

# Incidence and Risk Factors for Deep Venous Thrombosis of Lower Extremity After Surgical Treatment of Isolated Patella Fractures

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## Research article

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# Abstract

**Background:** Limited information exists on the incidence of postoperative deep venous thromboembolism (DVT) in patients with isolated patella fractures. The objective of this study was to investigate the postoperative incidence and locations of deep venous thrombosis (DVT) of the lower extremity in patients underwent isolated patella fractures and to identify the associated risk factors.

**Methods:** We collected the medical data of 716 hospitalized patients with acute isolated patella fracture who presented at the 3rd Hospital of Hebei Medical University between January 1, 2016, and February 31, 2019 and all patients met the inclusion criteria. Medical data were collected using the inpatient record system, including the patient demographics, patient's bad hobbies, comorbidities, past medical history, fracture and surgery-related factors, and hematological biomarkers, total hospital stay, preoperative stay. Doppler examination was conducted for the diagnosis of DVT, Univariate analyses and multivariate logistic regression analyses were used to identify the independent risk factors.

**Results:** Among the 716 patients, DVT was confirmed in 29 cases, indicating an incidence of 4.1%. DVT involved bilateral limbs (injured and uninjured) in one patient (3.4%). DVT involved superficial femoral common vein in 1 case (3.4%), popliteal vein in 6 cases (20.7%), posterior tibial vein in 11 cases (37.9%), and peroneal vein in 11 cases (37.9%). The median of the interval between surgery and diagnosis of DVT was 4.0 days (range: 1.0 to 8.0 days). Six variables were identified to be independent risk factors for DVT, including age category (>65 years old), OR, 4.44 (1.34 - 14.71), arrhythmia, OR, 4.41(1.20 - 16.15), intra-operative blood loss, OR, 1.01 (1.00 - 1.02), preoperative stay (delay of each day), OR, 1.43 (1.15 - 1.78). Surgical duration, OR, 1.04 (1.03 - 1.06), LDL-C (> 3.37 mmol/L), OR, 2.98 (1.14 - 7.76).

**Conclusion:** Incidence of postoperative DVT in patients with isolated patella fractures is not low. More attentions should be paid on postoperative DVT prophylaxis in patients with isolated patella fractures. Identification of associated risk factors can help clinicians recognize the risk population, assess the risk of DVT and develop personalized prophylaxis strategies.

## Background

Deep vein thrombosis (DVT), is very common in hospitalized patients, peculiarly in patients with trauma. It is an important source of morbidity and may cause fatal pulmonary embolism (PE). So far, A fair number of researchers have investigated the occurrence of DVT in patients who had undergone orthopaedic major surgeries.[1] And the association between trauma and DVT was also well recognized, [2] numerous authors have studied DVT following major orthopaedic trauma, such as hip fractures,[3] pelvic-acetabular fractures,[4] spinal fractures.[5]

However, studies on the incidence of DVT in patients with isolated fractures of the lower extremity are limited. And just few studies focused on the thromboembolic events in femoral shaft fracture,[6] tibia fracture,[7] ankle fractures,[8] and calcaneal fractures.[9] To our knowledge, so far just two researches studied the incidence of DVT in isolated patella fractures.[10, 11] Patella fractures are relatively

uncommon in emergency department or orthopedics department and the reported incidence was 13.5/100,000 person/years in China.[12] Because such fracture is relatively minor, the risk of DVT as a complication is easily overlooked by orthopedic surgeons. Determining the incidence of postoperative DVT in patients with isolated patella fracture is conducive to improving orthopaedic surgeons' rational understanding of this kind of complication. Identification of associated risk factors can help clinicians recognize the risk population, assess the risk of DVT and develop personalized prophylaxis strategies. Given these above, we conducted the research to determine the incidence and location of postoperative DVT following acute isolated patella fractures and to identify the correlated independent risk factors.

## Methods

This is a retrospective study. The ethics committee of our institution (the 3rd Hospital of Hebei Medical University) approved this research before the start of the study.

## Inclusion And Exclusion Criteria

This research consisted of hospitalized patients with isolated patella fractures in our institution between January 1, 2016, and February 31, 2019. The demographic variables and clinical data were acquired from the medical records. Inclusion criteria were as follows: (a) age > 18 years old, (b) confirmed isolated patella fracture, (c) underwent operation treatment, and (d) with complete medical data. Exclusion criteria were as follows: (a) pathological fracture, (b) old fracture (treatment delayed > 3weeks), (c) open fracture, (d) concurrent with other fractures or cerebral trauma, (e) nonsurgical treatment, (f) incomplete clinical data, (g) administration of anticoagulants on admission for treatment of other illness (h) preoperative diagnosis of DVT and (i) patients who had suffered haemorrhagic stroke;

In our institution, we administered routine anticoagulant therapy to all the hospitalized patients with patella fractures (low molecular weight heparin, 2500–4100 IU once daily, subcutaneous injection). Mechanical thromboprophylaxis (ankle pump exercise) was also administered to each patient.

## Diagnosis Of Dvt

DVT in lower extremities was identified by duplex ultrasound scanning. We consulted doppler ultrasound reports to acquire the diagnostic data of DVT.

Duplex ultrasound scanning was conducted in postoperative patients with suspected clinical symptoms such as: swelling, lower limb pain, superficial varicose veins. The indication of DVT diagnosed by Doppler ultrasound is deep venous obstruction or constant intraluminal filling defect. Conventional scanning included: the common femoral vein, superficial femoral, deep femoral vein, popliteal vein, anterior tibial vein, posterior tibial vein and common fibular vein. Intermuscular vein thrombosis was excluded for less clinical significance.[13]

# Data Collection

Clinical data was collected using Electronic medical records (EMR). Data on patient demographic variables such as age, gender, BMI (body mass index) and patients' bad hobbies such as cigarette smoking, and alcohol consumption were assembled. When did the postoperative duplex ultrasound examinations conducted was also queried. Data on comorbidities collected in this study included: hypertension, diabetes mellitus, ischemic heart disease, arrhythmia, chronic lung diseases. Data on past medical history contained: history of cerebral infarction and previous surgery. Fracture-related data consisted of injury mechanism (low or high energy), fracture type (simple or comminuted). Surgery-related data included: ASA (American Society of Anesthesiologists) classification, anesthesia, surgical duration, intraoperative blood loss, tourniquet. Preoperative stay (from injury to operation) and total hospital stay were also included in the study. BMI ( $\text{kg}/\text{m}^2$ ) was grouped into four types: normal (18.5–23.9), underweight ( $< 18.5$ ), overweight (24.0–27.9), and obesity ( $\geq 28.0$ ). Age was categorized into three categories: between 18 and 44 years old, between 45 and 64 years old and  $> 65$  years old. Low energy damage was defined as the damage caused by falling from a standing height, and other damages, such as traffic accidents, falling from a height, were defined as high-energy injuries.

The biomarkers included TP (total protein) level, ALB (albumin) level, FBG (fasting blood glucose) level, RBC (red blood cell) count, WBC (white blood cell) count, NEUT (neutrophile) count, LYM (lymphocyte) count, HGB (hemoglobin) level, HCT (hematocrit), PLT (platelet), PDW (platelet distribution width), RDW (red cell distribution width), TC (total cholesterol) level, TG (triglyceride) level, LDL-C (low-density lipoprotein cholesterol) level, HDL-C (high-density lipoprotein cholesterol) level, very low-density lipoprotein (VLDL) level, and D-dimer level. All the biomarkers data were obtained from the laboratory tests that were closest to the diagnosis time of postoperative DVT.

## Statistical analysis

Continuous data were shown in the form of means and standard deviations (SD). Categorical data were shown in the form of numbers and percentages. Continuous variables were compared with Student t test (normal distribution) or Mann-Whitney U test (non-normal distribution). Categorical variables were compared with Chi-square or Fisher's exact test. A multivariate logistics regression model was established and stepwise backward elimination method was utilized to determine independent risk factors correlated with DVT. Variables with  $p < 0.10$  were kept in the final model, and the correlation strength was expressed in terms of OR (odds ratio) and 95% CI (95% confidence interval). The statistical test level was  $P < 0.05$ . Hosmer-Lemeshow (H-L) test was performed to assess the fitting degree of the final model, and  $p > 0.05$  indicated eligibility. All data were analyzed in SPSS23.0 (IBM, Armonk, New York, USA).

## Results

An amount of 716 patients with isolated patella fracture underwent surgical treatment met the inclusion criteria, consisting of 425 males and 291 females. The average age was  $51.3 \pm 14.6$  years (range: 18.0–92.0 years). The average preoperative stay (from injury to operation) was  $3.8 \pm 2.8$  days (range: 0–23.0 days) and the total hospitalization stay was  $11.8 \pm 5.4$  days (range: 2.0–44.0 days) in average. During the period of hospitalization, no one was diagnosed with symptomatic PE (pulmonary embolism). Of the 716 patients, 29 cases were diagnosed with postoperative DVT, and the incidence rate was 4.1%. One case (3.4%) developed DVT in bilateral limbs (injured and uninjured). DVT located in superficial femoral common vein in 1 case (3.4%), popliteal vein in 6 cases (20.7%), posterior tibial vein in 11 cases (37.9%), and peroneal vein in 11 cases (37.9%). None DVT involved anterior tibial vein. The median of the interval between surgery and diagnosis of DVT was 4.0 days (range: 1.0 to 8.0 days). The results of univariate analysis was presented in Table 1. A total of 11 variables were found significantly different between cases with DVT and with non-DVT, including: Age (continuous,  $p = 0.002$ ; categorical,  $p = 0.000$ ), hypertension ( $p = 0.008$ ), arrhythmia ( $p = 0.000$ ), chronic lung diseases [ $p = 0.038$ ], preoperative stay [ $p = 0.004$ ], intraoperative blood loss [ $p = 0.015$ ], surgical duration ( $p = 0.000$ ), LDL-C ( $> 3.37$  mmol/L) [ $p = 0.027$ ], HCT ( $<$  lower limit) [ $p = 0.021$ ], PLT ( $> 300 \times 10^9/L$ ) [ $p = 0.010$ ], D-dimer ( $> 0.3$  mg/L) [ $p = 0.007$ ]. Finally, variables significantly different in the univariate analysis and the variable of alcohol consumption [ $p = 0.051$ ] were involved in the multivariate model. Six variables were determined to be independent risk factors for DVT, including age category ( $> 65$  years old), OR, 4.44 (1.34–14.71), arrhythmia, OR, 4.41 (1.20–16.15), intra-operative blood loss, OR, 1.01 (1.00–1.02), preoperative stay (delay of per day), OR 1.43 (1.15–1.78). Surgical duration, OR, 1.04 (1.03–1.06), LDL-C ( $> 3.37$  mmol/L), OR, 2.98 (1.14–7.76). (Table 2). Hosmer and Lemeshow Test revealed good fitness of the final model ( $p = 0.727$ ).

Table 1  
Univariate analyses of risk factors associated with DVT of lower extremity following isolated patella fracture (Continued)

<b>Variables</b>	<b>Non-DVT (n = 687) Number (%)</b>	<b>DVT (n = 29) Number (%)</b>	<b>p</b>
Gender(male)	406(59.1)	19(65.5)	.491
Age(year)	51.0 ± 14.5	59.6 ± 14.6	.002
18–44	228(33.2)	6(20.7)	.000
45–64	338(49.2)	9(31.0)	
65 or older	121(17.6)	14 (48.3)	
BMI (kg/m <sup>2</sup> )			.937
18.5–23.9	412(60.0)	18(62.1)	
< 18.5	24(3.5)	0(0)	
24.0–27.9	185(26.9)	8(27.6)	
≥ 28.0	66(9.6)	3(10.3)	
Cigarette smoking	90(13.1)	4(13.8)	.784
Alcohol consumption	63(9.2)	6(20.7)	.051
Diabetes mellitus	71(10.3)	6(20.7)	.115
Hypertension	142(20.7)	12(41.4)	.008
Ischemic heart disease	41(6.0)	3(10.3)	.414
Arrhythmia	29(4.2)	7(24.1)	.000
Chronic lung diseases	6(0.9)	2(6.9)	.038
History of cerebral infarction	25(3.6)	2(6.9)	.300
History of any surgery	116(16.9)	8(27.6)	.136
Injury mechanism (high energy)	90(13.1)	3(10.3)	.665
Fracture type (comminuted)	69(10.0)	6(20.7)	.110

DVT: deep venous thrombosis; BMI: body mass index; ASA: American Society of Anesthesiologists; RBC: red blood cell, reference range: female,  $3.5-5.0 \times 10^{12}/L$ , males,  $4.0-5.5 \times 10^{12}/L$ ; HGB: hemoglobin, reference range: females, 110–150 g/L, males, 120–160 g/L; FBG: fasting blood glucose; HCT: hematocrit, 40–50%; WBC: white blood cell; NEUT: neutrophile; LYM: lymphocyte; PLT: platelet,  $100-300 \times 10^9/L$ ; TP: total protein; ALB: albumin; RDW: red cell distribution width; PDW: platelet distribution width; TC: total cholesterol; TG: triglyceride; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; VLDL: very low-density lipoprotein

Variables	Non-DVT (n = 687)	DVT (n = 29)	p
	Number (%)	Number (%)	
Preoperative stay	3.0 ± 1.8	4.8 ± 3.2	.004
Total hospital stay	11.9 ± 6.6	13.4 ± 6.9	.238
Anesthesia (general)	32(4.7)	3(10.3)	.164
ASA class			.174
III and above	33(4.8)	3(10.3)	
I and II	654(95.2)	26(89.7)	
Intra-operative blood loss	98.5 ± 42.8	126.9 ± 58.4	.015
Surgical duration	95.5 ± 30.3	139.3 ± 37.8	.000
Tourniquet use (yes)	553(80.5)	26(89.7)	.219
TP (< 60 g/L)	327(47.6)	11(37.9)	.307
ALB (< 35 g/L)	202(29.4)	5(17.2)	.157
FBG (> 6.1 mmol/L)	209(30.4)	7(24.1)	.470
TC (> 5.2 mmol/L)	53(7.7)	3(10.3)	.489
TG (> 1.7 mmol/L)	149(21.7)	5(17.2)	.568
LDL-C (> 3.37 mmol/L)	180(26.2)	13(44.8)	.027
VLDL (> 0.78 mmol/L)	147(21.4)	5(17.2)	.592
HDL-C (< 1.1 mmol/L)	189(27.5)	7(24.1)	.690
WBC (> 10 × 10 <sup>9</sup> /L)	141(20.5)	5(17.2)	.667
NEUT (> 6.3 × 10 <sup>9</sup> /L)	248(36.1)	11(37.9)	.084
LYM (< 1.1 × 10 <sup>9</sup> /L)	108(15.7)	5(17.2)	.796
RBC (< lower limit)	146(21.3)	9(31.0)	.210
HGB (< lower limit)	148(21.5)	10(34.5)	.100

DVT: deep venous thrombosis; BMI: body mass index; ASA: American Society of Anesthesiologists; RBC: red blood cell, reference range: female, 3.5–5.0 × 10<sup>12</sup>/L, males, 4.0–5.5 × 10<sup>12</sup>/L; HGB: hemoglobin, reference range: females, 110–150 g/L, males, 120–160 g/L; FBG: fasting blood glucose; HCT: hematocrit, 40–50%; WBC: white blood cell; NEUT: neutrophile; LYM: lymphocyte; PLT: platelet, 100–300 × 10<sup>9</sup>/L; TP: total protein; ALB: albumin; RDW: red cell distribution width; PDW: platelet distribution width; TC: total cholesterol; TG: triglyceride; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; VLDL: very low-density lipoprotein

Variables	Non-DVT (n = 687)	DVT (n = 29)	p
	Number (%)	Number (%)	
HCT (< lower limit)	121(17.6)	10(34.5)	.021
PLT (> 300 × 10 <sup>9</sup> /L)	42(6.1)	6(20.7)	.010
PDW (> 18.1%)	13(1.9)	1(3.4)	.442
RDW (> 16.5%)	6 (0.9)	0(0)	.780
D-dimer (> 0.3 mg/L)	299(43.5)	20(69.0)	.007

DVT: deep venous thrombosis; BMI: body mass index; ASA: American Society of Anesthesiologists; RBC: red blood cell, reference range: female, 3.5–5.0 × 10<sup>12</sup>/L, males, 4.0–5.5 × 10<sup>12</sup>/L; HGB: hemoglobin, reference range: females, 110–150 g/L, males, 120–160 g/L; FBG: fasting blood glucose; HCT: hematocrit, 40–50%; WBC: white blood cell; NEUT: neutrophile; LYM: lymphocyte; PLT: platelet, 100–300 × 10<sup>9</sup>/L; TP: total protein; ALB: albumin; RDW: red cell distribution width; PDW: platelet distribution width; TC: total cholesterol; TG: triglyceride; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; VLDL: very low-density lipoprotein

Table 2

Multivariate analyses of risk factors associated with DVT of lower extremity following isolated patella fracture

Risk factors	OR (95% CI)	P
Arrhythmia	4.41(1.20–16.15)	.025
Intra-operative blood loss	1.01 (1.00–1.02)	.023
Surgical duration	1.04 (1.03–1.06)	.000
Preoperative stay (delay of each day)	1.43 (1.15–1.78)	.001
LDL-C (> 3.37 mmol/L)	2.98 (1.14–7.76)	.025
Age category		.019
18–44	Reference	
45–64 (1)	1.26 (0.39–4.04)	.700
65 or older (2)	4.44 (1.34–14.71)	.015

DVT: deep venous thrombosis; OR: odds ratio; CI: confidence interval; LDL-C: low density lipoprotein cholesterol

Figure 1. Exclusion criteria and the eligible cases included in this study

## Treatment Of Diagnosed Postoperative Dvt Cases

Three of the diagnosed cases (two located in popliteal vein, one in superficial femoral common vein) of DVT was treated with insertion of retrievable IVCF (inferior vena cava filters) and anticoagulation therapy. The other diagnosed cases of DVT were treated with intravenous infusion of heparin during hospitalization, and oral warfarin for a duration of three months after discharge. APTT (activated partial thromboplastin time) was used to monitor the therapeutic level of heparin and INR (international normalized ratio) was used to monitor the therapeutic level of warfarin.

## Discussion

Multiple researches have focused on the incidence of DVT following surgical treatment of the lower extremity fractures. However, many researchers failed to differentiate specific fracture sites,[14, 15] other few studies found the incidence of DVT at each anatomic location of the fracture varies greatly.[7, 11] In our research, the result showed the incidence rate of DVT in isolated patella fractures was 4.1%. Jared A et al.[10] studied the incidence rate of postoperative VET (venous thromboembolism) in patients with lower extremity trauma from 2008 to 2016 in the United States, the results showed that the incidence rate of DVT in patients with patella fractures over the study was 0.6% and ranged from 0.0–1.5%, but the specific locating of the DVTs was not mentioned in his study. In Wang et al.'s [11] study a small cohort of 59 patients with isolated patella fractures were included, the DVT was categorized into proximal DVT (localized in the popliteal vein or proximally) and distal DVT (localized distal to popliteal vein), the postoperative incidence rate of proximal DVT was 1.7% (1/59) and distal DVT was 23.7% (14/59). In our research, the incidence rate of proximal and distal DVT was 1.0% (7/716) and 3.1% (22/716) respectively. Intermuscular vein blood clot was excluded in our research, while involved as the distal DVT in Wang et al.'s[11] study, this may explain the higher incidence of distal DVT in Wang et al.'s[11] study.

Both of the above studies indicated that DVT following isolated patella fractures mostly referred to the calf vein (gastrocnemius, soleal, anterior tibial, posterior tibial, and peroneal veins). However, controversy exists on the treatment of isolated calf DVT, and the effect of anticoagulation on the morbidity and mortality of calf DVT was inconclusive.[13, 16–19] Treatment recommendations included just observation with monitoring, and anticoagulation therapy, further investigations are needed to determine the ideal treatment option. In this study, three (one in femoral common vein, two in the popliteal vein) of the diagnosed cases of DVT received insertion of retrievable IVCF (inferior vena cava filter) followed by anticoagulation therapy, other DVTs were administrated with intravenous infusion of heparin during hospitalization, and oral warfarin for a duration of three months after discharge under monitoring. None of the cases was diagnosed as symptomatic PE.

The risk of PE and mortality grew greatly due to the complication of DVT in patients undergone major orthopedic surgeries. Chemical thromboprophylaxis has become a routine procedure after major orthopedic surgeries.[20, 21] However, routine use of chemical prophylaxis in isolated lower extremity fractures is controversial. According to the 9th American College of Chest Physicians Evidence-Based Clinical Practice Guideline:[22] the use of thromboprophylaxis is recommended in high risk situations, such as patients undergoing major joint surgery in hips and knees or hip fracture surgery, but not

recommend in patients with isolated lower-leg injuries need leg immobilization. Despite the guideline do not recommend chemical thromboprophylaxis, multiple studies[23] have investigated the impact of chemical prophylaxis on lower extremity fractures. Se-Jun Park et al. [14] performed a study to compare the incidence of thrombus treated with and without thromboprophylaxis in patients with lower extremity fractures and concluded that thromboprophylaxis could decrease the incidence of postoperative VTE. By comparison, Zheng et al. [8] performed a study to inquire into the influence of chemical thromboprophylaxis on postoperative DVT in patients underwent foot and ankle fractures and concluded that it was unnecessary to administrate routine chemical thromboprophylaxis in such fractures. In contrast to the controversy over whether routine chemoprophylaxis was necessary for lower limb fractures, studies[20, 21, 24] have shown that DVT seemed to be unpreventable in major orthopedic trauma despite adherence to modern prophylactic protocols. In both this and Wang et al.'s[11] study, the incidence rate of DVT was not low despite all patients received routine thromboprophylaxis. We believe that routine prophylaxis should be recommended in operative patients with isolated patella fractures.

Identification of risk factors for postoperative DVT in patients underwent patella fractures is of great significance. In our study, multivariate analysis revealed that age category (age > 65 years old), arrhythmia, intra-operative blood loss, surgical duration, preoperative stay (each day delay in surgery), LDL-C (> 3.37 mmol/L) are independent risk factors for postoperative DVT in patients with isolated patella fractures. It is commonly recognized that increased age was correlated with increased occurrence of DVT, despite a few studies resulted that no correlation could be identified between the occurrence of thromboembolic events and age.[25] With increase of age, the vascular system gradually aged. Advanced age has been identified to be a independent risk factor for DVT in patients with lower extremity fractures in multiple studies: Lee SY et al. [26] got the result that the relative risk of DVT was five times increment in patients 50–69 years old and 10 times increment in patients > 70 years old contrast with patients < 49 years old in his study. Se-Jun Park et al. [14] got similar result, he found an advanced age > 60 years was one independent risk factor for DVT. In this study, patient age was divided into three categories, despite significant difference was not found between the category of age 18–44 years old and age 45–64 years old ( $p = 0.700$ ), risk for DVT significantly increased in the category of age > 65 years old, OR 4.44 (1.34–14.71), ( $P = 0.015$ ). This is slightly different with the Lee SY et al's result. [26]. And this implied that the effect of increased age on occurrence of DVT may be the outcome of blood vessels aging rather than increased age itself, and there were individual variations in vascular aging.

Multiple studies have tried to analyze the effect of various comorbidities on the occurrence of DVT, comorbidities such as hypertension, coronary heart disease, arrhythmia, diabetes mellitus, and chronic lung disease had been reported to be risk factors for DVT in different studies.[27] However, the results from these studies were not entirely consistent with each other. In our study, only arrhythmia was found to be a predictor for DVT in patients undergone isolated patella fracture surgeries. In fact, the relation between comorbidities and occurrence of DVT is very complicated and may be related to individual variations. Blood lipids had been identified to be etiologic factor for DVT in previous studies, [28, 29] consistent with this, we found LDL-C (> 3.37 mmol/L) was a risk factor for DVT in patients undergone

patella fracture surgeries. Previous study [30] demonstrated the lower HGB was correlated with DVT, however, we didn't found this association.

Delayed operation meant prolonged immobilization of the wounded lower extremity, which was one of the main etiological factors for DVT in trauma patients. Smith et al. [31] found the daily increment incidence was 14.5% if operation was delayed > 1 day, while it was 33.3% if the operation was delayed > 7 days in a prospective study. Similarly, in this study, we found each additional day operation delayed was correlated with an 43% increment incidence of DVT. The average preoperative stay was 4.8 days in cases with DVT, by comparison, just 3.0 days in cases without DVT ( $p < 0.001$ ). The reasons for delay in surgery in our institution were mainly as follows: A considerable number of patients were referred to our hospital from lower level hospitals, which may prolonged the preoperative stay to some extent. Another important reason was multi-disciplinary consultation and preoperative evaluation in the elderly patient for severe comorbidities.

The surgery related factors were reported to influence the occurrence of postoperative DVT. one study showed that an increase in surgical duration was closely correlated with an increase in the risk for VTE, [32] we got the similar result in our study, surgical duration was identified to be one of the risk factors for DVT in the multivariate model. A longer surgical duration often accompanied with a more intra-operative blood loss, which was also identified to be risk factor for DVT in our study. While other surgery related factors such as anesthesia, ASA class, tourniquet use was not identified to be risk factors for postoperative DVT in patient with isolated patella fracture, which is not consistent with some other researches.[27]

There are some deficiencies in our research. First of all, the research was retrospective, to some extent, affected the precision of the data. Secondly, some cases were abandoned for incomplete data, though randomly, this may have some influence on the results. Thirdly, this was a single-center study, and multi-center study are needed in the future. Fourthly, doppler ultrasound scanning was conducted only in the patients clinically suspected, also the thrombus monitoring was limited to hospitalization, and the thrombus situation after discharge is not continuously monitored, which may lead to underestimation of the incidence of DVT.

## Conclusion

Incidence of postoperative DVT in patients with isolated patella fractures is not low. More attentions should be paid on postoperative DVT prophylaxis in patients with isolated patella fractures. Identification of associated risk factors can help clinicians recognize the risk population, assess the risk of DVT and develop personalized prophylaxis strategies.

## Abbreviations

DVT: Deep venous thrombosis; VET: venous thromboembolism; PE: pulmonary embolism; BMI: Body mass index; EMR: Electronic medical records;

ASA: American Society of Anesthesiologists; SD: Standard deviation; OR: Odds ratio; CI: confidence interval; RBC: Red blood cell; HGB: Hemoglobin; ALB: Albumin; FBG: Fasting blood glucose; HCT: Hematocrit; WBC: White blood cell; NEUT: Neutrophile; LYM: Lymphocyte; PLT: Platelet; TP: Total protein; PDW: Platelet distribution width; RDW: Red cell distribution width; TC: Total cholesterol; TG: Triglyceride; LDL-C: Low-density lipoprotein cholesterol; HDL-C: High-density lipoprotein cholesterol; VLDL: Very low density lipoprotein

APTT: activated partial thromboplastin time; INR: international normalized ratio.

IVCF: inferior vena cava filter

## **Declarations**

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### **Authors' contributions**

Yingze Zhang designed the study. Jian Zhu, Dandan Ye and Xiaodong Cheng inquired the EMR for data interest. Hongzhi HU and Xiangtian Deng searched relevant literature. Yanbin Zhu analyzed and interpreted the data. Zhanchao Tan wrote the manuscript, and Yingze Zhang approved the final version of the manuscript. The authors read and approved the final manuscript.

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### **Availability of data and materials**

All the data will be available upon motivated request to the corresponding author of the present paper.

### **Ethics approval and consent to participate**

This study was approved by the ethics committee of the 3rd hospital of Hebei Medical University. Informed consent was obtained from all the participants.

### **Consent for publication**

Written informed consent was obtained from each patient to authorize the publication of their data.

## Competing interests

The authors declare that they have no competing interests.

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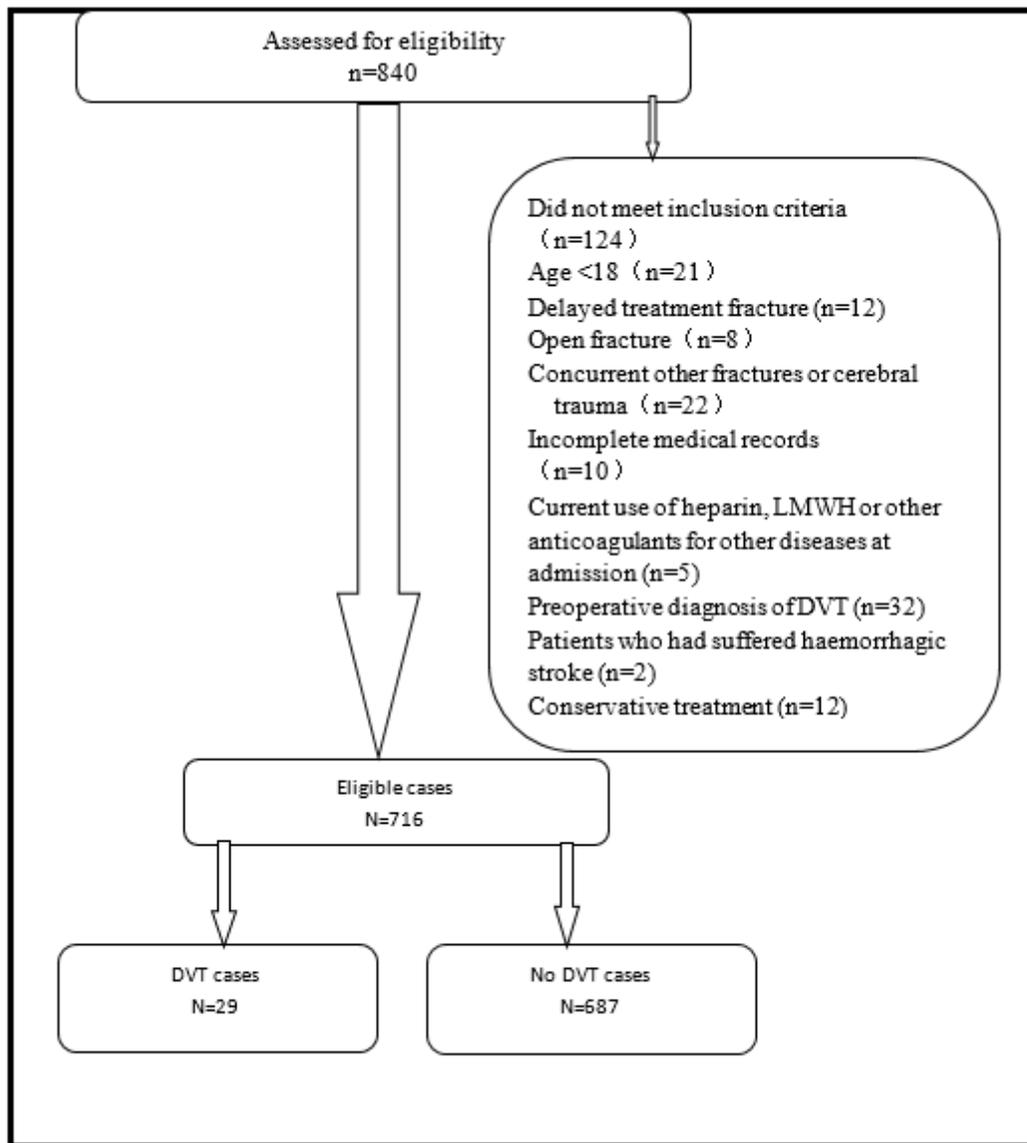
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33. Declaration.

## Figures



**Figure 1**

Exclusion criteria and the eligible cases included in this study