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Clinical Study on the Efficacy and Safety of Tirofiban Arterial Thrombolysis Combined with Sequential Intravenous Therapy for Acute Ischemic Stroke

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Abstract: *Objective*: To investigate the clinical efficacy and safety of tirofiban arterial thrombolysis combined with sequential intravenous therapy in patients with acute ischemic stroke (AIS). *Methods*: A total of 85 AIS patients admitted to the hospital from February 2024 to February 2026 were selected as the study subjects. They were divided into a control group (44 cases, treated with tirofiban intravenous therapy alone plus conventional therapy) and an observation group (41 cases, treated with tirofiban arterial thrombolysis combined with sequential intravenous therapy plus conventional therapy) according to the treatment regimen. The National Institutes of Health Stroke Scale (NIHSS) scores and modified Rankin Scale (mRS) scores of the two groups were compared before treatment and at 1 day, 3 days, 7 days, and 90 days after treatment. The occurrence of adverse reactions during treatment was also recorded. *Results*: Compared with the control group, the NIHSS scores of the observation group were lower at all time points (1 day, 3 days, 7 days, and 90 days after treatment) (all $P < 0.001$). At 90 days after treatment, the proportion of patients with an mRS score of 0–2 in the observation group was 78.05%, higher than that in the control group (56.82%). Meanwhile, the proportion of patients with poor prognosis and death in the observation group was 21.95%, lower than that in the control group (43.18%) ($P < 0.05$). During treatment, there was no statistically significant difference in the incidence of adverse reactions between the observation group and the control group ($P > 0.05$). *Conclusion*: Tirofiban arterial thrombolysis combined with sequential intravenous therapy for AIS can effectively improve neurological deficits in patients, enhance long-term prognosis, and does not increase the risk of serious adverse reactions, demonstrating high clinical safety.

Keywords: Acute ischemic stroke; Tirofiban; Arterial thrombolysis; Sequential intravenous therapy; Neurological function; Safety

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1. Introduction

Acute ischemic stroke (AIS) is a common neurological emergency characterized by high morbidity, disability, and mortality, seriously threatening patients' lives, health, and quality of life [1]. According to statistics, ischemic stroke accounts for more than 70% of all strokes, and approximately 1/5 to 1/3 of patients have progressive stroke. If not promptly intervened, the neurological deficits will continue to worsen, significantly increasing the risk of poor prognosis [2]. Currently, intravenous thrombolysis and endovascular therapy are the mainstream reperfusion treatment options for AIS. However, due to the limited treatment time window, some patients cannot receive standard intravenous thrombolysis within the effective time frame. Moreover, the issues of vascular re-occlusion and poor neurological recovery after intravenous thrombolysis alone remain prominent. Tirofiban, a reversible platelet glycoprotein IIb/IIIa receptor antagonist, exerts an antithrombotic effect by inhibiting platelet aggregation. It is widely used in the treatment of coronary heart disease and acute coronary syndrome and has gradually been applied as an adjuvant therapy for AIS in recent years [3]. Although conventional intravenous tirofiban therapy can inhibit platelet aggregation, for patients with severe occlusion of the responsible vessel and a large thrombus burden, it is difficult to rapidly achieve an effective local drug concentration with intravenous administration alone, resulting in limited treatment effects. Arterial thrombolysis can directly deliver the drug to the responsible lesion vessel, rapidly dissolve the thrombus, and restore blood flow perfusion. Combined with sequential intravenous therapy, it can maintain the antiplatelet effect while reducing the risk of vascular re-occlusion [4]. Currently, more data are needed to support clinical studies on tirofiban arterial thrombolysis combined with sequential intravenous therapy for AIS. This study retrospectively analyzed the data of 85 AIS patients admitted to the hospital to investigate the clinical efficacy and safety of this combined regimen and provide a reference for optimizing clinical treatment plans.

2. Materials and methods

2.1. General information

A total of 85 AIS patients admitted to the Department of Neurology of the hospital from February 2024 to February 2026 were selected as the study subjects. They were divided into a control group (44 cases) and an observation group (41 cases) according to the treatment regimen. Inclusion criteria: (1) Met the diagnostic criteria for AIS in the "Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke 2023" and had ischemic lesions confirmed by cranial CT or MRI; (2) First-ever stroke with an onset time ≤ 24 hours and presenting with neurological deficits; (3) NIHSS score ≥ 4; (4) Aged 18–90 years; (5) Patients and their families signed informed consent forms. Exclusion criteria: (1) Combined with intracranial hemorrhage, bleeding tendency, or coagulation dysfunction; (2) Severe cardiac, hepatic, or renal insufficiency; (3) Platelet count < 50 × 10^9/L; (4) Allergic to tirofiban or contrast agents; (5) Combined with malignant tumors or severe infections; (6) Previous history of stroke with significant residual neurological deficits.

In the control group, there were 24 males and 20 females, with an average age of (63.45 ± 7.21) years and an average onset time of (11.26 ± 3.45) hours. There were 28 cases of hypertension, 16 cases of diabetes, and 19 cases of hyperlipidemia. In the observation group, there were 22 males and 19 females, with an average age of (64.12 ± 7.53) years and an average onset time of (11.58 ± 3.62) hours. There were 26 cases of hypertension, 14 cases of diabetes, and 17 cases of hyperlipidemia. There was no statistically significant difference in general information between the two groups ($P > 0.05$), indicating comparability.

2.2. Treatment methods

Both groups of patients received conventional AIS treatment, including oxygen inhalation, maintenance of water and electrolyte balance, control of blood pressure and blood sugar, antiplatelet aggregation (aspirin 100 mg/day orally), statin therapy to regulate lipids and stabilize plaques, and symptomatic supportive treatment to improve circulation and nourish nerves.

The control group received tirofiban intravenous therapy alone in addition to conventional treatment. Tirofiban hydrochloride for injection was initially infused intravenously at a rate of 0.4 μg/(kg·min) for 30 minutes, followed by maintenance intravenous infusion at a rate of 0.1 μg/(kg·min) for 24–48 hours. During treatment, platelet count and coagulation function were monitored. If the platelet count was < 90 × 10^9/L, the platelet count was rechecked to exclude pseudothrombocytopenia, and the drug was discontinued if necessary.

The observation group received tirofiban arterial thrombolysis combined with sequential intravenous therapy in addition to conventional treatment. Patients underwent femoral artery puncture for whole-brain angiography to identify the responsible lesion vessel and thrombus location. Tirofiban (0.25–1 mg) was slowly injected into the responsible lesion vessel through a microcatheter at a rate of 1 ml/min. After injection, angiography was repeated to assess vascular recanalization. Immediately after arterial administration, sequential intravenous therapy was initiated, with tirofiban maintained at a rate of 0.1 μg/(kg·min) for 24–48 hours. The monitoring indicators during treatment were the same as those in the control group.

2.3. Observation indicators

(1) Degree of neurological deficits: The National Institutes of Health Stroke Scale (NIHSS) was used to assess the degree of neurological deficits in patients before treatment and at 1 day, 3 days, 7 days, and 90 days after treatment. The total score of the scale ranges from 0 to 42, with higher scores indicating more severe neurological deficits.

(2) Long-term prognosis: At 90 days after treatment, the modified Rankin Scale (mRS) was used to assess the prognosis of patients. An mRS score of 0–2 indicated a good prognosis (no significant disability or mild disability, able to live independently), 3–5 indicated a poor prognosis (moderate to severe disability, dependent on others for care), and 6 indicated death.

(3) Safety indicators: The occurrence of thrombocytopenia (platelet count < 100 × 10^9/L), bleeding events (including intracranial hemorrhage, skin and mucous membrane bleeding, gastrointestinal bleeding, etc.), allergic reactions, and abnormal liver and kidney function during treatment in the two groups was recorded.

2.4. Statistical methods

SPSS 27.0 was used for data analysis. The t-test was used for inter-group comparison of measurement data, and the χ^2 test was used for inter-group comparison of count data. $P < 0.05$ indicated a statistically significant difference.

3. Results

3.1. Comparison of NIHSS scores at different time points between the two groups

Compared with the control group, the NIHSS scores of the observation group were lower at 1 day, 3 days, 7

days, and 90 days after treatment (all $P < 0.001$), as shown in **Table 1**.

Table 1. Comparison of NIHSS scores at different time points between the two groups

Group	Before treatment	After treatment 1d	After treatment 3d	After treatment 7d	After treatment 90d
Control group (n=44)	12.35 ± 3.12	10.21 ± 2.87	8.56 ± 2.43	6.89 ± 2.15	4.23 ± 1.87
Observation group (n=41)	12.51 ± 3.08	8.12 ± 2.56	6.34 ± 2.11	4.52 ± 1.98	2.56 ± 1.34
t	0.252	3.549	4.474	5.275	4.717
P	0.802	0.001	<0.001	<0.001	<0.001

3.2. Comparison of mRS scores between the two groups of patients at 90 days after treatment

At 90 days after treatment, the proportion of patients in the observation group with an mRS score of 0-2 was 78.05%, which was higher than that in the control group (56.82%). Meanwhile, the proportion of patients with poor prognosis and death in the observation group was 21.95%, which was lower than that in the control group (43.18%) ($P < 0.05$), as shown in **Table 2**.

Table 2. Comparison of mRS scores between the two groups of patients at 90 days after treatment [Case (%)]

Group	mRS 0-2 (Good Prognosis)	mRS 3-5 (Poor Prognosis)	mRS 6 (Death)	Poor Prognosis + Death Total
Control Group (n=44)	25 (56.82)	17 (38.64)	2 (4.55)	19 (43.18)
Observation Group (n=41)	32 (78.05)	8 (19.51)	1 (2.44)	9 (21.95)
x^2	-	-		4.331
P	-	-		0.037

3.3. Comparison of the incidence of adverse reactions between the two groups of patients

During the treatment period, there was no statistically significant difference in the incidence of adverse reactions between the observation group and the control group ($P > 0.05$), as shown in **Table 3**.

Table 3. Comparison of the incidence of adverse reactions between the two groups of patients

Group	Thrombocytopenia	Intracranial Hemorrhage	Skin and Mucosal Hemorrhage	Total Adverse Reactions
Control Group (n=44)	5 (11.36)	3 (6.82)	4 (9.09)	12 (27.27)
Observation Group (n=41)	4 (9.76)	2 (4.88)	3 (7.32)	9 (21.95)
x^2				0.323
P				0.570

4. Discussion

Acute ischemic stroke (AIS) is the most prevalent type of stroke in clinical practice. Its core pathophysiological mechanism involves the occlusion of the responsible blood vessel, leading to cerebral ischemia and hypoxia. This, in turn, initiates an ischemic cascade reaction, resulting in neuronal cell damage or even necrosis. Therefore, rapidly restoring blood flow perfusion in the ischemic area, inhibiting platelet

aggregation, and preventing vascular re-occlusion are crucial for improving patients' clinical outcomes [5]. Tirofiban, as a highly effective glycoprotein IIb/IIIa receptor antagonist, competitively binds to the IIb/IIIa receptors on the platelet membrane, blocking the interaction between fibrinogen and platelets, thereby potently inhibiting platelet aggregation and preventing thrombus formation and further expansion. It holds significant value in the antithrombotic treatment of AIS [6]. In clinical practice, although conventional intravenous infusion of tirofiban can exert certain antiplatelet effects, for patients with a heavy thrombus burden and severe vascular occlusion, the intravenous administration method struggles to rapidly achieve effective therapeutic concentrations at the local lesion site. Additionally, some patients may exhibit drug resistance, leading to suboptimal treatment outcomes and difficulty in meeting clinical treatment needs.

This study addressed the aforementioned treatment challenges by applying intra-arterial thrombolysis with tirofiban combined with sequential intravenous therapy to patients in the observation group. This treatment regimen directly delivers the drug to the responsible lesion vessel via the arterial route, enabling rapid thrombolysis and restoration of blood flow perfusion in the ischemic area. Subsequently, sequential intravenous administration maintains a sustained antiplatelet effect, effectively reducing the risk of vascular re-occlusion. Clinical results demonstrated that the NIHSS scores of the observation group were significantly lower than those of the control group at 1 day, 3 days, 7 days, and 90 days post-treatment, indicating that the combined treatment regimen could more rapidly and effectively improve patients' neurological deficit symptoms. Further analysis of its mechanism of action revealed that intra-arterial thrombolysis directly acts on the lesion vessel, rapidly opening the occluded vessel, restoring cerebral blood flow supply, and alleviating neuronal cell damage caused by ischemia and hypoxia. Sequential intravenous tirofiban therapy continuously inhibits platelet aggregation, prevents thrombus reformation, maintains vascular patency, and creates favorable conditions for neurological recovery [7].

In terms of long-term prognosis, the proportion of patients with an mRS score of 0–2 in the observation group at 90 days post-treatment was 78.05%, significantly higher than the 56.82% in the control group. This suggests that intra-arterial thrombolysis with tirofiban combined with sequential intravenous therapy can effectively improve patients' long-term prognostic quality and reduce the incidence of disability [8]. This outcome is closely related to the combined treatment's ability to rapidly restore blood flow perfusion, alleviate cerebral ischemia-reperfusion injury, and reduce neuronal cell apoptosis, laying a solid foundation for patients' subsequent neurological rehabilitation [9]. Furthermore, the incidence of death and poor prognosis in the observation group was lower than that in the control group, further confirming that the combined treatment regimen can effectively reduce the risk of adverse outcomes in AIS patients and improve their long-term quality of life.

Safety assessments showed no statistically significant difference in the incidence of thrombocytopenia and bleeding events between the two groups, and no severe adverse reactions occurred in either group. Tirofiban can potentially induce thrombocytopenia in clinical use, with most such adverse reactions being reversible and gradually returning to normal after drug discontinuation. Bleeding events are a critical adverse reaction requiring close attention during tirofiban treatment, particularly intracranial hemorrhage, which can be life-threatening in severe cases. In this study, the incidence of intracranial hemorrhage was low in both groups, suggesting that intra-arterial thrombolysis with tirofiban combined with sequential intravenous therapy does not increase the risk of severe bleeding. This may be related to strict control of arterial drug dosage, standardized patient screening, and close monitoring of relevant indicators during medication in

clinical practice. In clinical practice, regular monitoring of patients' platelet counts and coagulation function, along with timely adjustment of drug dosage, can effectively reduce the risk of thrombocytopenia and bleeding events, ensuring treatment safety [10].

This study has certain limitations, as it is a single-center retrospective study with a relatively small sample size and a short follow-up period, which may introduce some bias into the results. Future research should involve multi-center, large-sample prospective clinical studies to further validate the long-term efficacy and safety of intra-arterial thrombolysis with tirofiban combined with sequential intravenous therapy for AIS, providing more reliable evidence-based medical evidence for its clinical application.

5. Conclusion

In conclusion, intra-arterial thrombolysis with tirofiban combined with sequential intravenous therapy for AIS can effectively improve patients' neurological deficits, increase the rate of favorable long-term prognosis, and does not increase the risk of adverse reactions such as thrombocytopenia and severe bleeding. It exhibits high clinical application safety and is worthy of further promotion and application in clinical practice. In clinical practice, it is essential to strictly grasp treatment indications and strengthen monitoring during medication to ensure the safety and effectiveness of treatment.

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Disclosure statement

The authors declare no conflict of interest.

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