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Research on the Clinical Outcome Evaluation of Intravenous Thrombolysis in Elderly Patients with Cerebral Infarction Using Thromboelastography (TEG)

Jingjing Liu, Liyuan Dong, Yu Yan

Jixi Jikuang Hospital, Jixi 158100, Heilongjiang, China

Abstract: *Objective*: To investigate the role and value of thromboelastography (TEG) in the clinical evaluation of intravenous thrombolysis in elderly patients with cerebral infarction. *Methods*: This study selected 33 patients who underwent intravenous thrombolysis within the 3–4.5-hour treatment window as the intravenous thrombolysis group, and included 202 patients who received conventional drug therapy. All patients underwent thromboelastography evaluation and were divided into three age groups: 60–70 years old, 70–80 years old, and 80–90 years old. Thromboelastography indicators were compared among different groups. *Results*: Compared to pre-treatment values, the R and K values significantly increased, while the α angle and CI significantly decreased in the 60–70 years old, 70–80 years old, and 80–90 years old groups, with statistical significance ($P < 0.05$). Compared to pre-treatment values, the MA value in the intravenous thrombolysis group significantly decreased, with statistical significance ($P < 0.05$). Within the intravenous thrombolysis group, the R and K values in the 70–80 years old group were longer than those in the 60–70 years old group and the conventional drug therapy group, while the CI was higher than in the 60–70 years old group and the conventional drug therapy group. The α angle and MA values were lower than in the 60–70 years old group and the conventional drug therapy group, with statistical significance ($P < 0.05$). *Conclusion*: Thromboelastography can be used to evaluate the clinical outcomes of intravenous thrombolysis in elderly patients with cerebral infarction and can provide an optimized treatment plan for intravenous thrombolysis in elderly patients with acute cerebral infarction, making it worthy of clinical promotion and application.

Keywords: Thromboelastography (TEG); Elderly cerebral infarction; Intravenous thrombolysis; Clinical outcomes; Evaluation

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1. Introduction

Cerebral infarction is one of the commonly encountered cardiovascular and cerebrovascular diseases in clinical practice, posing a severe threat to the health of the Chinese population. Currently, cerebral infarction has become the second leading cause of death globally and the primary factor contributing to disability among the elderly, with both its incidence and disability rates continuously rising [1]. According to statistics from the World Health Organization, annually, 5 million people worldwide die from cerebral infarction, with the pathogenic causes closely related to numerous factors. Relevant studies indicate that cerebral infarction primarily forms due to platelet activation and disruptions in the balance between the coagulation and fibrinolytic systems. In China, the thrombolysis rate among cerebral infarction patients is relatively low, mainly due to associated risks. For elderly patients, the risk-benefit balance mechanism of thrombolytic therapy is particularly complex due to decreased vascular elasticity and increased complications [2]. Elderly patients often suffer from comorbidities such as hypertension, diabetes, and atrial fibrillation, leading to vascular endothelial damage and coagulation dysfunction. Some studies directly point out that the incidence of symptomatic intracranial hemorrhage after thrombolysis is higher in elderly cerebral infarction patients, with the risk of bleeding significantly increasing with age [3]. Due to reduced liver and kidney function, elderly patients exhibit decreased metabolic capacity for thrombolytic drugs like alteplase, making them prone to drug resistance. Thromboelastography (TEG), through whole blood testing, provides a real-time recording of coagulation initiation and clot formation, offering more comprehensive coagulation information [4]. Based on this, this study selected 33 patients who underwent intravenous thrombolysis within the 3-4.5-hour treatment window as the intravenous thrombolysis group and included 202 patients receiving conventional drug therapy. It explored the role and application value of thromboelastography in the clinical outcomes of intravenous thrombolysis for elderly cerebral infarction patients.

2. Materials and methods

2.1. General information

In this study, 33 patients who underwent intravenous thrombolysis within the 3–4.5-hour treatment window were selected as the intravenous thrombolysis group, and 202 patients receiving conventional drug therapy were included. The patients were divided into groups based on age: 60-70 years old, 70–80 years old, and 80–90 years old.

Inclusion Criteria: (1) Age ≥ 60 years old; (2) Diagnosed with cerebral infarction by cranial CT examination in our hospital; (3) Score on the Activities of Daily Living (ADL) scale < 70; (4) Received intravenous thrombolysis within the 3–4.5-hour treatment window; (5) Patients had a fixed caregiver and demonstrated high treatment compliance; (6) Patients and their families signed informed consent forms indicating their voluntary participation in this study.

Exclusion Criteria: (1) Patients with concurrent acute infections; (2) Patients with concurrent cardiogenic cerebral infarction; (3) Patients with cerebral hemorrhage identified by cranial CT examination; (4) Patients with concurrent tumors or immune system diseases; (5) Patients who had recently used antiplatelet or anticoagulant medications; (6) Patients who did not sign informed consent forms.

2.2. Methods

For routine coagulation tests, 2 mL of antecubital venous blood was collected using a sodium citrate anticoagulant tube in the fasting state in the morning. After centrifugation, the plasma was separated and then analyzed using an automated coagulation analyzer to measure prothrombin time (PT), activated partial thromboplastin time (APTT), thrombin time (TT), and fibrinogen (FIB). Additionally, 1 ml of antecubital venous blood was collected using a sodium citrate anticoagulant tube for thromboelastography (TEG) analysis using a TEG 5000 analyzer (Haemoscope Corporation). The temperature was set at 37°C, and a TEG image was generated. After the clot reached its maximum amplitude, the measurement was continued for an additional 30 minutes before ending. It is important to note that the measurement should be completed within 2 hours of blood collection.

2.3. Observation indicators

The observation indicators in this study were TEG parameters, including R value, K value, α angle, CI (coagulation index), and MA (maximum amplitude).

2.4. Statistical methods

Statistical analysis of the data in this study was performed using SPSS 23.00 software. Measurement data were expressed as mean ± standard deviation (Mean ± SD) and compared using *t*-tests. The count data were expressed as n (%) and compared using chi-square tests. A *P*-value < 0.05 indicated a statistically significant difference in the data comparison.

3. Results

3.1. Comparison of R, K, α, CI, and MA values before and after treatment

The study results showed that after treatment, the R and K values in the 60-70-year-old, 70-80-year-old, and 80-90-year-old groups were significantly prolonged, with statistically significant differences in the data comparison ($P < 0.05$), as shown in **Table 1**.

Table 1. Comparison of R and K values before and after treatment

Group	Time Point	R	P	K	P
60–70 years group	Before treatment	6.30±1.15	0.033	1.50±0.08	<0.001
	After treatment	7.19±1.25		1.79±0.11	
70–80 years group	Before treatment	6.43±1.30	0.013	1.59±0.14	<0.001
	After treatment	7.81±1.19		2.21±0.13	
80-90 years group	Before treatment	6.45±0.60	0.041	1.64±0.12	0.005
	After treatment	7.99±0.67		2.13±0.10	

Upon comparing the results of α, CI, and MA, it was found that the values of α angle, CI, and MA all significantly decreased after treatment compared to before treatment, as detailed in **Table 2**.

Table 2. Comparative results of the α angle, CI value, and MA value before and after treatment

Group	Time Point	α angle	P	CI	P	MA	P
60–70 years group	Before treatment	65.88±5.12	0.022	3.25±0.54	<0.001	62.88±4.46	0.008
	After treatment	61.85±4.98		2.42±0.43		58.70±4.41	
70–80 years group	Before treatment	64.92±5.01	0.002	3.28±0.47	<0.001	62.59±4.40	<0.001
	After treatment	58.14±4.49		2.01±0.38		54.92±4.26	
80–90 years group	Before treatment	64.58±2.13	0.045	3.22±0.45	0.028	62.68±2.13	0.030
	After treatment	58.91±2.67		2.13±0.33		55.75±2.97	

3.2. Comparison of results between the intravenous thrombolysis group and the conventional treatment group after treatment

The study results indicate that in the intravenous thrombolysis group, the R and K values in the 70–80 age group were longer than those in the 60–70 age group and the conventional medication treatment group, while the CI was higher than that in the 60–70 age group and the conventional medication treatment group, as detailed in **Table 3**.

Table 3. Comparison of R and K values between the intravenous thrombolysis group and the conventional treatment group after treatment

Group	Number of Cases	R value	K value
Conventional Treatment Group	202	7.03 ± 1.04	1.50 ± 0.10
60–70 Years Group	18	7.19 ± 1.25	1.79 ± 0.11
70–80 Years Group	12	7.81 ± 1.19*#	2.21 ± 0.13*#
80–90 Years Group	3	7.99 ± 0.67*#	2.13 ± 0.10*#

Note: "*" indicates statistical significance compared to the conventional treatment group, and "#" indicates statistical significance compared to the 60–70 age group. The same applies in the following table.

In the comparison of CI, α angle, and MA values, the CI, α angle, and MA values in the 70–80 age group were significantly lower than those in the 60–70 age group and the conventional medication treatment group, with statistical significance ($P < 0.05$) in the data comparison, as detailed in **Table 4**.

Table 4. Comparison of CI, α Angle, and MA values between the intravenous thrombolysis group and the conventional treatment group after treatment

Group	Number of Cases	CI	α Angle (°)	MA
Routine Treatment Group	202	2.50 ± 0.45	62.15 ± 4.19	58.86 ± 4.27
60–70 Years Group	18	2.42 ± 0.43	61.85 ± 4.98	58.70 ± 4.41
70–80 Years Group	12	2.01 ± 0.38*#	58.14 ± 4.49*#	54.92 ± 4.26*#
80–90 Years Group	3	2.13 ± 0.33#	58.91 ± 2.67*#	55.75 ± 2.97*#

4. Discussion

Elderly patients with cerebral infarction often have multiple underlying diseases, which may lead to abnormal coagulation function and significantly increase the risk of thrombosis and bleeding. Although intravenous thrombolysis is the primary treatment for acute cerebral infarction, elderly patients face a higher risk of hemorrhagic transformation after thrombolysis due to significantly reduced vascular elasticity and poor collateral circulation [5]. The therapeutic effect can also be influenced by the coagulation status. Traditional coagulation tests can only reflect certain aspects of the coagulation process and are inadequate for assessing the dynamic balance between thrombosis and fibrinolysis. Thromboelastography (TEG) simulates the in vivo coagulation process and monitors real-time changes in the elasticity of whole blood samples, effectively reflecting coagulation factor activity, fibrin formation, platelet function, and fibrinolytic status [6]. Some studies have directly indicated that TEG can effectively identify patients requiring increased doses of rt-PA [7]. During thrombolysis, real-time monitoring of TEG parameters allows for adjustments in the infusion rate of the drug. Generally, elderly patients exhibit significantly elevated fibrinogen levels, impaired platelet function, and decreased coagulation factor activity, with a coexistence of hypercoagulable and hypocoagulable states. TEG can comprehensively evaluate these dynamic changes, preventing misdiagnosis and missed diagnosis caused by relying on a single indicator [8–9]. Additionally, elderly patients may also have diabetes and impaired liver and kidney function, which can affect coagulation function [10].

Based on this, this study included 33 patients who underwent intravenous thrombolysis within the 3–4.5-hour treatment window and patients receiving conventional drug therapy as the research subjects. By comparing indicators before and after treatment, the results showed that, compared to pre-treatment values, the R and K values significantly increased, while the α angle and CI significantly decreased in the 60–70 years old, 70–80 years old, and 80–90 years old groups, with statistical significance ($P < 0.05$). The primary reason for this is the significantly decreased activity of coagulation factors, impaired liver and kidney function in elderly patients, and reduced synthesis capacity of coagulation factors. Due to the slower rate of fibrin production, thrombolytic therapy consumes fibrinogen, and heparin drugs increase antithrombin activity, leading to a significant decrease in the α angle. Thrombolytic drugs degrade fibrinogen and inhibit coagulation factor activity, resulting in a decrease in the CI value. Furthermore, the R and K values in the 70–80 years old group were longer than those in the 60–70 years old group and the conventional drug therapy group, while the CI was higher than in the 60–70 years old group and the conventional drug therapy group. The α angle and MA values were lower than in the 60-70 years old group and the conventional drug therapy group ($P < 0.05$). The reason for this is that elderly patients have decreased drug metabolism capacity, leading to prolonged drug retention time and affected coagulation factor activity. Patients aged 70-80 years have even poorer drug metabolism capacity, resulting in a more significant impact on coagulation factors and more pronounced prolongation of R and K values. Patients in the 70-80-year-old group also exhibit a more significant decrease in fibrinogen levels and potentially greater impairment of platelet function, leading to a more pronounced decrease in the α angle and MA values.

5. Conclusion

In summary, for patients with prolonged R and K values and decreased α angle and MA values, the dose of thrombolytic drugs can be appropriately reduced, or the thrombolysis time can be extended to lower the risk of bleeding. Simultaneously, monitoring the fibrinolytic status through TEG allows for timely adjustments in the use of antifibrinolytic drugs to ensure the effectiveness and safety of thrombolytic therapy. Through TEG monitoring, abnormal coagulation function in patients can be detected earlier, enabling timely intervention measures to improve patient prognosis.

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Disclosure statement

The authors declare no conflict of interest.

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