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Original Article

Correlation between ABO blood type and lower extremity deep vein thrombosis in elderly patients following hip fracture

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Abstract: Objective: To examine the correlation between ABO blood type and the incidence of lower extremity deep vein thrombosis (LEDVT) in elderly patients after hip fracture surgery, while identifying contributing factors to thrombogenesis. Methods: We conducted a retrospective analysis of 159 elderly patients with hip fractures treated at Tianjin Hospital (Affiliated Hospital of Tianjin University) from December 2021 to December 2023. The cohort was divided into two groups: those with O blood type (45 patients) and those with non-O blood types (114 patients). We analyzed clinical data and the incidence of LEDVT between the groups. Logistic regression was used to identify independent risk factors for LEDVT, and receiver operator characteristic (ROC) curve analysis evaluated the predictive efficacy of these factors. Results: The incidence of LEDVT was significantly higher in the non-O blood type group compared to the O blood type group (34.21% vs. 15.56%, P = 0.0408). Logistic regression identified high body mass index (BMI), comorbid hypertension, low platelet count (PLT), prolonged prothrombin time (PT), and non-O blood type as independent risk factors for LEDVT. The ROC curve for these predictors showed an area under the curve of 0.862, with a sensitivity of 75.22%, a specificity of 86.96%, and an accuracy of 78.62%. Conclusion: ABO blood type is correlated with the occurrence of LEDVT in elderly patients' post-hip fracture. Those with non-O blood type, alongside other factors such as high BMI, hypertension, low PLT, and extended PT, are at increased risk of developing LEDVT.

Keywords: ABO blood type, hip fracture, lower extremity deep vein thrombosis, correlation analysis, risk factors

Introduction

Hip fractures are commonly diagnosed in elderly patients and frequently necessitate surgical intervention in orthopedics [1]. Post-surgery, these patients often face restricted mobility due to mandatory bed rest, leading to decreased blood flow in the lower limbs. This reduction in mobility and blood flow substantially elevates the risk of lower extremity deep vein thrombosis (LEDVT) [2].

LEDVT, characterized by the formation of blood clots in the deep veins of the lower extremities, is a significant peripheral vascular disease and the most prevalent complication following hip fracture [3]. Epidemiological studies indicate a rising annual incidence of LEDVT [4], with a notable proportion of cases associated with post-hip fracture conditions [5]. Thus, understanding the factors influencing LEDVT formation and implementing early preventative measures, along with timely and accurate diagnosis and treatment, is crucial.

The development of LEDVT involves multiple factors, including prolonged bed rest, surgical intervention, trauma, genetic predispositions, and more [6]. Nonetheless, LEDVT can occur even in the absence of clear precipitating factors [7]. Notably, individuals with non-O blood types exhibit a higher prevalence of LEDVT compared to those with type O blood. While common risk factors for LEDVT are well-recognized, the potential link between ABO blood type and thrombosis risk is frequently underestimated or overlooked.

This study aims to explore the correlation between ABO blood type and the incidence of

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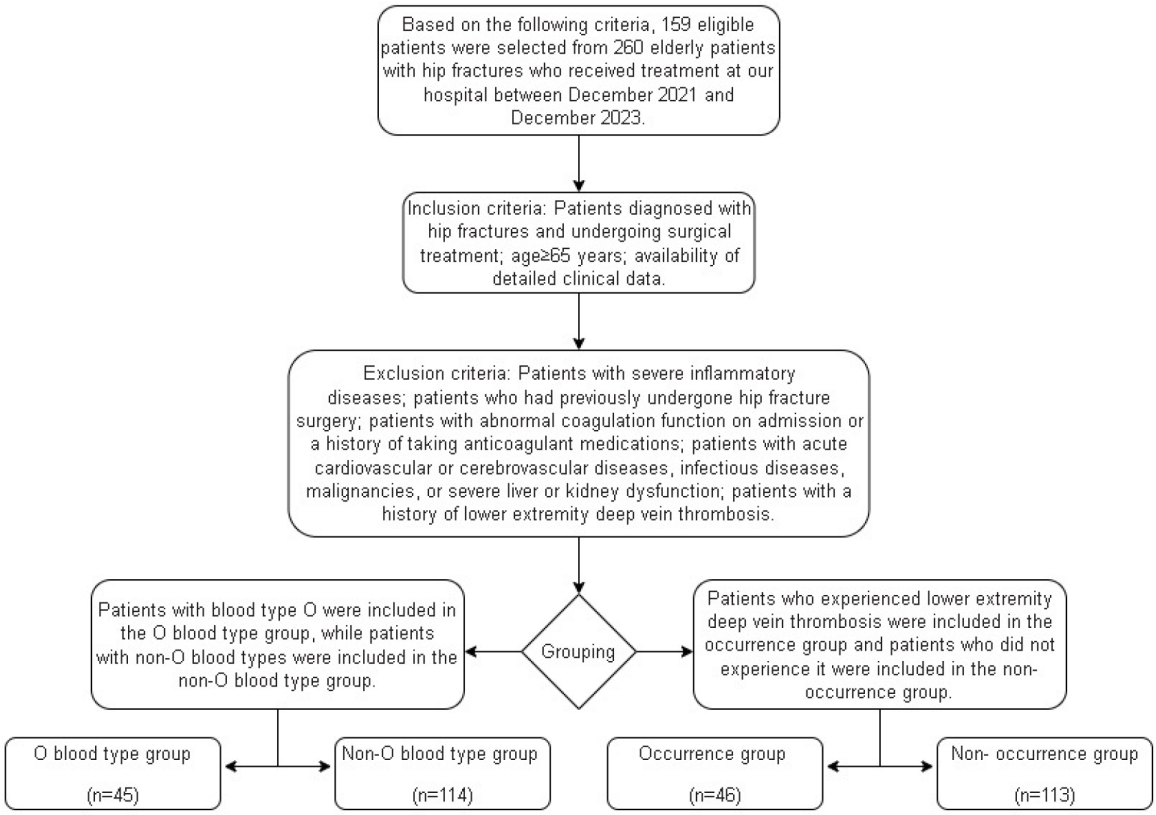

Figure 1. Screening and grouping process.

LEDVT in elderly patients post-hip fracture, focusing also on the influencing factors of thrombus formation.

Materials and methods

Clinical data

This retrospective study was conducted with approval from the Medical Ethics Committee of Tianjin Hospital (Affiliated Hospital of Tianjin University). A total of 260 elderly patients with hip fractures treated at Tianjin Hospital from December 2021 to December 2023 were initially screened. Ultimately, 159 patients met the eligibility criteria and were included in the study. Inclusion criteria were as follows: patients diagnosed with hip fractures who underwent surgical treatment; patients aged 65 years or older; and patients with comprehensive clinical data available. Exclusion criteria included: patients with severe inflammatory diseases; those who had previous hip fracture surgery; those with abnormal coagulation function at hospital admission or a history of anticoagulant use; and those suffering from acute cardiovascular or cerebrovascular diseases, infectious diseases, malignant tumors, or severe hepatic or renal dysfunction; as well as those with a history of LEDVT. We collected data on age, gender, body mass index (BMI), smoking history, alcohol consumption, comorbid hypertension, comorbid diabetes, occurrence of LEDVT, platelet count (PLT), prothrombin time (PT), and activated partial thromboplastin time (APTT) from the enrolled patients.

Grouping

Patients were categorized into two groups based on their ABO blood type: 45 patients with O blood type were placed in the O blood type group, and 114 patients with non-O blood types in the non-O blood type group. Further classification was based on the occurrence of LEDVT: 46 patients who developed LEDVT were assigned to the occurrence group, while the remaining 113 who did not develop LEDVT were placed in the non-occurrence group. The grouping is illustrated in **Figure 1**. Diagnostic criteria for LEDVT included: (1) clinical symptoms such as limb swelling, severe pain, tenderness in the femoral triangle or calf, dark red skin coloration, elevated temperature in the affected

Table 1. Comparison of clinical data

Factors	O blood type group (45)	Non-O blood type group (114)	*P* value
Age	80.3±76	79.3±7.6	0.4614
Sex			0.3544
Male	16	32	
Female	29	82	
BMI	23.4±4.49	23.15±4.15	0.8768
Smoking history			0.9765
Yes	6	15	
No	39	99	
Alcohol consumption history			0.2055
Yes	6	8	
No	39	106	
PLT (10^9/L)	238.49±77.12	224.63±77.74	0.4278
PT (s)	12.18±0.93	12.13±0.96	0.7323
APTT (s)	29.47±3.09	30.40±3.03	0.9927
Comorbid hypertension			0.3030
Yes	20	61	
No	25	53	
Comorbid diabetes			0.0556
Yes	17	26	
No	28	88	

BMI, Body mass index; PLT, platelet count; PT, prothrombin time; APTT, activated partial thromboplastin time.

limbs, superficial vein dilation, and a positive Homans sign; (2) confirmation through diagnostic imaging such as Doppler ultrasound, venous flow imaging, or venography; and (3) elevated plasma D-dimer levels above the normal range during the acute phase [7].

Methods

To assess comparability, clinical data from the O blood type group and non-O blood type group were compared. The incidence of LEDVT in both groups was analysed. Logistic regression was used to identify factors influencing thrombus formation, with the occurrence of LEDVT as the dependent variable. A ROC curve was constructed to evaluate the predictive efficacy of the identified risk factors in predicting LEDVT.

Statistical analysis

Statistical analysis was performed using SPSS 20.0. Categorical data were presented as n (%) and analysed using chi-square tests for intergroup comparisons. Continuous data were expressed as mean ± standard deviation and compared using t-tests. Logistic regression was utilized to determine the factors influencing thrombus formation. ROC curves, generated using GraphPad Prism 7, assessed the combined predictive value of these factors for LEDVT. A *p*-value <0.05 was considered statistically significant.

Results

Comparison of clinical baseline data

A comparison of clinical data between the O blood type group and the non-O blood type group revealed no significant differences in age, sex, BMI, smoking history, alcohol consumption history, and other factors (all P> 0.05), indicating comparability between the groups (**Table 1**).

Comparison of incidence of LEDVT

The incidence of LEDVT was significantly different between the groups: 7 out of 45 individuals (15.56%) in the O blood type group and 39 out of 114 individuals (34.21%) in the non-O blood type group developed LEDVT. This indicates a notably lower incidence of LEDVT in the O blood type group (P = 0.0194, **Figure 2**).

Analysis of influencing factors for LEDVT

Significant differences were observed between the occurrence group and the non-occurrence

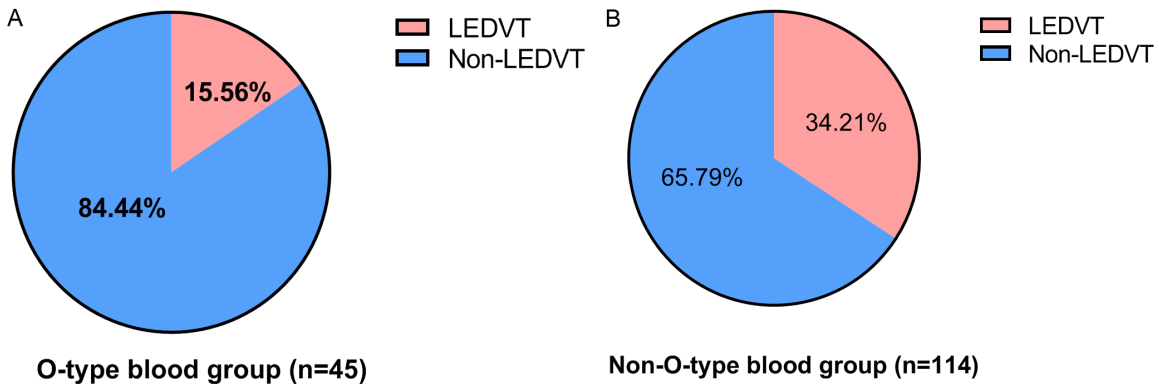

Figure 2. Incidence of lower extremity deep vein thrombosis in O blood type (A) and non-O blood type (B) groups. LEDVT, lower extremity deep vein thrombosis.

Table 2. Univariate analysis of factors influencing LEDVT after hip fracture in elderly patients

Factors	Non-occurrence group (113)	Occurrence group (46)	*P* value
Age	78.5±7.8	82.2±6.5	0.0056
Sex			0.4723
Male	36	12	
Female	77	34	
BMI	22.61±4.44	24.37±3.43	0.0168
Smoking history			0.0450
Yes	11	10	
No	101	36	
Alcohol consumption history			0.5578
Yes	9	5	
No	104	41	
PLT (10^9/L)	236.50±82.28	206.09±59.60	0.0243
PT (s)	11.98±0.95	12.54±0.82	0.0006
APTT (s)	29.36±2.82	30.64±3.655	0.0177
Comorbid hypertension			<0.0001
Yes	42	39	
No	71	7	
Comorbid diabetes			<0.0001
Yes	85	15	
No	28	31	
Blood type			0.0194
O blood type	38	7	
Non-O blood type	75	39	

BMI, Body mass index; PLT, platelet count; PT, prothrombin time; APTT, activated partial thromboplastin time; LEDVT, lower extremity deep vein thrombosis.

group in factors such as age, BMI, smoking history, comorbid hypertension, PLT, PT, APTT, and blood type (all P<0.05), as shown in **Table 2**. These factors were identified as risk factors influencing the occurrence of LEDVT. The differing indicators mentioned above were assigned values (**Table 3**) and subjected to multivariate analysis. Logistic regression analysis revealed that relatively high BMI, comorbid hypertension, low PLT, prolonged PT, and non-O blood type were independent risk factors for LEDVT (**Table 4**).

Table 3. Assignment

Factors	Assignment
Age	≥80 = 1, <80 = 0
BMI	≥23 = 1, <23 = 0
PLT (10^9/L)	<200 = 1, ≥200 = 0
PT (s)	≥12 = 1, <12 = 0
APTT (s)	≥30 = 1, <30 = 0
Smoking history	Yes = 1, None = 0
Comorbid hypertension	Yes = 1, None = 0
Comorbid diabetes	Yes = 1, None = 0
Blood type	Non-O blood type = 1, O blood type group = 0

BMI, Body mass index; PLT, platelet count; PT, prothrombin time; APTT, activated partial thromboplastin time.

Predictive value of independent risk factors

The predictive capability of a combination of independent risk factors for LEDVT was assessed. The area under the curve (AUC) for the joint prediction model, incorporating BMI, comorbid hypertension, PLT levels, PT levels, and blood type, was 0.862. This model achieved a sensitivity of 75.22%, specificity of 86.96%, and accuracy of 78.62% (**Figure 3**).

Discussion

With age, bone strength and density naturally decrease, resulting in an increased prevalence of hip fractures among the elderly [8]. Post-surgery, these patients typically undergo extended periods of bed rest and immobilization, significantly raising the risk of developing LEDVT [9]. The incidence of LEDVT is notably high, although there is considerable individual variation in disease occurrence, with many patients lacking clear triggering factors [10]. Studies have linked ABO blood type with LEDVT risk; for instance, Pomero et al. [11] observed a higher risk of venous thromboembolism in non-O blood type individuals, and Spiezia et al. [12] suggested that non-O blood type may predispose individuals to post-thrombotic syndrome.

This study observed a significantly lower incidence of LEDVT in the O blood type group compared to the non-O blood type group, reinforcing the potential correlation between ABO blood type and LEDVT occurrence. Logistic regression analysis identified high BMI, comorbid hypertension, low PLT, prolonged PT, and non-O blood type as independent risk factors for LEDVT. While many studies suggest that patient age influences LEDVT formation post-hip surgery [13], our focus on elderly patients aged 65 and above, excluding younger age groups, found that age did not emerge as an independent risk factor for LEDVT in this demographic. Additionally, smoking and alcohol consumption, known to increase vascular damage and inflammation risk [14], were considered in this study. However, the limited sample size prevented a definitive conclusion regarding alcohol consumption as a risk factor for LEDVT.

Age, BMI, smoking history, alcohol consumption, and comorbidities in internal medicine are well-recognized risk factors for LEDVT. Elevated BMI [15], comorbid hypertension [16], and similar factors can impair venous blood flow, heighten inflammatory responses, and increase levels of clotting factors, thus raising the risk of LEDVT. It is imperative to implement preventive strategies for individuals with these risk factors. Engaging in regular physical activity to maintain a healthy weight and adopting a diet low in cholesterol and saturated fats can reduce clotting factor levels, thereby decreasing the incidence of LEDVT.

Furthermore, platelets are critical components in hemostasis and thrombus formation [17]. A reduced PLT can lead to decreased clotting capability, extended clotting times, and greater difficulty in forming clots, which in turn increases the risk of LEDVT. PT is commonly used to evaluate coagulation function; a prolonged PT indicates impaired clotting function, which may extend clotting time and heighten the risk of thrombus formation.

Blood type has also been identified as an influential factor in the occurrence of LEDVT [11, 18, 19]. In this study, non-O blood type emerged as an independent risk factor for LEDVT. This association may be due to differences in the activities of coagulation factors and platelet aggregation among blood types [20]. ABO blood type significantly affects plasma levels of von Willebrand factor (vWF) and factor VIII (FVIII), with type O individuals typically display-

Table 4. Multivariate logistics regression analysis

Factors	B	S.E.	Wals	df	Sig.	Exp (B)	95% C.I. for EXP (B).	
							Lower limit	Upper limit
Age	0.795	0.473	2.827	1	0.093	2.214	0.877	5.593
BMI	1.129	0.456	6.120	1	0.013	3.093	1.264	7.567
PLT (10^9/L)	1.154	0.458	6.359	1	0.012	3.171	1.293	7.774
PT (s)	1.467	0.483	9.217	1	0.002	4.338	1.682	11.185
APTT (s)	0.716	0.472	2.303	1	0.129	2.046	0.812	5.158
Smoking history	0.987	0.648	2.324	1	0.127	2.684	0.754	9.548
Comorbid hypertension	1.981	0.497	15.921	1	0.000	7.252	2.740	19.193
Comorbid diabetes	0.657	0.524	1.571	1	0.210	1.929	0.691	5.389
Blood type	1.418	0.572	6.145	1	0.013	4.131	1.346	12.679

BMI, Body mass index; PLT, platelet count; PT, prothrombin time; APTT, activated partial thromboplastin time.

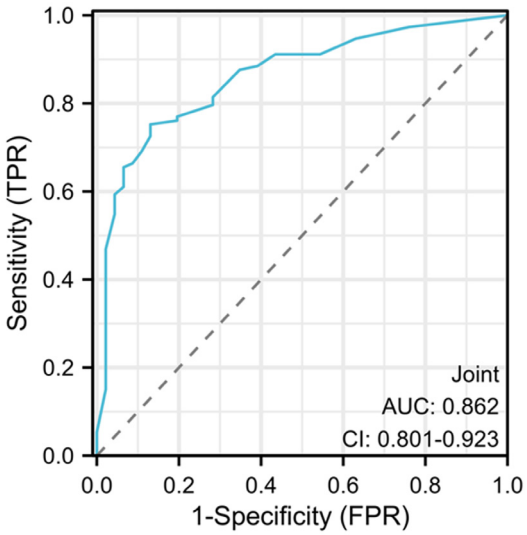

Figure 3. Clinical value of independent risk factors in predicting LEDVT. LEDVT, lower extremity deep vein thrombosis.

ing lower levels of these glycoproteins. The role of ABO blood type in thrombosis is primarily mediated by its effect on vWF plasma levels. ABO blood type potentially influences the synthesis or secretion rate of vWF in endothelial cells, as well as the plasma clearance rate of vWF [21]. Elevated plasma levels of vWF and factor VIII have been recognized as risk factors for venous thromboembolism, further underscoring the clinical significance of blood type in thrombosis risk.

Finally, ROC curve analysis revealed that the combination of BMI, comorbid hypertension, PLT, PT, and blood type achieved an AUC of 0.862 for predicting LEDVT. This model demonstrated high sensitivity (75.22%), specificity (86.96%), and accuracy (78.62%), highlighting the substantial predictive value of these five factors in assessing LEDVT risk. Utilizing these factors for joint prediction can enhance diagnostic accuracy and risk assessment, aiding clinicians and patients in making informed decisions and developing tailored preventive strategies.

This study was a retrospective case-control study, and the identification of patients with LEDVT was based solely on medical record findings. The study faces several limitations: the diagnostic criteria were not comprehensive, and the limited data on patient characteristics and risk factors might have impacted the conclusions. Moreover, the data were derived only from records during hospitalization, without long-term follow-up, which could introduce bias into the results. Future research should aim to overcome these limitations by using more comprehensive diagnostic criteria and collecting extensive patient data. Conducting long-term follow-up would also provide deeper insights into long-term outcomes and complications.

In conclusion, there is a significant association between ABO blood group and LEDVT. Elderly patients with hip fractures who possess non-O blood type, alongside higher BMI, comorbid hypertension, lower PLT, and prolonged PT, face an increased risk of developing LEDVT.

Disclosure of conflict of interest

None.

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