

Effectiveness of Comprehensive Nursing Care in Preventing Deep Vein Thrombosis after Orthopedic Surgery

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Abstract: This study evaluated the effectiveness of comprehensive nursing interventions in preventing deep vein thrombosis (DVT) and improving postoperative outcomes in orthopedic patients. Eighty patients undergoing orthopedic surgery were randomized into control (routine care) and intervention (routine care plus comprehensive nursing interventions) groups, with 40 patients in each group. Comprehensive interventions included early mobilization, leg elevation, pain management, psychological support, and individualized dietary guidance. Outcome measures were postoperative lower limb swelling resolution time, pain scores, nursing satisfaction, and DVT incidence. Baseline characteristics were comparable between groups. The intervention group demonstrated significantly shorter swelling resolution time (14.65 ± 2.20 days vs. 9.28 ± 1.62 days, $p < 0.01$), lower pain scores (6.68 ± 1.64 vs. 4.08 ± 1.53 , $p < 0.001$), higher nursing satisfaction ($p = 0.046$), and reduced DVT incidence (7.5% vs. 35.0%, $p = 0.006$). Comprehensive nursing care effectively prevented DVT, promoted limb function recovery, reduced pain, and increased satisfaction, supporting its use in clinical practice.

1. Introduction

Deep vein thrombosis (DVT), the formation of a blood clot in a deep vein (typically in the legs or pelvis), is a significant health threat, particularly for patients undergoing major surgery, experiencing severe trauma, or those confined to prolonged bed rest. DVT poses a serious risk due to its potential to cause life-threatening complications, such as pulmonary embolism. Therefore, implementing effective prophylactic measures is crucial for orthopedic surgery patients.

The pathogenesis of DVT is primarily explained by Virchow's triad, encompassing three key factors: alterations in blood flow, changes in blood composition, and damage to the vessel wall [1-4]. Orthopedic patients, especially those undergoing major joint replacements or long bone fracture repairs, often face prolonged immobility due to postoperative restrictions. This immobility leads to reduced venous blood flow in the lower extremities, increasing the risk of DVT. Additionally, surgical trauma and prolonged bed rest contribute to a hypercoagulable state, making blood more prone to clotting [2,5]. Furthermore, surgical procedures inevitably cause some degree of damage to the

vascular endothelium, further contributing to the risk of thrombosis [2].

Orthopedic procedures, particularly joint replacements and long bone fracture repairs, are inherently associated with a higher risk of DVT due to their invasiveness and complexity. For instance, joint replacements, such as hip and knee arthroplasty, involve surgical sites in close proximity to major veins, making direct injury or compression of the vascular endothelium more likely, thereby promoting thrombus formation [2,5]. Similarly, long bone fracture repairs, often requiring extensive fixation and potentially associated with significant blood loss, can also lead to substantial alterations in blood flow dynamics and vascular injury [1]. This study focuses on these two major orthopedic surgery types — joint replacements and long bone fracture repairs to evaluate the effectiveness of comprehensive nursing care in preventing DVT following these procedures.

2. Methods

2.1 Study Design and Participants

This prospective, randomized controlled trial was conducted from January 2022 to March 2024. Eighty patients undergoing orthopedic surgery were randomly assigned to either a control group (receiving routine care) or an intervention group (receiving routine care plus comprehensive nursing interventions), with 40 patients in each group. Surgical procedures were categorized as joint replacement (including hip and knee arthroplasty) or long bone fracture repair, with 20 patients in each surgery category within each group.

2.2 Inclusion and Exclusion Criteria

(1) Inclusion Criteria

- ① Age \geq 18 years;
- ② Undergoing hip or knee replacement, or long bone fracture repair surgery;
- ③ Expected postoperative bed rest $>$ 3 days;
- ④ Informed consent obtained from patient and family.

(2) Exclusion Criteria

- ① Active bleeding or bleeding diathesis;
- ② Malignancy or major organ dysfunction;
- ③ Psychiatric illness or cognitive impairment precluding study comprehension;
- ④ History of DVT or current anticoagulant therapy.

2.3 Nursing Interventions

2.3.1 Routine Care: Control Group

The control group received routine postoperative care, which included:

① Basic care and monitoring: Assistance with activities of daily living (e.g., feeding, hygiene), vital signs monitoring (heart rate, blood pressure, temperature), and postoperative wound assessment, including monitoring for swelling and signs of infection.

② Pain management: Administration of analgesics (e.g., NSAIDs, opioids) as prescribed, pain level assessment using a pain scale, and adjustment of the pain management plan as needed.

③ Patient education: Provision of basic information on postoperative recovery, including wound care, activity restrictions, and measures to prevent complications. Written materials were provided emphasizing the importance of early mobilization and guidance on safe resumption of activities.

2.3.2 Comprehensive Nursing Care: Intervention Group

In addition to routine care, the intervention group received comprehensive nursing interventions, which included:

① Individualized dietary guidance: A registered dietitian provided a personalized meal plan, adjusted at least weekly, emphasizing high-protein, low-fat, vitamin-rich foods to promote wound healing and overall health. Daily supplementation with omega-3 fatty acids and antioxidants was recommended to reduce inflammation and improve circulation, with adherence monitored by nursing staff.

② Leg elevation: Patients were instructed to elevate their operated leg to 20-30 degrees using pillows or specialized devices for at least 30 minutes, four times daily, to enhance venous return and reduce venous pressure. Circulation and skin integrity were assessed every 2 hours to prevent pressure ulcers.

③ Early mobilization: Starting on postoperative day 2, patients engaged in passive and active range-of-motion exercises (ankle rotations, knee flexion/extension) at least three times daily under the guidance of a physical therapist. Activity intensity and frequency were adjusted based on individual progress, with a focus on gradual increases in activity while monitoring patient comfort and response.

④ Psychological support: A mental health professional or trained nurse conducted weekly emotional assessments to identify any anxiety or depressive symptoms. Individual or group counseling sessions were provided at least weekly to address concerns and develop coping strategies for postoperative psychological challenges.

⑤ Enhanced pain management: A multimodal approach was used, combining pharmacologic analgesia with non-pharmacological interventions (heat/cold therapy, massage, cognitive-behavioral therapy). Pain management strategies were adjusted at least daily based on patient feedback. Pain levels were assessed every 4 hours, and treatment plans were modified according to pain diary entries to ensure optimal comfort.

2.4 Outcome Measures

2.4.1 DVT incidence

All patients underwent lower extremity venous ultrasound on postoperative days 3 and 7, and prior to discharge to assess for DVT. The presence, timing, and location of DVT were recorded.

2.4.2 Swelling resolution time

Lower limb circumference was measured daily until discharge to evaluate swelling reduction. The number of days from surgery to significant swelling reduction was recorded.

2.4.3 Pain scores

Pain intensity was assessed daily using a visual analog scale (VAS), ranging from 0 (no pain) to 10 (worst pain imaginable).

2.4.4 Nursing satisfaction

A self-developed nursing satisfaction questionnaire was administered before discharge. It included items assessing responsiveness, quality of care, communication, and overall satisfaction, using a 5-level Likert scale (very satisfied to very dissatisfied).

2.5 Statistical Analysis

Data were analyzed using SPSS 25.0. Continuous variables were expressed as mean \pm standard deviation and compared using t-tests. Categorical variables were presented as percentages and analyzed using chi-square tests. A two-sided p-value < 0.05 was considered statistically significant.

2.6 Ethical Considerations

This study was approved by the Institutional Review Board. All participants provided written informed consent. The study adhered to the ethical principles of the Declaration of Helsinki, ensuring patient confidentiality and data security.

3. Results

3.1 Baseline Characteristics of the Two Groups

The mean age of the control group was (61.12 \pm 10.91) years, while the mean age of the intervention group was (64.32 \pm 8.21) years. The difference in age between the two groups was not statistically significant ($p=0.130$). In terms of sex distribution, 37.5% of the control group were male and 62.5% were female, while 47.5% of the intervention group were male and 52.5% were female. There was no significant difference in sex distribution between the two groups ($p=0.497$). The distribution of surgery types was as follows: 42.5% and 32.5% of patients underwent hip arthroplasty in the control and intervention groups, respectively; 32.5% and 35.0% underwent knee arthroplasty; and 25.0% and 32.5% underwent long bone fracture repair. There was no statistically significant difference in the distribution of surgery types between the two groups ($p=0.618$). Overall, there were no statistically significant differences between the two groups in terms of age, sex, or type of surgery. Table 1.

Table 1: Baseline Characteristics of the Two Groups (n=80)

Variable	Control Group	Intervention Group	t/ χ^2	P
Age (years; $\bar{x} \pm s$)	61.12 \pm 10.91	64.32 \pm 8.21	1.53	0.130
Sex (n, %)				
Male	15(37.5)	19(47.5)	0.46	0.497
Female	25(62.5)	21(52.5)		
Type of Surgery (n, %)				
Hip Arthroplasty	17(42.5)	13(32.5)	0.96	0.618
Knee Arthroplasty	13(32.5)	14(35.0)		
Long Bone Fracture Repair	10(25.0)	13(32.5)		

3.2 DVT Incidence between the Two Groups

The incidence of postoperative DVT was significantly lower in the intervention group (7.5%) compared to the control group (35.0%), ($\chi^2=7.47$, $p=0.006$). Table 2.

Table 2: Comparison of DVT Incidence Between the Two Groups (n=80; n[%])

Variable	Control Group	Intervention Group	χ^2	P
DVT Occurrence	14 (35.0)	3 (7.5)	7.47	0.006
No DVT	26 (65.0)	37 (92.5)		

3.3 Postoperative Swelling Resolution Time and Pain Scores Between the Two Groups

The intervention group demonstrated a significantly shorter time to swelling resolution (9.28 ± 1.62 days) compared to the control group (14.65 ± 2.20 days), ($t=12.44$, $p<0.001$). Pain scores were also significantly lower in the intervention group (4.08 ± 1.53) than in the control group (6.68 ± 1.64), ($t=7.34$, $p<0.001$). Table 3.

Table 3: Postoperative Swelling Resolution Time and Pain Scores Between the Two Groups
($n=80; \bar{x} \pm s$)

Variable	Control Group	Intervention Group	<i>t</i>	<i>P</i>
Swelling Resolution Time (days)	14.65 ± 2.20	9.28 ± 1.62	12.44	<0.001
VAS	6.68 ± 1.64	4.08 ± 1.53	7.34	<0.001

3.4 Nursing Satisfaction Between the Two Groups

Nursing satisfaction was significantly higher in the intervention group compared to the control group ($p=0.046$). Specifically, 27.5% of patients in the intervention group reported being "very satisfied" with the nursing care, compared to only 12.5% in the control group. The remaining satisfaction categories showed the following distributions: Satisfied (22.5% in both groups), Neutral (45.0% in the control group vs. 25.0% in the intervention group), Dissatisfied (15.0% in the control group vs. 22.5% in the intervention group), and Very Dissatisfied (5.0% in the control group vs. 2.5% in the intervention group). Table 4.

Table 4: Nursing Satisfaction Between the Two Groups ($n=80; n[\%]$)

Variable	Control Group	Intervention Group	χ^2	<i>p</i>
Very Satisfied	5 (12.5)	11 (27.5)	8.02	0.046
Satisfied	9 (22.5)	9 (22.5)		
Neutral	18 (45.0)	10 (25.0)		
Dissatisfied	6 (15.0)	9 (22.5)		
Very Dissatisfied	2 (5.0)	1 (2.5)		

4. Discussion

Deep vein thrombosis (DVT) is a frequent complication following orthopedic surgery, significantly impacting patient outcomes. This study aimed to investigate the effects of comprehensive nursing interventions on postoperative lower limb swelling resolution time, pain levels, and nursing satisfaction in orthopedic patients, and to evaluate its potential value in preventing DVT and improving prognosis. The results demonstrated that, compared with routine care, comprehensive nursing intervention effectively shortened the time for postoperative lower limb swelling resolution, reduced pain levels, and significantly improved nursing satisfaction. The incidence of DVT in the observation group (7.5%) was significantly lower than that in the control group (35.0%), with a statistically significant difference ($p=0.006$), suggesting that comprehensive nursing interventions have a positive effect on preventing DVT after orthopedic surgery.

4.1 Early Mobilization

This study emphasizes the role of early mobilization in promoting lower limb blood circulation, accelerating interstitial fluid return, and effectively reducing swelling. A study by Holm et al. [5] found that early mobilization and weight-bearing activities contribute to improved functional recovery after surgery and reduce residual displacement of the articular surface. Recent studies further support the benefits of early mobilization. A study by Krištof Mirt P et al. [6] found that early mobilization significantly reduced postoperative pain and swelling and accelerated lower limb blood flow. Similarly, a multicenter study by Lei et al. [7] demonstrated that early ambulation is effective in reducing the incidence of complications and length of hospital stay after total knee arthroplasty. These findings are consistent with the results of this study, further confirming the importance of early mobilization in promoting lower limb blood circulation, accelerating interstitial fluid return, and reducing postoperative swelling and pain.

4.2 Positioning

This study found that positioning interventions, such as elevating the affected limb and avoiding compression, are crucial for promoting venous return and reducing swelling. Related studies have shown that early range of motion (ROM) exercises and proper positioning can significantly reduce postoperative pain and swelling [6]. These measures effectively prevent postoperative DVT formation by increasing venous return velocity and reducing venous pressure.

A study by Kim et al. [8] showed that postoperative rehabilitation care, including correct positioning and massage, can significantly reduce the incidence of DVT and improve patients' quality of life. Krištof Mirt P et al. [6] further supported this finding, indicating that postoperative positioning and functional exercise play an important role in reducing DVT incidence and alleviating postoperative swelling. Similarly, this study also pointed out that elevating the affected limb can significantly promote venous return, reduce lower limb venous pressure, and thereby reduce the risk of thrombus formation [6]. Zhu et al. [9] stated that individualized nursing interventions, including positioning and early mobilization, can significantly reduce the incidence of postoperative DVT, improve patients' self-care ability and satisfaction. Moreover, Nie et al. [10] found that a modified lower limb exercise method also showed a significant effect in preventing lower limb DVT after intracranial aneurysm surgery.

These consistent research findings demonstrate the importance of positioning in postoperative rehabilitation. By adopting correct positioning and implementing early mobilization, lower limb blood circulation can be effectively promoted, venous pressure can be reduced, and consequently, the incidence of DVT can be significantly reduced, improving patients' postoperative recovery.

4.3 Pain Management

Patients in the intervention group in this study showed better pain management outcomes, likely due to the multifaceted positive impacts of comprehensive nursing interventions. The combination of ROM exercises and deep breathing exercises can effectively alleviate postoperative pain [6]. Additionally, a study by Melnyk et al. [11] found that early ambulation combined with comprehensive pain management strategies, such as a combination of analgesic medications, physical therapy, and psychological support, can significantly improve patients' postoperative pain experience. These measures can not only effectively alleviate patients' physical pain but also reduce anxiety and depression through psychological support, thereby comprehensively enhancing patients' postoperative recovery. Aldanyowi et al. [12] found in a study that the use of anti-thrombotic elastic stockings combined with pneumatic compression therapy interventions can help reduce the incidence

of postoperative lower limb DVT while significantly reducing postoperative pain and swelling. The conclusions of these related studies all confirm the findings of this study, indicating that comprehensive nursing interventions can effectively manage postoperative pain through various means and promote rapid recovery in patients.

4.4 Nursing Satisfaction

The results of this study showed that the nursing satisfaction of patients in the observation group was significantly higher than that of the control group, indicating that comprehensive nursing intervention has a significant advantage in improving patient satisfaction. Relevant studies have also shown that systematic health education and individualized nursing interventions can significantly improve patients' nursing satisfaction and overall treatment outcomes. Studies have found that improving information and communication, providing personalized health education materials, and conducting regular patient education can not only significantly enhance patients' satisfaction with nursing services but also improve their overall health status and rehabilitation experience [13,14]. Furthermore, by enhancing the interaction between patients and nursing staff and providing more attentive and personalized nursing services, patient satisfaction can also be significantly improved [15]. Ataro et al. found that optimizing nursing processes and strengthening communication before and after surgery can significantly improve patients' nursing experience and satisfaction [13]. Tano's research emphasized the importance of personalized nursing interventions in reducing postoperative complications and improving patient satisfaction. These research findings are consistent with the results of this study, further demonstrating the positive role of comprehensive nursing interventions in improving patient satisfaction and postoperative recovery.

This study has some limitations. Firstly, the sample size was relatively small, and the study was conducted in only one hospital, making it difficult to avoid selection bias. Future research needs to be conducted on a larger scale and in multiple centers to further validate the conclusions of this study. Secondly, the follow-up period of this study was relatively short, making it difficult to assess the long-term effects of comprehensive nursing interventions. Future research could extend the follow-up period to observe the impact of interventions on patients' long-term functional recovery and quality of life.

In conclusion, the results of this study indicate that implementing comprehensive nursing interventions for patients after orthopedic surgery can effectively promote lower limb function recovery, alleviate pain, and improve nursing satisfaction, providing an important reference for clinical nursing practice, and it is worthy of clinical promotion and application. Future research can further explore the optimal combination of different nursing intervention measures and individualized nursing plans for patients undergoing different types of orthopedic surgery.

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