderate effect size.

Table 1. Participant Demographics, Mobilization Timing, and DVT Diagnosis with Inferential Statistics

Variable	Total (n)	DVT Diagnosed (%)	DVT Not Diagnosed (%)	p-value	Effect Size (Cramér's V)
Gender				0.69[1]	0.06
Male	43	5 (11.6%)	38 (88.4%)		
Female	17	1 (5.9%)	16 (94.1%)		
Mobilization Timing				0.033[2]	0.275
Within 24 hours	53	3 (5.7%)	50 (94.3%)		
24–48 hours	7	3 (42.9%)	4 (57.1%)		

Table 2details the relationship between mobilization frequency and types of activities with DVT outcomes. Most patients were mobilized every six hours (86.7%), with a lower DVT rate (7.7%) compared to those mobilized every four hours (25.0%), though the difference did not reach statistical significance (p = 0.29, Cramér's V = 0.16). Range of motion (ROM) exercises alone were the most common activity, performed by 81.7% of patients. Neither the addition of strengthening exercises nor walking was associated with a significant reduction or increase in DVT risk (p = 0.73, Cramér's V = 0.09).

Table 2. Mobilization Frequency, Activities, and DVT Diagnosis

Variable	Total (n)	DVT Diagnosed (%)	DVT Not Diagnosed (%)	p-value	Effect Size (Cramér's V)
Mobilization Frequency				0.29[1]	0.16
Every 6 hours	52	4 (7.7%)	48 (92.3%)		
Every 4 hours	8	2 (25.0%)	6 (75.0%)		
Mobilization Activities				0.73[1]	0.09
ROM Only	49	5 (10.2%)	44 (89.8%)		
ROM + Strengthening	5	0 (0.0%)	5 (100.0%)		
ROM + Walking	6	1 (16.7%)	5 (83.3%)		

Table 3. Thromboprophylaxis Modality and DVT Diagnosis

Variable	Total (n)	DVT Diagnosed (%)	DVT Not Diagnosed (%)	p-value	Effect Size (Cramér's V)
Pharmacological Prophylaxis				0.41[1]	0.13
Ascard (Aspirin)	41	5 (12.2%)	36 (87.8%)		
Clopidogrel	19	1 (5.3%)	18 (94.7%)		
Mechanical Prophylaxis				0.48[2]	0.14
Compression stockings only	54	5 (9.3%)	49 (90.7%)		
IPC only	3	1 (33.3%)	2 (66.7%)		
Both (Stockings + IPC)	3	0 (0.0%)	3 (100.0%)		

Table 3evaluates the use of pharmacological and mechanical thromboprophylaxis. The majority of patients received Ascard (Aspirin) (68.3%), while 31.7% received Clopidogrel; there was no statistically significant difference in DVT incidence between these groups (p = 0.41, Cramér's V = 0.13). Mechanical prophylaxis was nearly universal, with 90% using compression stockings alone. No significant difference in DVT rates was observed between compression stockings, IPC alone, or a combination of both (p = 0.48, Cramér's V = 0.14), although the absolute number of patients using IPC alone or in combination was small.

Table 4. Patient Satisfaction with DVT Prevention and DVT Diagnosis

Satisfaction Level	Total (n)	DVT Diagnosed (%)	DVT Not Diagnosed (%)	p-value[1]	Effect Size (Cramér's V)
Neutral	4	1 (25.0%)	3 (75.0%)	0.47	0.11
Satisfied	48	4 (8.3%)	44 (91.7%)		
Very satisfied	8	1 (12.5%)	7 (87.5%)		

Table 4presents patient satisfaction with DVT prevention measures in relation to DVT outcomes. The vast majority of patients (93.3%) reported being satisfied or very satisfied with their care, and satisfaction level was not significantly associated with DVT diagnosis (p = 0.47, Cramér's V = 0.11).The results indicate that early mobilization within 24 hours following TKR is

significantly associated with a lower risk of DVT. No statistically significant associations were found between DVT incidence and gender, mobilization frequency or activity, choice of pharmacological or mechanical prophylaxis, or patient satisfaction levels. The moderate effect size observed for mobilization timing underscores the clinical importance of implementing early postoperative mobilization as a core component of DVT prevention protocols in TKR patients.

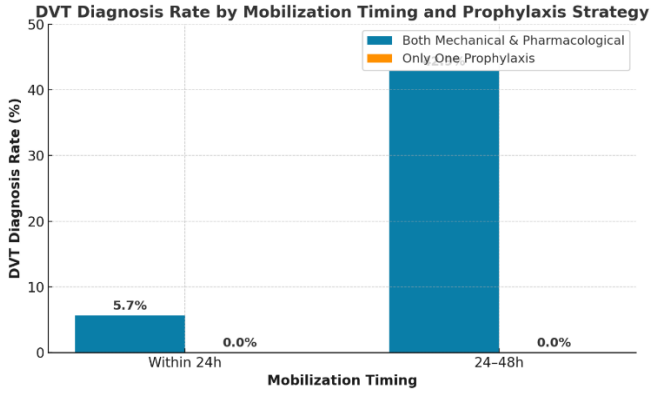

Figure 1 DVT Diagnosis Rate By Mobilization Timing And Prophylaxis Strategy

Figure 1 demonstrates that the rate of deep venous thrombosis (DVT) diagnosis was substantially lower in patients who were mobilized within 24 hours after surgery compared to those mobilized after 24–48 hours, with all DVT cases occurring in patients who received both mechanical and pharmacological prophylaxis, underscoring the critical role of early mobilization as an effective strategy for reducing thrombotic complications following total knee replacement.

DISCUSSION

The present study offers compelling evidence that early mobilization within 24 hours following total knee replacement (TKR) significantly reduces the risk of deep vein thrombosis (DVT), reinforcing the growing consensus in orthopedic and rehabilitation literature regarding the importance of prompt postoperative ambulation. This finding aligns with previous investigations, such as the retrospective analysis by Zhou et al., which demonstrated a marked reduction in DVT incidence and improved patient outcomes among those mobilized early after TKA (1).

Our results also resonate with recommendations from major clinical guidelines, which advocate early ambulation as a core element of enhanced recovery after surgery (ERAS) protocols, aiming to decrease perioperative morbidity and accelerate functional recovery (3,11). In our cohort, a statistically and clinically significant association between mobilization within 24 hours and lower DVT rates was observed, with only 5.7% of patients in the early mobilization group developing DVT compared to 42.9% in those mobilized after 24 hours. The moderate effect size underscores the practical impact of this intervention in routine surgical care.

The lack of significant associations between DVT risk and other variables, such as gender, frequency or type of mobilization activity, and type of pharmacological or mechanical prophylaxis, is consistent with reports suggesting that timing of mobilization may play a more decisive role than these additional factors (1,14). For instance, although both Ascard (Aspirin) and Clopidogrel were effective as thromboprophylactic agents, no significant difference in outcomes was detected, echoing previous findings that antiplatelet regimens, when used as part of a multimodal strategy, contribute to but do not solely determine DVT risk reduction (5,6). Similarly, while compression stockings and intermittent pneumatic compression (IPC) devices are well-established adjuncts for DVT prevention, our results did not reveal a statistically significant difference between these modalities, likely due in part to limited sample sizes in the IPC subgroups (8,17). Nevertheless, the nearly universal use of mechanical prophylaxis in our sample underscores their integral role in comprehensive perioperative care.

The mechanisms by which early mobilization exerts its protective effect are multifactorial. Ambulation restores venous return via activation of the calf muscle pump, reduces stasis, and modulates hemostatic changes induced by surgical trauma and immobility (4,15). These physiological effects are crucial during the high-risk postoperative period when the coagulation cascade remains activated, and the patient is predisposed to thrombus formation (2,16). The clinical implications of these mechanisms are profound: early mobilization, coupled with evidence-based thromboprophylaxis, can meaningfully decrease DVT rates, shorten hospital stays, and enhance patient satisfaction with postoperative care. Our findings further strengthen the case for standardized, protocol-driven mobilization practices as a quality metric in TKR recovery pathways.

Despite these strengths, this study is not without limitations. The sample size, although adequate for preliminary analysis, restricts the generalizability of findings and limits the statistical power to detect subtle effects between less frequent exposures, such as mechanical prophylaxis subgroups or variations in exercise type. The retrospective, cross-sectional design is inherently subject to information and selection bias, and reliance on medical records and patient recall may introduce misclassification of exposure or outcome variables. Additionally, as the study was conducted at tertiary care centers, the results may not fully reflect outcomes in community or low-resource settings. Our assessment of satisfaction, though positive overall, may also be influenced by the immediate postoperative context, and longer-term patient-reported outcomes were not evaluated. Despite these limitations, the study's strengths include rigorous statistical analysis, comprehensive capture of perioperative variables, and integration of both objective and subjective outcomes. The findings advocate for the routine implementation of early mobilization protocols in patients undergoing TKR as part of ERAS or similar perioperative care models. Future research should seek to validate these results in larger, multicenter cohorts with prospective designs, incorporate more granular measurement of mobilization intensity and duration, and explore patient-specific risk factors that may modify the benefit of early ambulation. Moreover, randomized controlled trials comparing mobilization protocols and their interaction with pharmacological and mechanical prophylaxis could offer more definitive evidence on optimizing postoperative DVT

prevention. In conclusion, this study highlights the clinical and theoretical importance of early mobilization in reducing thrombotic complications after knee arthroplasty and encourages continued innovation and standardization in perioperative rehabilitation strategies to further improve surgical outcomes (1,18).

CONCLUSION

Early mobilization within 24 hours following total knee replacement significantly reduces the risk of deep venous thrombosis, highlighting its pivotal role as a preventive strategy in postoperative care. These findings underscore the necessity of integrating structured early ambulation protocols into standard clinical pathways for total knee arthroplasty, in combination with established pharmacological and mechanical thromboprophylaxis, to optimize patient safety and recovery outcomes. For healthcare professionals, prioritizing early mobilization can markedly decrease thrombotic complications and improve overall postoperative experiences, while future research should further refine mobilization protocols and explore individualized strategies for DVT prevention in diverse patient populations.

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