ORIGINAL PAPER/PŮVODNÍ PRÁCE

Preoperative Incidence of Deep Venous Thrombosis and Its Risk Factors in Older Patients with Hip Fracture

Předoperační výskyt hluboké žilní trombózy a její rizikové faktory u starších pacientů se zlomeninou kyčle: retrospektivní studie

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ABSTRACT

Purpose of the study

Hip fractures in the elderly are commonly complicated by deep venous thrombosis (DVT), particularly in the preoperative phase. This retrospective study aimed to determine the preoperative incidence of DVT and identify its risk factors in older patients with hip fractures.

Material and methods

This single-center retrospective study enrolled 278 patients (aged ≥ 60 years) with unilateral hip fracture, who underwent color Doppler ultrasonography of the lower extremity veins on the day of surgery at the Second People's Hospital Affiliated to Fujian University of Traditional Chinese Medicine between 1st January 2015 and 31st December 2020. Demographic data, clinical characteristics, and surgical history were analyzed. Multivariate logistic regression was used to identify independent risk factors for preoperative DVT.

Results

The incidence of DVT was 15.5%, including peripheral venous thrombosis at 18.6% and central venous thrombosis at 5.4%. Univariate analysis showed no significant differences in gender, age, and type of fracture. However, delayed admission, longer time from admission to surgery, and atrial fibrillation were significant risk factors. Multivariate logistic regression analysis identified delayed admission (OR = 2.597, 95% CI 1.275–5.290, *P* = .009), prolonged time from admission to surgery (OR = 1.166, 95% CI 1.034–1.314, *P* = .012), and atrial fibrillation (OR = 2.848, 95% CI 1.115–7.275, *P* = .029) as significant independent risk factors for DVT.

Conclusions

Early admission and prompt surgery of elderly patients with hip fractures are critical to prevent the occurrence of DVT. Atrial fibrillation remains a significant risk factor that requires close attention. Prospective studies are warranted to validate these findings and optimize prophylactic strategies.

Key words: aged, deep vein thrombosis (DVT), hip fracture, incidence, risk factors.

INTRODUCTION

Hip fractures are a common fracture type in older adults. They mainly include femoral neck fractures and intertrochanteric fractures (14). Most of these fractures require surgical treatment (18). Deep venous thrombosis (DVT), predominantly in the lower limbs, poses a significant risk to patients undergoing surgery for hip fracture, especially in the elderly (5). DVT causes repeated swelling of the lower limbs, and the discharge of DVT into the pulmonary artery can lead to pulmonary embolism, which is life-threatening (4). Although most cases of DVT are asymptomatic, up to 40% of patients with DVT experience pulmonary embolism (12). Despite advancements in prophylactic measures and treatment strategies, the preoperative period

remains a critical window where the risk of DVT is considerably heightened due to factors such as immobilization and hypercoagulable state induced by trauma (21, 24).

Routine screening for preoperative lower-limb thrombosis is performed using ultrasound; however, the timing of ultrasound examination in most previous studies has varied from the day of admission to the day of surgery, which compromises the accuracy of the assessment (3, 15, 23). In this study, all patients underwent bilateral lower-extremity venous ultrasound on the day of surgery in order to provide a more accurate assessment and analysis. Understanding the prevalence of DVT and identifying its risk factors in the preoperative phase can facilitate early intervention, thereby improving patient outcomes.

MATERIAL AND METHODS

This retrospective study was approved by the institutional ethical review board of our institution (Second People's Hospital Affiliated to Fujian University of Traditional Chinese Medicine, Fuzhou, China). Data for 325 consecutive patients with hip fracture (including 140 patients with femoral neck fracture and 185 patients with intertrochanteric fracture) admitted to the Second People's Hospital Affiliated to Fujian University of Traditional Chinese Medicine from 1st January 2015 to 31st December 2020 were collected. The inclusion criteria were as follows: (1) age 60 years or higher; (2) unilateral hip fracture; (3) color Doppler ultrasonography of the iliac veins and the lower-limb veins performed on the day of operation; (4) complete clinical data available; (5) complete orthopedic surgery performed (internal fixation or joint replacement). The exclusion criteria were as follows: (1) multiple fractures; (2) open fracture; (3) tumor-induced fracture; (4) continuous anticoagulant therapy before injury (such as in patients with cerebral infarction); (5) surgical treatment not performed because of contraindication, or patients and their families chose conservative treatment; (6) a history of DVT before the injury. Eventually, the study included 278 patients with hip fracture, namely 96 men and 182 women, with an age range of 60–99 years and mean age of 80.94 years (standard deviation 8.18). There were 109 cases of femoral neck fracture and 169 cases of intertrochanteric fracture.

The complete clinical data of the cases were collected, including age, gender, fracture type (femoral neck fracture, intertrochanteric fracture), admission time (time from injury to admission), delayed admission (admission time > 48 hours), time from admission to surgery, comorbidities (hypertension, diabetes, atrial fibrillation), previous surgical history, and blood test results within 24 hours of admission (hemoglobin, thrombin time, fibrinogen, and D-dimer levels).

None of the patients had contraindications for anticoagulant therapy, so they were given low-molecular-weight heparin (LMWH sodium injection 5000 IU, once a day, Qilu Pharmaceutical Co., Ltd.). On the day of the operation, color Doppler ultrasonography of the iliac veins and lower-extremity veins was routinely performed. If venous thrombosis occurred in any anatomical part of both lower limbs, the patient was assigned to the DVT group. According to the ultrasonography results, the patients were divided into the DVT group (43 cases, 15.5%) and the non-DVT group (235 cases, 84.5%). All cases admitted to hospital received blood examination for hemoglobin, thrombin time, fibrinogen, and D-dimer levels at admission. DVT of the lower extremity can be divided into the peripheral type and the central type. The peripheral type includes thrombosis of the popliteal vein, tibial veins, peroneal veins, and intermuscular veins, whereas the central type includes thrombosis of the common iliac vein, internal iliac vein, external iliac vein, and common femoral vein. If ultrasound examination revealed DVT, and the thrombus was located in the popliteal vein or proximal, or it was a floating thrombus, the operation was suspended, evaluation was performed at the Department of Vascular Surgery, and an inferior vena cava (IVC) filter was used to prevent fatal pulmonary embolism if needed.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software (version 25.0; SPSS Inc., Chicago, IL, USA). The measurement data were first tested by Shapiro–Wilk test to determine whether they followed a normal distribution. The data conforming to the normal distribution and showing homogeneity of variance were expressed as $x \pm s$. The non-normally distributed data were compared using Wilcoxon rank-sum test and displayed as median and interquartile range. Independent-samples t test was used for comparison between groups. Count data were compared by χ^2 test; univariate analysis was performed first, and $P < 0.05$ was considered statistically significant. Multivariate analysis was performed using logistic regression analysis. $P < .05$ was considered statistically significant.

RESULTS

Patient characteristics

Of 278 patients with hip fracture who underwent lower-extremity vascular ultrasound examination, 43 cases (15.5%) had lower-extremity DVT, including 29 cases (18.6%) of peripheral venous thrombosis and 14 cases (5.4%) of central venous thrombosis, with 10 males (10.8%) and 33 females (16.5%).

Single-factor analysis of DVT of lower limbs in patients with hip fracture was performed. There were no significant differences in gender, age, fracture type, hemoglobin, fibrinogen,

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Table 1. **Univariate analysis of lower-limb DVT in patients with hip fracture**

	THROMBOSIS	NO THROMBOSIS	χ2/Z	P
Number	43	235		
Gender			2.376	0.123
Male (%)	10 (23.26)	83 (35.32)		
Female (%)	30 (76.74)	152 (64.68)		
Age [years, M (Q1, Q3)]	81.00 (76.00, 87.00)	82.00 (76.00, 86.50)	−0.378	0.706
Fracture type			0.002	0.962
Femoral neck (%)	17 (39.53)	92 (39.15)		
Intertrochanteric (%)	26 (60.47)	143 (60.85)		
Admission time [days, M (Q1, Q3)]	1.00 (0.25, 6.50)	0.42 (0.12, 1.00)		0.003
Delayed admission			9.696	0.003
Admission time > 48 h	18 (41.86)	47 (20.00)		
Admission time ≤ 48 h	25 (58.14)	188 (80.00)		
Time from admission to surgery [days, M (Q1, Q3)]	4.00 (2.00, 6.00)	3.00 (2.00, 4.00)	−2.799	0.005
Hemoglobin [g/L, M (Q1, Q3)]	107.00 (99.00, 121.50)	114.00 (103.00, 126.50)	−1.684	0.092
Fibrinogen [g/L, M (Q1, Q3)]	4.24 (3.55, 5.02)	4.08 (3.55, 4.90)	−0.878	0.380
Thrombin time [s, M (Q1, Q3)]	15.60 (15.00, 16.00)	15.80 (15.00, 16.70)	−1.605	0.108
D-dimer [mg/L, M (Q1, Q3)]	4.65 (2.96, 9.70)	5.68 (2.70, 12.34)	−0.489	0.625
Hypertension (%)	29 (67.44)	146 (62.13)	0.440	0.507
Diabetes (%)	9 (20.93)	65 (27.66)	0.843	0.359
Atrial fibrillation (%)			8.043	0.005
No	34 (79.07)	218 (92.77)		
Yes	9 (20.93)	17 (7.23)		
Operation history (%)			3.963	0.047
No	32 (74.42)	137 (58.30)		
Yes	11 (25.58)	98 (41.70)		

DVT = deep venous thrombosis.

thrombin time, hypertension, and diabetes between the DVT group and the non-DVT group ($P > 0.05$). However, there were significant differences in operation history, history of atrial fibrillation, delayed admission, and time from admission to surgery between the two groups ($P < 0.05$), as shown in Table 1.

Multivariate logistic regression analysis

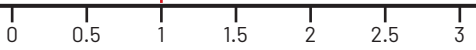
Multivariate logistic regression analysis was performed on the four high-risk factors identified by the univariate analysis—delayed admission, time from admission to surgery, atrial fibrillation, and operation history. The results showed that delayed admission (OR = 2.597, 95% CI 1.275–5.290, $P = 0.009$), time from admission to surgery (OR = 1.166, 95% CI 1.034–1.314, $P = 0.012$), and atrial fibrillation (OR = 2.848, 95% CI 1.115–7.275, $P = 0.029$) were independent risk factors for preoperative DVT of lower extremities in patients with hip fracture ($P < 0.05$), as shown in Table 2.

DISCUSSION

In this retrospective study, the preoperative incidence of DVT and its risk factors were evaluated in older patients with hip fractures. All of the patients underwent bilateral lower-extremity venous ultrasound on the day of surgery. The results yielded some important insights, namely a 15.5% incidence of DVT among the study participants, split between peripheral (18.6%) and central venous thrombosis (5.4%). The incidence of DVT among females and males was 16.5% and 10.8%, respectively.

Table 2. **Logistic regression analysis of lower-limb DVT in patients with hip fracture**

VARIABLE	OR(95%CL)	P
Delayed admission	2.597(1.275–5.29)	0.009
Admission time<=48h	1.166(1.034–1.314)	0.012
Admission time>48h		
Time from admission to surgery		
Atrial fibrillation		
No		
Yes	2.848(1.115–7.275)	0.029
Operation history		
No		
Yes	0.475(0.22–1.025)	0.058



Similarly, Atılgan et al. (1) reported that the incidence of DVT was higher in the female population. Nevertheless, the current analysis did not find a statistically significant difference in DVT incidence based on gender or some other single factors such as age, fracture type, and several laboratory parameters.

Chang et al. (3) reported the presence of diabetes and hypertension as potential risk factors and indicators for preoperative DVT in patients with lower-extremity fractures, but our results showed that hypertension and diabetes were not high-risk factors for lower-extremity DVT in patients with hip fracture. In contrast, atrial fibrillation was a significant risk factor for preoperative DVT with an OR of 2.848. Atrial fibrillation is an arrhythmia with the highest incidence, and the incidence of atrial fibrillation increases with age (6). It has been proven that atrial fibrillation contributes to intra-atrial blood stasis, which creates conditions for thrombus formation and thrombus embolization (20). Atrial fibrillation also contributes to a hypercoagulable state due to the irregular and often rapid heartbeat leading to inefficient blood flow and potential clot formation (16). The specific procoagulant conditions of atrial fibrillation include atrial enlargement, atrial contraction, endothelial cell hypertrophy and fibrosis, and secretion of procoagulant factors such as interleukin-6 (IL-6) and von Willebrand factor (vWF) (17). Motoki et al. (13) also reported that atrial fibrillation could be a risk factor for DVT, which can be explained by poor hemodynamics and abnormal hemostasis, such as increased levels of fibrinogen, D-dimer, factor VIII: C, β-thromboglobulin (β-TG), platelet factor 4 (PF4), and thrombin–antithrombin complex III (TAT). This association calls for heightened vigilance in managing patients with atrial fibrillation who are awaiting hip fracture surgery, possibly through more aggressive anticoagulant prophylaxis.

Since older patients have lower-limb braking in bed once they experience a hip fracture, the risk of venous thromboembolism increases with delayed admission (8). Bengoa et al. (2) also showed that the incidence of DVT in older hip fracture patients admitted to hospital more than 48 hours after injury was 17.1%. The bed-rest time of patients after injury actually includes both the time from injury to admission and the time from admission to surgery. Although previous studies have shown a decrease in the incidence of DVT due to anticoagulant intervention after admission (10), this study showed that the time from admission to surgery was also an independent risk factor for DVT. Most researchers have reported that the longer the patients stayed in bed and waited before surgery, the higher was the risk of preoperative venous thrombosis (9, 11, 19). Smith et al. (15) found that the average operation delay of patients with DVT was 5.7 days, while the average operation delay of patients without DVT was 3.2 days; the incidence of DVT was 14.5% when waiting for 1 day before surgery, and 33.3% when waiting for 7 days before surgery. Therefore, it is necessary to perform hip fracture surgery as early as possible to avoid waiting time before surgery, which is an important means to reduce the prevalence of DVT.

The results of univariate analysis showed that there was no significant difference in preoperative hemoglobin level, fibrinogen, thrombin time, and D-dimer between the DVT group and the non-DVT group. Because of hemorrhage after fracture, the observation index of hemoglobin needs further study. D-dimer levels are affected by many factors, with positive results observed in liver disease, inflammatory response, malignant tumors, pregnancy, trauma, and even recent surgery. Because older patients with hip fracture may have elevated D-dimer levels due to their underlying diseases and trauma, which are not related to DVT, D-dimer levels have

high sensitivity but low specificity in the diagnosis of venous thrombosis. So, there are limitations to using D-dimer alone to confirm DVT (7, 22).

Contrary to expectations, history of a previous surgery did not significantly increase the risk of DVT, as indicated by an OR of 0.475. Despite not reaching statistical significance, this finding introduces an interesting premise that previous surgical history does not necessarily increase the risk of DVT in the preoperative period for hip fracture. It could be hypothesized that these patients may receive more rigorous DVT prophylaxis due to their known medical history.

CONCLUSIONS

In conclusion, the study identified delayed admission, prolonged time from admission to surgery, and atrial fibrillation as significant independent risk factors for DVT. These findings underscore the importance of timely management in the prevention of thrombotic complications.

This study's findings must be interpreted in light of its limitations, including its retrospective nature and the inherent biases associated with such a study design. Additionally, the relatively small number of DVT cases compared with the non-DVT group could have affected the power of the study to detect smaller effects. Future research should focus on prospective studies to validate these findings, explore the mechanisms underlying the observed associations, and assess the efficacy of intervention strategies that could mitigate the identified risks. Expanding the sample size and including multicenter data could provide a more generalizable understanding of DVT risks in this population. ■

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Ethical Statement

This study has been approved by the Ethics Committee of Fujian Provincial Second People's Hospital, Affiliated Hospital of Fujian University of Traditional Chinese Medicine. All patients agreed to the use of data in the study by oral consent. The oral consent approval was documented in the patients' files, which was approved by the Ethics Committee of Fujian Provincial Second People's Hospital, Affiliated Hospital of Fujian University of Traditional Chinese Medicine. All clinical investigations were conducted in accordance with the guidelines of the Declaration of Helsinki.

Abbreviations

β-TG = β-thromboglobulin, DVT = deep venous thrombosis, IL-6 = interleukin-6, IVC = inferior vena cava, LMWH = low-molecular-weight heparin, PF4 = platelet factor 4, SPSS = Statistical Package for the Social Sciences, TAT = thrombin-antithrombin complex III, vWF = von Willebrand factor.

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