Postoperative Mobilization Based Hemovac Drain Management After Total Knee Arthroplasty: A Prospective Comparative Study

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Abstract

Aim: The optimal timing of hemovac drain removal after total knee arthroplasty (TKA) remains controversial. This study aimed to compare the effects of drain removal before versus after initial postoperative mobilization on early clinical outcomes, functional recovery, and length of hospital stay (LOS) following primary TKA. **Materials and Methods:** This prospective comparative cohort study included 207 patients who underwent unilateral primary TKA for knee osteoarthritis. Patients were allocated into two groups according to the timing of drain removal on postoperative day 1: pre-mobilization drain removal (Group 1, $n = 103$) and post-mobilization drain removal (Group 2, $n = 104$). Clinical outcomes included total drainage volume, hemoglobin change, transfusion requirement, acute infection, and LOS. Functional outcomes were assessed at 6 weeks using the Knee Society Score (KSS), KSS-Function (KSS-F), and Visual Analog Scale (VAS). **Results:** The post-mobilization group demonstrated a significantly higher total drainage volume ($p < 0.001$) but no significant difference in hemoglobin change or transfusion requirement compared with the pre-mobilization group. LOS was significantly shorter in the post-mobilization group ($p < 0.001$). No significant differences were observed between groups regarding acute infection rates or 6-week functional outcomes (KSS, KSS-F, VAS; all $p > 0.05$). **Conclusion:** Hemovac drain removal after initial mobilization following TKA is associated with a shorter hospital stay without compromising early clinical safety or functional recovery. Optimizing drain removal timing after mobilization may facilitate earlier discharge and improve postoperative care efficiency.

Keywords: Total knee arthroplasty; Hemovac drain; Drain removal timing; Early mobilization; Length of hospital stay

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1. Introduction

Total knee arthroplasty (TKA) is one of the most commonly performed and successful surgical procedures for the treatment of end-stage knee osteoarthritis, aiming to reduce pain, improve functional capacity, and enhance quality of life[1,2]. Knee osteoarthritis represents a major source of pain, disability, and healthcare utilization worldwide[3]. Despite advances in surgical techniques, postoperative bleeding, hemarthrosis, the need for blood transfusion, and early postoperative complications remain clinically significant concerns[4,5].

Tourniquet use is frequently preferred during TKA to improve surgical visualization and reduce intraoperative blood loss[6]. However, tourniquet application may lead to hidden blood loss and hemarthrosis following reperfusion[7]. Many surgeons employ hemovac drains postoperatively to reduce blood accumulation. Nevertheless, the literature presents conflicting evidence regarding whether drain use reduces total blood loss, decreases transfusion need, or improves functional outcomes[8,9]. Moreover, drain use may increase infection risk, delay early mobilization, and prolong hospital stay[10].

The optimal timing for hemovac drain removal following TKA has been increasingly investigated. While some studies report that early drain removal does not increase total blood loss or affect transfusion requirements, others suggest that delayed removal may reduce hemarthrosis and intra-articular pressure[8,11]. A standardized clinical protocol has not yet been established. The aim of this study is to compare the effects of hemovac drain removal before versus after the first postoperative mobilization on functional outcomes, hemodynamic parameters, transfusion requirements, early complications, and length of hospital stay in patients undergoing TKA.

2. Materials and Methods

This study was designed as a prospective comparative cohort study with a quasi-randomized allocation method. Between May 2025 and November 2025, patients who underwent unilateral primary TKA at the Department of Orthopaedics and Traumatology were consecutively enrolled. Ethical approval was obtained from the local institutional ethics committee (2-25-1015, 30.04.2025), and the study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants. The study protocol was registered in a public clinical trials registry (NCT07342894).

Patients were divided into two groups: Group 1 (pre-mobilization), in which the hemovac drain was removed 1 hour before the initial rehabilitation session on postoperative day 1, and Group 2 (post-mobilization), in which the drain was removed 1 hour after the initial rehabilitation session. The investigator performing clinical and functional assessments was blinded to group allocation. During the study period, 226 consecutive patients were screened; 19 were excluded due to predefined exclusion criteria, and 207 were included in the final analysis. Exclusion criteria included revision knee arthroplasty, bilateral TKA, inflammatory arthritis, known coagulopathy, incomplete data, and refusal to participate.

Surgical Technique and Postoperative Care

All patients underwent unilateral primary TKA under a standardized surgical protocol with tourniquet use (300 mmHg). A standard midline skin incision and medial parapatellar approach were used. A Trauson® Total Knee Prosthesis was implanted in every case. A single closed-suction Hemovac drain was placed in all patients following wound closure.

All patients followed the same standardized care and rehabilitation protocol. Cefazolin 2 g was administered 30 minutes before skin incision, followed by 1 g four times daily for 24 hours postoperatively. Tranexamic acid 1 g was administered intravenously before tourniquet inflation. Enoxaparin sodium 4000 IU was initiated subcutaneously once daily and continued for 20 days. Full weight-bearing mobilization was initiated within the first 24 hours under physiotherapist supervision. Discharge was based on predefined criteria including adequate pain control, independent ambulation with assistive devices, satisfactory wound status, and medical stability.

Clinical and Functional Evaluation

Clinical evaluation included total drainage volume (mL), hemoglobin change (g/dL), length of hospital stay (days), transfusion requirement, and acute infection. Blood transfusion was indicated when hemoglobin decreased below 8 g/dL, or between 8–9 g/dL with clinical symptoms of anemia[12]. Acute postoperative infection was defined as an infection occurring within the first 30 days after surgery in accordance with the Musculoskeletal Infection Society (MSIS) criteria[13].

Functional outcomes were assessed at the 6-week follow-up using the Knee Society Score (KSS)[14], KSS-Function (KSS-F), and the Visual Analog Scale (VAS)[15]. All functional assessments were performed by a single blinded investigator.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 25.0. Continuous variables were tested for normality using the Shapiro–Wilk test. Normally distributed variables were compared using the Independent Samples t-test; non-normally distributed variables were analyzed using the Mann–Whitney U test. Categorical variables were compared using the Chi-square test or Fisher's Exact test. Continuous data are presented as mean ± SD; categorical data as numbers and percentages. A p-value <0.05 was considered statistically significant. A priori power analysis (Cohen's $d \approx 0.46$, $\alpha = 0.05$, power = 90%) determined a required sample size of approximately 101 patients per group.

3. Results

A total of 207 patients were included. No statistically significant differences were observed between groups with respect to age, sex, BMI, ASA classification, or operated side (all $p > 0.05$) (Table 1).

Table 1. Comparison of demographic and preoperative patient characteristics

	Group 1 (n=103)	Group 2 (n=104)	p-value
Age (years)	66.38 ± 7.57	67.72 ± 8.03	0.217[a]
Sex (Male/Female)	16 / 87	21 / 83	0.488[b]
BMI (kg/m^2)	32.57 ± 5.23	31.38 ± 5.17	0.078[a]
ASA classification (I/II/III)	25 / 48 / 30	21 / 47 / 36	0.540[b]
Operated side (Right/Left)	56 / 47	56 / 48	1.000[a]

[a] *Independent t-test;* [b] *Chi-square test. BMI: Body Mass Index; ASA: American Society of Anesthesiologists classification.*

The total drainage volume was significantly higher in Group 2 (425.8 ± 96.3 vs. 374.4 ± 70.1 mL; $p < 0.001$). No significant difference was found in hemoglobin change ($p = 0.710$) or transfusion requirement ($p = 1.00$). LOS was significantly shorter in Group 2 (3.25 ± 0.53 vs. 3.94 ± 0.88 days; $p < 0.001$). Acute infection was identified in only one patient in Group 1, treated with DAIR; no significant difference between groups ($p = 0.50$) (Table 2).

Table 2. Comparison of postoperative clinical outcomes

	Group 1 (n=103)	Group 2 (n=104)	p-value
Drain output (mL)	374.4 ± 70.1	425.8 ± 96.3	<0.001[a]
Hemoglobin change (g/dL)	−1.04 ± 0.85	−1.11 ± 0.96	0.710[a]
Length of hospital stay (days)	3.94 ± 0.88	3.25 ± 0.53	<0.001[a]
Transfusion required (Yes/No)	2 / 101	2 / 102	1.00[b]
Acute infection (Yes/No)	1 / 102	0 / 104	0.50[b]

[a] *Mann–Whitney U test;* [b] *Fisher's Exact test.*

No statistically significant differences were observed between groups in KSS (64.5 ± 7.3 vs. 64.1 ± 7.6; p = 0.77), KSS-F (60.6 ± 6.6 vs. 60.0 ± 6.6; p = 0.46), or VAS (2.0 ± 0.8 vs. 2.2 ± 0.8; p = 0.051) at the 6-week postoperative follow-up (Table 3).

Table 3. Comparison of postoperative functional outcomes at 6 weeks

	Group 1 (n=103)	Group 2 (n=104)	p-value
KSS	64.5 ± 7.3	64.1 ± 7.6	0.77[a]
KSS-F	60.6 ± 6.6	60.0 ± 6.6	0.46[a]
VAS	2.0 ± 0.8	2.2 ± 0.8	0.051[a]

[a] Mann–Whitney U test. KSS: Knee Society Score; KSS-F: Knee Society Score-Function; VAS: Visual Analog Scale.

4. Discussion

The most important finding of this study is that removal of the hemovac drain after the initial postoperative mobilization following TKA is associated with a shorter LOS, without negatively affecting early blood loss, transfusion requirements, or functional recovery. It has previously been demonstrated that an increase in postoperative drainage volume does not always reflect true total blood loss after TKA, as drainage does not account for hidden blood loss and may not correlate directly with hemoglobin decline or transfusion requirements[16,17].

Perioperative tranexamic acid administration reduces both visible and hidden blood loss, and adopting restrictive transfusion thresholds based on a hemoglobin level below 8 g/dL or the presence of symptomatic anemia is a safe approach following TKA[12,18,19]. Although a higher total drainage volume was observed in the post-mobilization group, the absence of significant differences in hemoglobin change and transfusion requirement suggests the increased drainage did not correspond to clinically meaningful blood loss. The shorter LOS in the post-mobilization group indicates that drain removal timing may influence postoperative care processes independently of bleeding-related parameters.

Shortening LOS after TKA has become an increasingly important goal. Meta-analyses examining ERAS-based protocols have demonstrated that a reduced LOS following TKA is directly associated with lower hospital costs[20,21,22]. Even minor modifications in postoperative care protocols may influence discharge timing[23]. In line with these findings, the significantly shorter LOS in the post-mobilization group suggests that drain removal timing may accelerate the discharge process without adversely affecting early safety parameters.

The absence of significant differences in KSS, KSS-F, and VAS scores at the 6-week follow-up is consistent with the literature indicating that mobilization timing and postoperative care strategies generally have a limited impact on early functional scores when standardized rehabilitation protocols are applied[23,24].

Regarding infection risk, contemporary series have demonstrated that when appropriate surgical technique, standardized antibiotic prophylaxis, and early mobilization are applied, the presence of a drain or its removal timing does not significantly increase infection risk[8,11,25,26]. Consistent with these findings, our study did not observe a statistically significant difference in acute postoperative complications or infection rates between the two groups. However, the very low incidence of infection limits the ability to detect meaningful between-group differences, and these findings should be interpreted with caution.

Strengths and Limitations

Strengths include the prospective cohort design, uniform application of standardized protocols, and clearly predefined criteria for drain removal timing. Limitations include the single-center design, absence of true randomization (alternating allocation method), and functional outcome assessment only at 6 weeks, limiting evaluation of very early recovery phases. The very low incidence of infection and complications limited statistical power for safety-related outcomes. Despite these limitations, the findings provide valuable data regarding the impact of drain removal timing on early safety and clinical outcomes.

5. Conclusion

This study demonstrates that removal of the hemovac drain after the initial postoperative mobilization following TKA may be associated with a shorter length of hospital stay, without adversely affecting early clinical or functional outcomes. These findings suggest that drain removal timing can be safely optimized within the postoperative care process, and that removing the drain after mobilization may facilitate earlier discharge and provide meaningful benefits in clinical practice. Further large-scale, randomized studies are warranted to elucidate the long-term outcomes and generalizability of this approach.

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Ethical Approval: Ethical approval was obtained from the local institutional ethics committee (Decision No: 2-25-1015, Date: 30.04.2025). The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

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Data Availability: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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