

Original Article

Effects of VTE preventative nursing management on DVT incidence, anemia and blood viscosity after hip fracture surgery

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Abstract: Background: In view of the high incidence of hip fracture in elderly patients and deep vein thrombosis (DVT) in patients after hip arthroplasty, this paper intends to explore the feasibility of implementing venous thromboembolism (VTE) preventative nursing management (PNM) in patients with hip fracture, in order to seek a more efficient and safe postoperative nursing management mode for patients with hip fracture. Objective: This study was designed to explore the effects of VTE PNM on the incidence of DVT, anemia and blood viscosity after a hip fracture surgery. Methods: In total, 194 patients who received surgery for hip fracture in our hospital in 2019 were divided into the Control Group (CG, n=86, without VTE PNM from January to June 2019) and the Experimental Group (EG, n=108, with VTE PNM from July to December 2019). DVT incidence, limb circumferences and temperatures at 15 cm above the patella and 10 cm below the patella at 3 d and 5 d after the surgery, blood flow velocity in femoral and popliteal veins were compared between the two groups, and the red blood cells (RBC), hemoglobin (Hb) as well as hematocrit (HCT) at 5 d after the surgery were analyzed. Results: The DVT incidence after the surgery was 1.85% (2/108) in the EG and 11.63% (10/83) in the CG ($P<0.05$). The limb circumferences and temperatures at 15 cm above the patella and 10 cm below the patella at 3 d and 5 d after the surgery were significantly lower in the EG in comparison with the CG ($P<0.05$). No statistical difference was found between the two groups in terms of RBC, Hb and HCT at 5 d after the surgery ($P>0.05$). At the 3 d and 5 d after the surgery, the blood flow velocity in femoral and popliteal veins observed in the EG was significantly higher than the CG's ($P<0.05$). Conclusion: VTE PNM is an effective tool to reduce the DVT incidence and improve the postoperative blood status in patients with hip fracture. However, no marked effects were found with anemia.

Keywords: VTE PNM, hip fracture, DVT, anemia, blood viscosity

Introduction

Hip fracture is one of the common fracture types in the elderly. Clinical practices have pointed out that with a high disability and fatality rate, hip fracture, if not handled properly, will severely affect patients' quality of life. With transcervical fracture mainly reported in senior females, as an example, the incidence is around 3.58%, the nonhealing rate is between 10% and 20%, and the necrosis rate is between 20% and 40%. Other relevant literature also reported a 30 d mortality of about 10% and a 1-year mortality of about 33% in the elderly who suffered from hip fracture [1-4].

Surgery is an effective tool to improve the clinical syndromes in patients with hip fracture, and

accelerate the development and metastasis of the disease. However, clinical studies have found that under the influence of factors such as long-term lying in bed, intraoperative vascular damage, and blood hypercoagulability, patients with hip fracture may face a high incidence of deep vein thrombosis (DVT) after the surgery. DVT is a common vascular disease and a severe complication of hip fracture [5-8]. The major cause of DVT is the abnormal coagulation of blood in the deep vein. Common clinical manifestations of DVT include limb swelling and pain, or life-threatening pulmonary embolism in some patients [9-11]. Data shows that venous thromboembolism ranks the 3rd in angiocardopathy in the United States, in terms of incidence, and accounts for

about 10% of the hospital deaths, indicating the extreme necessity of early DVT preventative intervention [12, 13].

Venous thromboembolism (VTE) preventative nursing management (PNM) is an emerging tool in recent years to improve the preventative level of VTE and standardize the preventive methods, so as to reduce the VTE incidence, associated pain and medical burden on patients [14]. So far, some research results have shown that preventive DVT nursing for patients with hip fractures can effectively reduce the thrombosis rate and shorten the patients' out of bed time and hospital stay after surgery. Some studies have analyzed the intervention mechanism and pointed out that VTE PNM can effectively reduce the blood viscosity of patients with hip fracture after surgery and reduce the possibility of postoperative thrombosis [15]. Standardization of preventive nursing measures for postoperative DVT of patients with hip fractures can provide a theoretical basis for accelerating the postoperative outcome of such patients and improving the joint function of patients. This study analyzes the feasibility of VTE preventive nursing for patients with hip fractures by setting up different groups, and analyzes the impact of PNM on postoperative blood flow status and anemia symptoms.

Materials and methods

General materials

A total of 194 patients who received surgery for hip fracture in our hospital in 2019 were divided into the Control Group (CG, n=86, without VTE PNM from January to June 2019) and the Experimental Group (EG, n=108, with VTE PNM from July to December 2019).

Inclusion criteria: (1) Clear consciousness to cooperate with the study; (2) Complete medical records; (3) Diagnosed with hip fracture by iconography and accepted surgical therapy; (4) Approval from the Ethics Committee of the Hospital; (5) Informed consent from subjects after understanding the study process, methods and principles.

Exclusion criteria: (1) Complication with metal disorders, malignant tumors, severe liver and kidney dysfunctions, congenital hip deformity/

coagulation disorders, anemia, local abnormalities of lower extremities, including dermatitis and thanatosis; (2) Allergic to the drugs used; (3) Pregnancy or lactation; (4) Dermatoplasty recently; Removal criteria: (1) Deaths during the study; (2) Active request for withdrawal during the study.

Methods

After admission, the patients of the two groups received the same nursing measures, including immobilization, dietary intervention, monitoring of physical signs, data collection, laboratory examination, and basic disease control. Meanwhile, patients in the CG received routine perioperative nursing of hip fracture, such as preoperative fasting, intraoperative heat preservation, postoperative immobilization and functional exercise according to the recovery situation. While patients in the EG, VTE PNM was given in addition to the regimen in the CG. The specific measures were as follows: (1) Patients were prohibited from lying in the bed for a long term after the surgery, but required to take exercise actively or passively, with or without assistance from the nurses or the family members, provided their conditions permit. The exercises involved both lower extremities and flexion and extension of acrotarsiums, or elevation of the affected limb. Each exercise lasted 1 to 2 h, during which, the popliteal space or the calf was not bolstered, and patients were encouraged to take deep breath and cough. (2) As conditions permit and for the purpose of accelerating blood circulation, patients were encouraged to take out-of-bed activities at an increased amount as early as possible with assistance from their family members or the nurses, before which, exercise with lower extremities in the bed was necessary. (3) For patients depending on long-term infusion or administration through the jugular vein due to special conditions, lower extremity puncturing was avoided as far as possible, and caution was paid to the use of drugs highly stimulating vessels. If puncturing at the lower extremities was inevitable, repeated puncturing at the same site or vein was not accepted. (4) Nurses were instructed to closely observe patients' lower extremities with emphasis on swelling, shallow venous engorgement, and deep muscle tenderness. Patients with any of those

symptoms were reported to the doctor in a timely manner. (5) Close communication was performed with patients, and the doctor was informed for intervention in the event of complaints from patients such as heavy lower extremities with swelling pain during standing, which worsened after exercise and improved after extremity elevation, or asymmetric lower extremities. (6) Routine interventions were applied, including prohibition of smoking and alcohol, mild diets, high drink, and drugs rich in fibrin to keep bowels open, and avoidance of excessively tight dressing. (7) Physical prevention was adopted to intervene with the patients' lower extremities, including plantar vein pump, intermittent inflation and pressurization device, stretch hoses with graded pressure. (8) According to patients' actual conditions, drug intervention was included with Warfarin and Rivaroxaban Tablets at proper doses to prevent thrombosis. Both groups had intervention for 7 d.

Observation indexes and evaluation criteria

DVT incidence: Siemens X300PE Color Doppler Ultrasound was used to record the DVT formation rate and compare the DVT incidences between the 2 groups after surgery.

Postoperative intergroup comparison of limb circumferences at 3 d and 5 d: Limb circumferences at 15 cm above the patella and 10 cm below the patella were measured three times with the same tape measure at 3 d and 5 d after the surgery. The mean was the final value used for intergroup comparison.

Postoperative intergroup comparison of limb temperatures at 3 d and 5 d: Limb temperatures at 15 cm above the patella and 10 cm below the patella were measured three times with the same electronic thermometer at 3 d and 5 d after the surgery. The mean was the final value used for intergroup comparison.

Postoperative intergroup comparison of anemia: Blood samples were collected at the 5 d after the surgery to measure the red blood cells (RBC), hemoglobin (Hb) and hematocrit (HCT) with the Siemens ADVIA1800 automatic biochemistry analyzer. Intergroup comparison was performed.

Blood viscosity at 5 d after the surgery: At 5 d after the surgery, the blood flow in the femoral vein and the popliteal vein was measured with

the Siemens X300PE Color Doppler Ultrasound. The measurement was performed three times for each group and the mean value was used final for intergroup comparison.

Statistical analysis

Statistical analysis was performed with SPSS 22.0. In case of numerical data it was expressed as Mean $\pm$ Standard Deviation, comparison studies were carried out through t test. In the case of nominal data expressed as [n (%)], comparison studies were carried out through χ^2 test for intergroup comparison. In the case of intergroup comparison at multiple points, ANOVA was adopted. For all statistical comparisons, significance was defined as $P < 0.05$ [16].

Results

Intergroup comparison of general clinical materials

No significant difference was found between the two groups for general clinical materials including gender, average age, educational background, marital status, and medical history ($P > 0.05$) (**Table 1**).

Intergroup comparison of DVT incidence

The DVT incidence was 1.85% (2/108) in the EG and 11.63% (10/86) in the CG ($\chi^2 = 3.942$, $P = 0.047$) (**Figure 1**).

Intergroup comparison of limb circumferences and temperatures at 3 d and 5 d

At 3 d and 5 d after the surgery, the limb circumferences and temperatures at 15 cm above the patella and 10 cm below the patella as measured in the EG were lower than the CG's ($P < 0.05$) (**Tables 2 and 3; Figures 2 and 3**).

Intergroup comparison of anemia at 5 d after the surgery

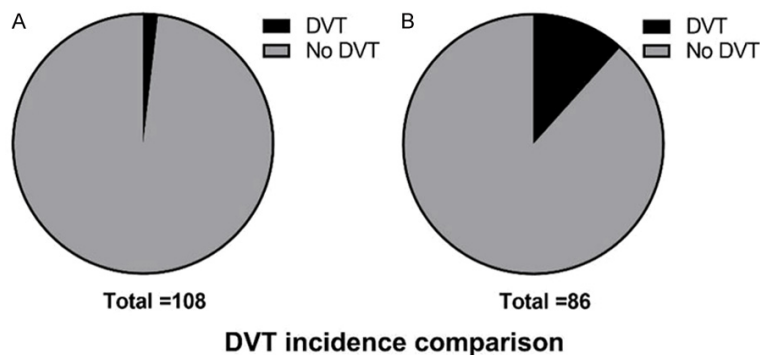
The two groups demonstrated no significant difference in anemia indexes (RBC, Hb and HCT) at the 5 d after the surgery ($P > 0.05$) (**Table 4 and Figure 4**).

Intergroup comparison of blood flow velocity in femoral and popliteal veins at the 5 d after the surgery

According to the results of color Doppler ultrasound, the blood flow velocity in femoral and

Table 1. Intergroup comparison of general clinical materials ($\bar{x} \pm s$)/[n (%)]

General Clinical Materials		EG (n=108)	CG (n=86)	t/X ²	P
Gender	Male	56	44	0.005	0.946
	Female	52	42		
Average age (y)		59.22±2.73	59.18±2.87	0.07	0.944
Educational background	Illiteracy	24	20	0.218	0.671
	Elementary school	28	22		
	Middle school	38	32		
	High school, etc.	18	12		
Marital status	Married	82	74	0.28	0.597
	Unmarried	26	12		
Monthly revenue (RMB yuan)	<1000	22	20	0.311	0.439
	1000-3000	56	48		
	>3000	30	18		
History of hypertension	Y	66	46	0.57	0.45
	N	42	40		
History of diabetes	Y	60	42	0.433	0.51
	N	48	44		

**Figure 1.** Postoperative DVT incidences. The incidence of DVT was 1.85% in the EG based on 2 cases (A) and 11.63% in the CG based on 10 cases (B) ($P < 0.05$).

popliteal veins at the 5 d after the surgery was significantly higher in the EG patients ($P < 0.05$) (Table 5 and Figure 5).

Discussion

Accompanying the marked aging of society in recent years is the gradual rise in the incidences of degenerative diseases on an annual basis. As a common fracture in the elderly, hip fracture affects about 1 million Chinese people each year, according to relevant data, of whom, about 95% are seniors. Osteoporosis, reduced bone mass and chronic medical diseases are the direct factors accounting for the increase of hip fracture incidence [17]. In most studies, hip

fracture patients who select conservative treatment may be more prone to the diseases of cardiovascular system, DVT, electrolyte disturbances, bedsores and urinary infection, and some life-threatening complications may occur in some cases; including hypostatic pneumonia and pulmonary embolism. For this reason, more active surgical treatment is suggested [18, 19]. However, according to the clinical practices in recent years, hip fracture patients

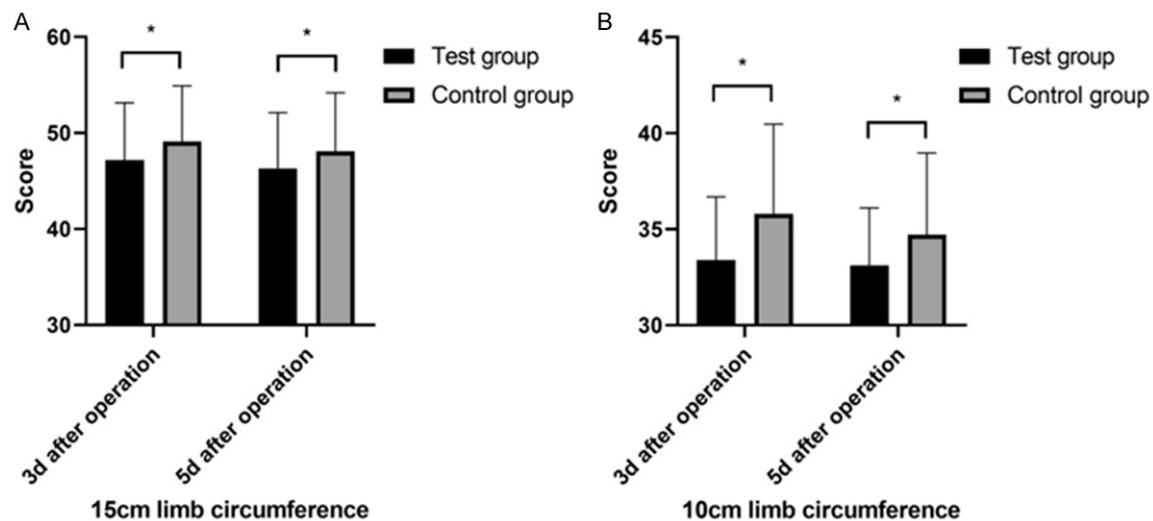
are confronted with a raised incidence of DVT and pulmonary embolism due to multiple factors, i.e., large amount of bleeding, long-term lying in bed, enhanced coagulation and platelet functions after fracture, blood hypercoagulation, and vessel damage as a result of surgery. Such cases are more particular with the elderly characterized by degraded functions, high blood viscosity, and low vascular elasticity, in whom, the possibility of thrombus is higher as compared with the younger patients [20, 21]. In some studies, it is stated that blood hypercoagulation, endovascular damage and hypostasis are the factors accounting for the thrombus after fracture. Elderly patients have a higher chance of DVT and even fatal pulmonary

Table 2. Intergroup comparison of limb circumferences at 3 d and 5 d after the surgery ($\bar{x} \pm s$) (cm)

Group	n	3 d after the Surgery		5 d after the Surgery	
		Limb circumference at 15 cm above the patella	Limb circumference at 10 cm below the patella	Limb circumference at 15 cm above the patella	Limb circumference at 10 cm below the patella
EG	108	47.18±4.21	33.39±2.33	46.28±4.12	33.12±2.11
CG	86	49.11±4.10	35.81±3.29	48.09±4.32	34.71±3.01
t	-	2.269	4.236	2.104	3.054
P	-	0.026	<0.001	0.038	0.003

Table 3. Intergroup comparison of limb temperatures at 3 d and 5 d after the surgery ($\bar{x} \pm s$) (°C)

Group	n	3 d after the Surgery		5 d after the Surgery	
		Limb temperatures at 15 cm above the patella	Limb temperatures at 10 cm below the patella	Limb temperatures at 15 cm above the patella	Limb temperatures at 10 cm below the patella
EG	108	36.01±0.43	36.35±0.67	35.82±0.78	36.21±0.36
CG	86	36.79±0.59	36.88±0.81	36.69±0.41	36.68±0.77
t	-	7.527	3.527	6.618	3.976
P	-	<0.001	0.001	<0.001	<0.001

**Figure 2.** Limb circumferences at 3 d and 5 d after the surgery. At 3 d and 5 d after the surgery, the limb circumferences at 15 cm above the patella and 10 cm below the patella were lower in the EG as compared with the CG ($P<0.05$) (A and B). * $P<0.05$ for number of patients at the same grade.

embolism after hip fracture. Therefore, how to effectively improve the blood hypercoagulation, reduce the DVT incidence and accelerate the blood circulation in the hip fracture patients has become a major focus of clinical studies [22].

At present, the dangers of DVT have been further understood in the clinic, and its preventa-

tive nursing is gradually being promoted. However, clinical nursing measures so far are not systematical, leading to the inapplicability of DVT preventative nursing in medical institutes. VTE PNM is a new concept emerging in recent years, in which, VT is a collective term of DVT and pulmonary thromboembolism. The significance of this nursing mode lies in reducing the VTE incidence, medical burden and

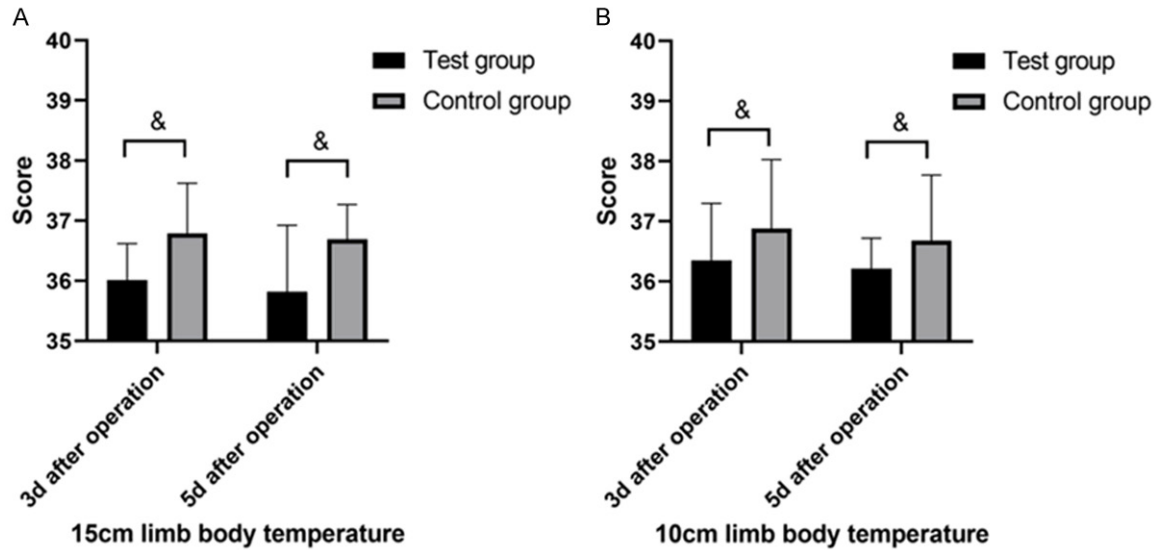
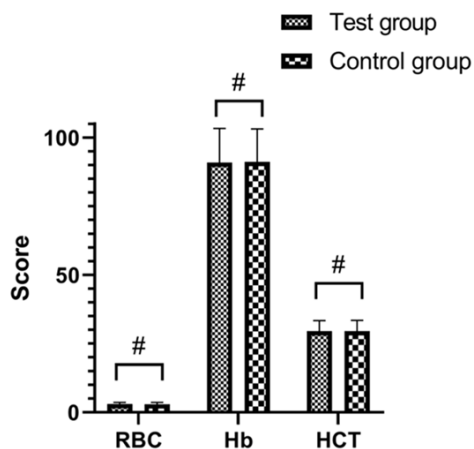


Figure 3. Limb temperatures at 3 d and 5 d after the surgery. At 3 d and 5 d after the surgery, the limb temperatures at 15 cm above the patella and 10 cm below the patella were lower in the EG as compared with the CG ($P < 0.05$) (A and B). & $P < 0.05$ for number of patients at the same grade.

Table 4. Intergroup comparison of anemia at 5 d after the surgery ($\bar{x} \pm s$)

Group	n	RBC ($\times 10^{12}/L$)	Hb (g/L)	HCT (%)
EG	108	2.98 ± 0.43	90.89 ± 8.77	29.51 ± 2.76
CG	86	2.93 ± 0.49	91.17 ± 8.43	29.49 ± 2.81
T	-	0.535	0.159	0.035
P	-	0.594	0.874	0.972



Index of anemia on the 5th day after operation

Figure 4. Anemia at 5 d after the surgery. Statistical difference was not found between the two groups in terms of RBC, Hb and HCT at 5 d after the surgery ($P > 0.05$). # $P > 0.05$ for number of patients at the same grade.

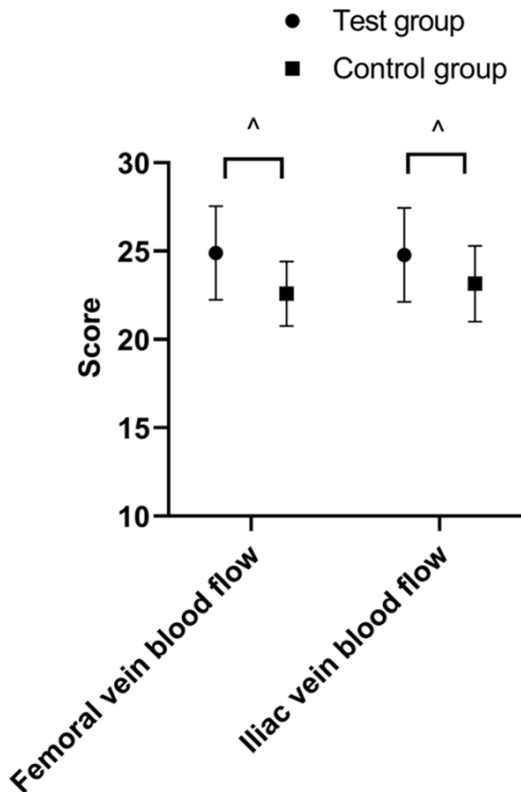
pain in patients through raising and regulating VTE preventions [23]. By setting up the EG

and the CG, this study analyzed the effects of VTE PNM on the DVT incidence, anemia and blood viscosity of hip fracture patients after the surgery. Results showed that, the DVT incidence was 1.85% in the EG and 11.63% in the CG, indicating that the preventative nursing management has practically reduced the postoperative DVT incidence of hip fracture patients. Some studies have categorized the causes of VTE as to hypostasis, vascular wall damage, and hypercoagulation. VTE PNM is capable to significantly improving the poor conditions and prognosis of hip fracture patients after surgery by reducing DVT incidence through basic preventative measures, drugs and physical measures [24]. Results also showed that, in comparison with common nursing, in preventative nursing mode, the common postoperative complications can be listed out through pre-stage analysis for targeted intervention to significantly raise the effectiveness and save medical resources [25].

In this study, the limb circumference and temperature (common indexes to identify the DVT after surgery) of the EG at 5 d after the surgery were significantly lower as compared with the CG patients, further indicating that the VTE PNM could improve prognosis. Compared with traditional nursing modes which are simple and poorly applicable, the VTE PNM is more comprehensive and has the advantages such as effectively promoting

Table 5. Intergroup comparison of blood flow velocity in femoral and popliteal veins at 5 d after the surgery ($\bar{x} \pm s$) (cm/s)

Group	N	Blood flow velocity in femoral vein	Blood flow velocity in popliteal vein
EG	108	24.89±1.87	24.78±1.88
CG	86	22.59±1.29	23.18±1.49
t	-	6.865	4.555
P	-	<0.001	<0.001

**Figure 5.** Blood flow velocities in femoral and popliteal veins at 5 d after the surgery. At 5 d after the surgery, the blood flow velocities in the femoral vein and the popliteal vein were higher in the EG ($P < 0.05$). ^ $P < 0.05$ for number of patients at the same grade.

blood backflow and circulation, and preventing hypostasis in the veins of lower limbs. As a result, limb swelling has improved noticeably. Limb temperature is an index positively correlated with inflammatory status. Studies have pointed out that a high inflammatory status accounts for the accelerate platelet aggregation (PA) process, which promotes thrombosis. The EG patients with lower limb temperature showed that VTE interventions also had a positive effect on improving inflammation

[26]. Besides, this study also analyzed the effects of VTE PNM on the anemia and blood viscosity of hip fracture patients, and found that it failed with the first condition because the intervention was too short to generate effects. In the meanwhile, the EG patients were not administered with anemia-improving drugs, which may have certain effects on the study results. The intergroup difference in blood flow velocity in femoral and popliteal veins at 5 d after the surgery also supported the conclusion that VTE PNM could improve the hypostasis after the surgery, and explained why the DVT incidence was lower in the EG.

In conclusion, VTE PNM can reduce the DVT incidence and improve the blood status of hip fracture patients, but fail to achieve marked effects with anemia. Shortages of the study include: (1) A limited number of subjects affected the scientificness of the results. We suggest to carry out random control experiments based on large sample size in the future, in order to verify the effects of VTE PNM on the DVT formation rate of hip fracture patients after the surgery. (2) Limited time and budget resulted in the failure of long-term follow-up recording. Only post-intervention effects were analyzed. In the next, long-term follow-up will be conducted with patients to understand the effects of VTE PNM on the long-term living quality of hip fracture patients.

Disclosure of conflict of interest

None.

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