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Original Article

Clinical observation and perioperative management of lower extremity deep vein thrombosis after hip fracture among elderly patients

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Abstract: Objective: To investigate the clinical characteristics and to analyze the clinical risk factors of lower extremity deep vein thrombosis (DVT) after hip fracture among elderly patients. Methods: From October 2000 to April 2010, 95 patients who suffered from hip fracture were recruited, including 30 males (mean age 75.3±12.47 years, range 60-90 years) and 65 females (mean age 77.9±11.45 years, range 61-96 years). There were 55 cases with femoral neck fracture and 40 cases with intertrochanteric fracture. Color Doppler flow imaging (CDFI) was used to screen DVT of bilateral lower extremities in all patients before orthopedic surgery and within 14 days postoperatively. All patients were treated with operation and given low-molecular-weight heparin (LMWH) for 10-14 days postoperatively to prevent DVT. Results: There were 16 patients who developed DVT preoperatively and 20 patients postoperatively. The perioperative and postoperative incidences were 16.8% (16/95) and 21.1% (20/95) respectively. 87.2% DVT were found in fractured extremities. Logistic regression analysis demonstrated a definite association of intertrochanteric fracture with postoperative DVT with odds ratio of 5.977 ($P<0.05$). Conclusions: There was higher perioperative DVT incidence in fractured extremities than that in the uninjured side. Intertrochanteric fracture was a risk factor for postoperative DVT. Patients with hip fracture are at a high risk of lower extremity DVT and should be screened using color Doppler ultrasound blood flow imaging (CDFI) before orthopedics surgery. Routine usage of LMWH is an effective way to prevent DVT during perioperative period. Anticoagulant and inferior vena cava filter had been proved to be effective to prevent perioperative DVT.

Keywords: Elderly patients, hip fracture, deep vein thrombosis (DVT)

Introduction

Hip fracture among elderly patients includes intertrochanteric fracture and femoral neck fracture. Venous thromboembolism is a major problem after hip fracture because hip fracture patients exhibit all three risk factors called Virchow's triad due to trauma, immobilization, advanced age, and comorbidities. Therefore, several guidelines recommended mechanical and pharmaceutical prophylaxis for hip fracture patients to prevent low extremity deep vein thrombosis (DVT). DVT has a significant clinical impact due to its possibly severe sequelae including pulmonary embolism (PE). PE is the direct cause of roughly 10% of all hospital deaths [1].

DVT may occur both before and after operation [2]. There are many studies focusing in the incidence, prevention, and treatment of postoperative DVT related to hip fracture [3-6]. However, preoperative low extremity DVT has not received enough attention yet. It has been reported that preoperative low extremity DVT occurs in 9% to 62% of patients receiving mechanical and pharmaceutical prophylaxis [7, 8]. In fact, it has been anticipated by many clinicians the development of preoperative DVT in the interval between the time of hip fracture and surgery, because hip fracture patients cannot move the injured extremity during this period of time. Till date, there is no study in China to document the preoperative incidence of DVT in elderly patients with hip fracture.

The purpose of the present study was to establish the prevalence of DVT in elderly patients with hip fracture and to determine what risk factors might have influenced this prevalence. Specifically, we examined the correlation between the fracture type and the development of DVT.

Subjects and methods

Subjects

A total of 95 patients were admitted to our hospital from October 2000 to April 2010 due to hip fracture with average age of 77.1 ± 10.35 years. There were 30 males with mean age of 75.3 ± 12.47 years ranging from 60 to 90 years and 65 females with mean age of 77.9 ± 11.45 years ranging from 61 to 96 years. There were a total of 63 cases of femoral neck fractures with 21 males and 42 females and 32 cases of intertrochanteric fractures with 9 males and 23 females. Inclusion criteria: 1. Age 60 years or older; 2. Low-violence fractures; 3. New fractures. Exclusion criteria: 1. Long-term bedridden patients; 2 Past history of serious medical diseases; 3. Long-term use of anticoagulants; 4. Past history of thrombosis.

This study was approved by the Institutional Ethics Committee of Beijing Hospital & National Center of Gerontology.

All patients provided informed consent to voluntarily participate in this study.

Methods

Preoperative examination

In addition to routine hemoglobin, platelet, liver and kidney function, blood electrolyte, blood sugar, coagulation function, chest x-ray, and ECG, special examinations including blood-gas analysis, pulmonary function, and echocardiography were also done depending on patient's individual situation.

Diagnosis of DVT

All the patients had color Doppler ultrasound blood flow imaging (CDFI) examination using DIASONIC 2D gateway and PHILIPS IU22 to screen low extremity DVT after admission. The majority of patients had CDPI within 3 days after admission. All the patients had CDPI within 7 days after admission. CDPI examination was performed again at the 7 days and 14 days after operation.

Anesthesia and surgery

The methods of anesthesia including general, lumbar spine, lumbar spine plus lumbar plexus, and epidural depend on patient's individual situation. The surgery methods include femoral head replacement, total hip replacement, PFNa internal fixation, and Gamma nail internal fixation.

The treatment for DVT

Patients did not routinely take LMWH to prevent DVT after admission. For patients who were found low extremity DVT before operation, they were given subcutaneous injection of LMWH Calcium (Fraxiparine, Laboratoire GlaxoSmithKline) 0.4 mL bid until 12 hours before operation. In the emergent situation, the inferior vena cava filter was placed before operation. All patients were given subcutaneous injection of LMWH Calcium (Fraxiparine, Laboratoire GlaxoSmithKline) 0.4 mL once daily for patients without DVT and bid for patients with DVT for 10-14 days. The inferior vena cava filter was placed in some patients to prevent embolism.

Statistical analysis

Statistical analysis was performed using SPSS 13.0. The data were expressed as the mean ± standard deviation (SD). Differences were analyzed by one-way analysis of variance (ANOVA) followed by the Newman-Keuls test. χ^2 test was used for single variable; Logistic regression analysis was used for multiple variables. $P<0.05$ was considered statistically significant.

Results

The demographic data of elderly patients with hip fracture

There were a total of 63 cases of femoral neck fractures in this study with 21 males and 42 females and 32 cases of intertrochanteric fractures with 9 males and 24 females. The demographic and clinical characteristics of patients were summarized in **Table 1**. There was no difference between the two groups regarding the types of hip fracture (P=0.920).

Table 1. The demographic and clinical characteristics of patients with hip fracture

Indexes	Total n=95	Femoral Neck fracture n=63 (66.32%)	Intertrochanteric fracture n=32 (33.68%)	P
Male, n (%)	30 (31.58)	21 (33.33)	9 (28.13)	0.606
Age (Y), median (IQR)	76 (69-82)	75 (67-81)	80 (74-85)	0.035
Min	49	49	53	
Max	96	94	96	
Time from being injured to being admitted (D), median (IQR)	1 (1-7)	1 (1-12)	1 (1-2)	0.163
Min	1	1	1	
Max	1000	1000	365	
Time from being admitted to operation (D), median (IQR)	6 (5-9)	7 (5-9)	6 (5-9)	0.324
Min	1	2	1	
Max	65	65	30	
Platelets before operation[a], n (%)				1.000
H	13	9 (14.75)	4 (13.33)	
L	2	1 (1.64)	1 (3.33)	
N	76	51 (83.61)	25 (83.33)	
Anesthesia time (h), median (IQR)	2.8 (2.5-3.5)	2.9 (2.6-3.7)	2.7 (2.3-3)	0.092
Min	1.6	1.75	1.6	
Max	6	6	5.2	
Operation time (h), median (IQR)	1.8 (1.4-2.4)	2 (1.5-2.4)	1.7 (1.3-2)	0.117
Min	0.8	0.9	0.8	
Max	5.1	5.1	5	
Blood loss (ml), median (IQR)	300 (200-600)	400 (200-600)	300 (200-400)	0.202
Min	20	20	30	
Max	2000	2000	2000	
Blood transfusion[b], n (%)	63 (67.74)	39 (61.90)	24 (80.00)	0.081
Anticoagulant[c], n (%)	90 (97.83)	59 (96.72)	31 (100.0)	0.548
Perioperation Thrombus, n (%)	31 (32.63)	15 (23.81)	16 (50.00)	0.010
Anticoagulant Frequency (times/D)[d]				0.421
1	47 (52.22)	29 (49.15)	18 (58.06)	
2	43 (47.78)	30 (50.85)	13 (41.94)	

Note: a, 4 cases lost; b, 2 cases lost; c, 3 cases lost; d, 5 cases lost.

The clinical characteristics of DVT

The general clinical characteristics: Among 95 cases of elderly patients with hip fracture, there were 31 cases of DVT (32.6%). All of them were fresh blood clots. 15 (15.8%) cases were pre-operational DVT. 16 (16.8%) cases were post-operational DVT. In the preoperational DVT group, the 80-89 age group was up to 8 cases (53.3%) followed by 70-79 age group (6 cases, 40%) and 60-69 group (6.7%) (**Table 2**).

The locations of DVT

A total of 55 low extremity (LE) DVTs were found in 31 patients. There were 48 (87.2%) DVTs located in the injured LEs and 7 (12.8%) DVTs located in the intact LEs. DVTs in the injured LEs were significantly higher than the intact side. The analysis of specific locations showed that 24 (43.6%) DVTs were located in proximal veins including femoral vein, superficial femoral vein, and popliteal vein and 31 (56.4%) DVTs were located in distal veins including tibia vein, posterior tibia vein, peroneal vein, and intra-muscular vein. The χ^2 analysis showed that there was no significant difference regarding DVT locations between preoperative and post-operative thrombus.

The analysis of preoperative factors of lower extremity DVT

All of the patients were divided into two groups according to with or without preoperative DVT. Logistic regression analysis was performed using age, gender, fracture type, time from

Table 2. Comparison of characteristics of patients with and without preoperative DVTs

Characteristics	Without preoperative DVT n=80	With preoperative DVT n=15	P
Male, n (%)	27 (33.75)	3 (20.00)	0.454
Age (Y), median (IQR)	79 (71-81)	76 (69-84)	0.732
(D), median (IQR)	1 (1-12)	1 (1-2)	0.134
Time from being admitted to operation (D), median (IQR)	6 (5-9)	6.5 (5-9)	0.778
Platelets before operation[a], n (%)			0.783
H	12 (15.79)	1 (6.67)	
L	2 (2.63)	0 (0.00)	
N	62 (81.58)	14 (93.33)	
The types of fracture			0.246
Femoral neck fracture	55 (68.75)	8 (53.33)	
Intertrochanteric fractures	25 (31.25)	7 (46.67)	

Note: a, 4 cases lost.

Table 3. Comparison of characteristics of patients with and without postoperative DVTs

Characteristics	Without postoperative DVT n=76	With postoperative DVT n=19	P
Male, n (%)	26 (34.21)	4 (21.05)	0.270
Age (Y), median (IQR)	76 (68-82)	78 (73-84)	0.138
Time from being injured to being admitted (D), median (IQR)	1 (1-7)	1 (1-1)	0.879
Time from being admitted to operation (D), median (IQR)	7 (5-9)	5.5 (3-11)	0.215
Platelet before operation[a], n (%)			0.829
H	11 (15.28)	2 (10.53)	
L	2 (2.78)	0 (0.00)	
N	59 (81.94)	17 (89.47)	
Anesthesia time (h), median (IQR)	2.8 (2.5-3.5)	3.1 (2.6-3.7)	0.350
Operation time (h), median (IQR)	1.8 (1.4-2.4)	2 (1.3-2.7)	0.862
Blood loss (ml), median (IQR)	300 (200-600)	350 (200-600)	0.602
Blood transfusion[b], n (%)	50 (66.67)	13 (72.22)	0.651
Anticoagulant use[c], n (%)	72 (97.30)	18 (100.0)	1.000
Preoperative thrombus, n (%)	12 (15.79)	3 (15.79)	1.000
The types of fracture, n (%)			0.051
Femoral neck fracture	54 (71.05)	9 (47.37)	
Intertrochanteric fractures	22 (28.95)	10 (52.63)	
Anticoagulant Frequency[d]			0.020
1	42 (58.33)	5 (27.78)	
2	30 (41.67)	13 (72.22)	

Note: a, 4 cases lost; b, 2 cases lost; c, 3 cases lost; d, 5 cases lost.

being admitted to operation, and time from injury to operation as variables to screen risk factors. All ages were divided into three groups including 60~69, 70~79, and ≥80 groups. As shown in **Tables 2** and **4**, the incidences of preoperative DVT were 9.5%, 15.8% and 19.0% for 60~69, 70~79, and ≥80 groups respectively. Compared to male patients, female patients' incidence of preoperative DVT was higher (18.1% vs. 10.3%). Compared to femoral neck fracture, intertrochanteric fracture's incidence of preoperative DVT was higher (23.3% vs. 10.3%). However, χ^2 test performed for the above three factors individually showed that all of the *P* values were greater than 0.05 indicating no statistically significant difference.

Table 4. The analysis of multiple variables which affected the incidence of preoperative DVT

Variables	OR	95% CI		P
		min	max	
Age	0.984	0.923	1.049	0.613
The types of fracture				0.234
Intertrochanteric vs. femoral neck	2.145	0.610	7.538	
Gender				0.464
Female vs. male	1.761	0.388	7.993	
Time from being injured to being admitted (D)				0.198
>1 vs. ≤1	0.428	0.117	1.561	
Time from being admitted to operation (D)				0.538
> 6 vs. ≤6	1.482	0.424	5.179	
Platelet before operation				0.470
H vs. N/L	0.433	0.045	4.197	

Table 5. The analysis of multiple variables which affected the incidence of postoperative DVT

Variables	OR	95% CI		P
		min	max	
Age	1.120	0.970	1.294	0.122
Blood loss (ml)				0.478
>300 vs. ≤300	2.150	0.260	17.779	
The types of fracture				0.017
Intertrochanteric vs. femoral neck	12.013	1.566	92.171	
Gender				0.656
Female vs. Male	0.563	0.045	7.027	
Anticoagulant Frequency (times/D)				0.025
2 vs. 1	18.988	1.447	249.160	
Anesthesia time (h)				0.204
>2.8 vs. ≤2.8	5.398	0.400	72.929	
Operation time (h)				0.947
>1.8 vs. ≤1.8	0.912	0.062	13.518	
Blood transfusion				0.807
No vs. Yes	0.777	0.102	5.906	
Time from being injured to being admitted (D)				
>1 vs. ≤1	0.681	0.120	3.868	0.665
Time from being admitted to operation (D)				
>6 vs. ≤6	1.224	0.183	8.168	0.835
Preoperative platelet				
H vs. N/L	1.062	0.090	12.596	0.962

The analysis of postoperative factors of lower extremity DVT

All of the patients were divided into two groups according to with or without postoperative DVT. Logistic regression analysis was performed using age, gender, fracture type, time from being admitted to operation, time from injury to operation, anesthesia time, anesthesia method, operation time, and operation method as variables to screen risk factors. As shown in **Tables 3** and **5**, fracture type was important risk factor (P<0.05), OR= 5.977.

Clinical outcomes

There were a total of 11 cases of inferior vena cava filter placement. Among these 11 cases, 8 cases were from 18 patients who were found preoperative DVT and 3 cases were from 20 patients who were found postoperative DVT. All filters are permanent filters. Among 95 patients, one patient underwent right total hip replacement and was given subcutaneous injection of LMWH Calcium (Fraxiparine, Laboratoire GlaxoSmithKline) 0.4 mL once a day. Left common iliac vein and right femoral superficial vein thrombosis were found 8 days after operation. He died from pulmonary embolism 11 days after operation. Other patients recovered well after operation. All of them were discharged without severe complications including intraoperative and postoperative hemorrhage, cerebral hemorrhage. Heparin-induced thrombocytopenia (HIT).

Discussion

The 2009 guideline of thromboembolism prevention for major orthopedic surgery was promulgated to prove the enough attention of

orthopedic surgeons for thromboembolic diseases. The incidence of DVT after hip fracture is relatively high in China. The systematic research for risk factors, prevention and treatment, and case reports still lack. Lu Y et al. [9] reported that the incidence of DVT after hip fracture was 15.7%. There was report showing the incidence of DVT was 13% and incidence of PE was 1.3% in other countries.

Our results showed that the incidence of DVT among elderly population was 15.8% and 19.8% after hip fracture and after operation respectively. Although there was no obvious clinical manifestation, DVT among elderly population was one of the potential risk factors for fatal PE [10]. The patients with hip fracture are generally elderly, with decreased vascular elasticity and multiple comorbidities [11]. In addition, their lower extremities are often restricted with movement due to pain and joint injuries. All the above factors result in relatively slow blood flow after hip fracture. The endothelium of veins was injured by fractured end [12]. The excessive infiltration of inflammatory cells in surrounding tissues caused local edema [13]. Trauma led to increased platelet activity and decreased C-reactive protein which was anticoagulant [14]. Therefore, the incidence of lower extremities DVT was relatively high after hip fracture. Research has shown that the incidence was as high as 50.0% and 64.3% respectively after hip fracture and after total hip replacement without any thrombosis prevention measure [15].

In this study, we found that the incidence of DVT in the injured limb was much higher than that of the uninjured limb (87.2% vs. 12.8%, $P<0.01$). Postoperative restriction and pain limited movement of the injured limb. Prolonged supine position caused relatively slow blood flow. All these are major reasons of high incidence of DVT in the injured limb [16]. In addition, the endothelium of veins was injured by fractured end. The inflammatory factors affected endothelium through vessel walls to induce thrombosis [17]. The location of perioperative lower extremity DVT had no significant difference regarding preoperative vs. postoperative DVTs. Among those 19 cases of postoperative DVTs, 5 of them were found before operation. The location was as same as the preoperative DVTs. The clinicians should raise enough vigilance for this. Thorough screening should be done immediately after admission in order to find and treat thrombosis in time. For patients with perioperative DVTs which were found before operation, clinicians should focus on the original location of DVTs during follow-up. In this study, we found that DVTs happened in the distal locations more often than proximal location. Therefore, extra attention should be paid to the distal locations. Among distal DVTs, 20% of them would be extended upward to the popliteal vein 40-50% of which would develop PE eventually. Therefore, more aggressive treatment should be applied to distal DVTs.

The gold standard for DVT diagnosis is angiography [18]. However, it was invasive examination and cannot be repeated frequently. It was difficult to use angiography to monitor DVTs consistently and continuously. Therefore, it was not the routine method to monitor low extremities DVTs. Color Doppler ultrasound blood flow imaging (CDFI) had 88-98% sensitivity, 97-100% specificity, and 98% accuracy for DVT diagnosis [19]. It was non-invasive and relatively easy to operate so became the first-choice method to screen DVTs. CDFI can not only obtain 2-D images for vessel wall, vessel lumen, and surrounding structure but also monitor blood flow and collateral circulation [20]. It was used to determine location and size of thrombosis and the degree of obstruction of blood vessels. It was especially applicable for elderly population to monitor the development of blood clots, to facilitate timely treatment, and to observe the treatment effect. In this study, all 95 patients underwent CDFI.

In this study, we studied the fresh blood clots after hip fracture, namely the acute phase of venous thrombosis after hip fracture. The properties of thrombosis were easily determined by CDFI. We were trying to use statistical method to determine the best time to inspect CDFI. However, we were not able to obtain positive results due to limited sample size. The results showed that most DVTs happed from injury to the 3rd day. Accordingly, we suggested that CDFI should be done as soon as possible after admission for elderly patients with hip fractures in order to find and treat DVT in time. In addition, timey follow-up was also necessary measure to ensure patient safety.

The risk factors of thrombosis include age, gender, fracture type, obesity, immobilization,

comorbidities, history of thromboembolic disease, valvular insufficiency, laboratory results including blood type, coagulation function, platelet, and blood lipids, general anesthesia, anesthesia time, operation method, operation time, and blood loss during operation [21]. In this study, we determined that fracture type was one of the risk factors of postoperative DVT via statistical analysis. Compared with femoral neck fracture, the incidence of DVT among patients with intertrochanteric fracture was much higher which was nearly six times to that among patients with femoral neck fracture. The average age of patients with intertrochanteric fracture was higher than that of patients with femoral neck fracture. The patients with intertrochanteric fracture had more comorbidities including hypertension. Therefore their vascular endothelium was in relatively poorer condition. In addition, intertrochanteric fracture was located outside of joint capsule with more severe pain and edema which resulted in compression of blood vessels and movement restriction due to pain. All the above factors introduced higher incidence of lower extremity DVTs.

In summary, the incidence of hip fracture is expected to increase as the population ages. The development of DVTs after hip fracture directly affected the clinical outcomes and even threatens patients' life. Perioperative especially preoperative thromboembolism prevention, diagnosis, and treatment will more and more be taken seriously. Their importance will also more and more be highlighted. Among elderly patients with hip fractures, perioperative CDFI should be routinely performed in order to screen low extremity DVTs. Postoperative anticoagulation treatment with LMWH can effectively reduce the incidence of DVT. In addition, implantation of inferior vena cava filter is an important guarantee of success of surgery and patient safety.

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Disclosure of conflict of interest

None.

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