

Efficacy of Intravenous Alteplase Thrombolysis in Acute Cerebral Infarction: Anterior vs. Posterior Circulation

Jing Huang¹, Fanrui Zeng^{2*}

¹Department of Cerebrovascular Disease, Zhuhai People's Hospital (The Affiliated Hospital of the Beijing Institute of Technology, Zhuhai Clinical Medical College of Jinan University), Zhuhai, China

²Department of Respiratory and Critical Care Medicine, Zhuhai People's Hospital (The Affiliated Hospital of the Beijing Institute of Technology, Zhuhai Clinical Medical College of Jinan University), Zhuhai, China

Email: *810552811@qq.com

How to cite this paper: Huang, J. and Zeng, F.R. (2026) Efficacy of Intravenous Alteplase Thrombolysis in Acute Cerebral Infarction: Anterior vs. Posterior Circulation. *Health*, 18, 125-133.
<https://doi.org/10.4236/health.2026.182009>

Received: January 1, 2026

Accepted: January 31, 2026

Published: February 3, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Objective: To compare the effects of intravenous alteplase thrombolysis on clinical outcomes and safety between patients with anterior and posterior circulation cerebral infarction. **Methods:** Between April 2019 and December 2024, 319 patients with acute cerebral infarction underwent intravenous alteplase thrombolysis within 4.5 hours at Zhuhai People's Hospital. They were divided by infarction site into anterior (n = 219) and posterior (n = 100) circulation groups. Comparisons were made for baseline risk factors, serial National Institute of Health stroke scale (NIHSS) scores, clinical efficacy, discharge mRS scores, and rates of bleeding complications (symptomatic or asymptomatic intracranial hemorrhages, oral/gingival, cutaneous, and gastrointestinal). **Results:** Baseline Characteristics: The ACS group had a higher proportion of atrial fibrillation, while hypertension and diabetes were more prevalent in the PCS group (both $P < 0.05$). Efficacy Outcomes: No significant differences were observed between the two groups in NIHSS scores at any time point (pre-thrombolysis, 24 h, and 7 d) or in the overall clinical improvement rate. Safety Outcomes: The rate of intracranial hemorrhage was significantly higher in the ACS group ($P < 0.05$). Rates of other bleeding events (oral/gingival, cutaneous, gastrointestinal) and total bleeding, as well as mortality, did not differ significantly between groups ($P > 0.05$). **Conclusion:** While atrial fibrillation is more common in anterior circulation infarction, hypertension and diabetes are more frequent in posterior circulation infarction. Early alteplase thrombolysis significantly and similarly improves prognosis in both types. For safety, posterior circulation infarction carries a lower risk of intracranial hemorrhage but comparable risks of extracranial bleeding.

Keywords

Acute Cerebral Infarction, Alteplase, Intravenous Thrombolysis, Anterior Circulation, Posterior Circulation

1. Introduction

Acute ischemic stroke is categorized into anterior circulation stroke (ACS) and posterior circulation stroke (PCS) based on the affected vascular territory, which are supplied by the carotid and vertebrobasilar artery systems, respectively. Owing to distinct anatomical and physiological underpinnings, these two subtypes present with different clinical manifestations and prognoses. Intravenous thrombolysis remains the standard treatment within the therapeutic time window. However, among patients receiving thrombolysis, PCS accounts for only 5% - 19% [1] [2], whereas it constitutes up to 36% of stroke patients with a National Institutes of Health Stroke Scale (NIHSS) score >25 [3]. Previous research has predominantly focused on ACS. Given inherent differences between the circulations—such as in blood flow velocity, vascular diameter, and collateral compensation, this pathophysiological heterogeneity may lead to divergent clinical outcomes following thrombolysis. Several international studies suggest that compared with ACS, PCS is associated with a lower risk of symptomatic intracranial hemorrhage post-thrombolysis [4], whereas others report no significant intergroup difference in safety outcomes [5]. Hence, this study systematically compares the clinical efficacy and safety of intravenous alteplase thrombolysis between ACS and PCS patients.

2. Materials and Methods

2.1. Study Population

We enrolled 319 AIS patients treated with intravenous alteplase within the 4.5-hour window at Zhuhai People's Hospital (April 2019-December 2024). The cohort included 226 males and 93 females, with a mean age of 66.34 ± 12.79 years (range: 29 - 93). Diagnosis followed the 2023 Chinese AIS guidelines [6] and was confirmed by CT/MRI. According to infarct location, patients were divided into an anterior circulation stroke (ACS) group ($n = 219$) and a posterior circulation stroke (PCS) group ($n = 100$).

Inclusion criteria

1) Age ≥ 18 years. 2) Diagnosis of AIS according to the 2023 Chinese guidelines, with intravenous alteplase treatment initiated within 4.5 hours of onset. 3) Intracranial hemorrhage ruled out by baseline CT; cranial MRI performed during hospitalization. 4) Informed consent obtained from the patient or legal representative.

Exclusion criteria

1) Underwent bridging endovascular therapy. 2) Prior history of disabling stroke ($mRS > 2$). 3) Contraindications to MRI, such as metal implants or cardiac pacemakers. 4) Incomplete key clinical or imaging data. 5) Severe dysfunction of

vital organs (heart, lung, liver, kidney, etc.).

2.2. Assessments and Outcome Measures

2.2.1. Baseline Variables

The following baseline data were documented for both groups: demographic characteristics (sex, age, weight, BMI), history of smoking and alcohol use, relevant medical comorbidities (hypertension, diabetes, atrial fibrillation, hyperlipidemia, hyperhomocysteinemia), and the severity of neurological deficits as measured by the NIHSS score on admission. Post-admission laboratory workup encompassed complete blood count, hepatic and renal function panels, blood glucose, lipid profile, electrolytes, coagulation studies, and homocysteine levels. Additionally, all patients completed a suite of imaging and ancillary tests, including electrocardiography, cranial MRI with MRA, transthoracic echocardiography, and carotid artery ultrasound.

2.2.2. Methods of Intravenous Thrombolysis

Intravenous thrombolysis was performed with alteplase (Boehringer Ingelheim, Germany) at a standard dose of 0.9 mg/kg (maximum 90 mg). The medication was reconstituted in 100 mL of 0.9% normal saline. The infusion protocol consisted of two phases: 10% of the total dose was given as an intravenous bolus over 1 minute; the remaining 90% was then infused continuously over 60 minutes via an infusion pump.

2.2.3. Observation Indicators

1) Efficacy Evaluation

Neurological function was assessed using the NIHSS at three time points: before thrombolysis, 24 hours after thrombolysis, and 7 days after thrombolysis. Lower NIHSS scores indicate better neurological function.

The improvement rate of NIHSS score at 7 days after thrombolysis was calculated as follows:

$$\text{NIHSS improvement rate (\%)} = (\text{NIHSS score before thrombolysis} - \text{NIHSS score after thrombolysis}) / \text{NIHSS score before thrombolysis} \times 100\%$$

The therapeutic effect was classified based on the improvement rate:

- Markedly effective: improvement rate $\geq 70\%$
- Effective: improvement rate between 30% and 69%
- Ineffective: improvement rate $< 30\%$

The clinical improvement rate was defined as the combination of markedly effective and effective cases.

Functional outcome was evaluated at discharge using the modified Rankin Scale (mRS). Lower mRS scores indicate better prognosis. Outcomes were categorized as follows:

- Good outcome: mRS score 1 - 2
- Poor outcome: mRS score 3 - 5
- Death: mRS score 6

2) Safety Evaluation

Patients were monitored for post-thrombolysis bleeding events, including cu-

taneous/mucosal, gastrointestinal, symptomatic or asymptomatic intracranial hemorrhages, and oral/gingival bleeding.

2.3. Statistical Analysis

All analyses were conducted using SPSS 26.0. Continuous variables are expressed as mean \pm SD, and their distribution was tested for normality with the Kolmogorov-Smirnov test. Group comparisons were made as follows: the independent t-test for normally distributed data, the Mann-Whitney U test for non-normally distributed data, and the chi-square test for categorical variables. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Baseline Characteristics

The two groups were comparable in age, sex, BMI, and the rates of smoking, alcohol use, hyperlipidemia, and hyperhomocysteinemia (all $P > 0.05$). Significant differences were observed in specific comorbidities: diabetes and hypertension were significantly more prevalent in the PCS group, while atrial fibrillation was more common in the ACS group ($P < 0.05$). Details are presented in **Table 1**.

Table 1. General characteristics of the two groups.

Variable	ACS (n = 219)	PCS (n = 100)	Test value	P value
Sex (Male/Female) n	(149/70)	(77/23)	2.34	0.126
Age, years	66.68 \pm 12.39	65.71 \pm 13.63	0.63	0.531
BMI (kg/m ²)	24.05 \pm 3.52	24.13 \pm 3.48	0.19	0.550
Smoking, n (%)	(91/41.6%)	(41/41%)	0.01	0.920
Alcohol, n (%)	(65/29.7%)	(37, 37%)	1.84	0.175
Diabetes, n (%)	(58, 26.5%)	(38, 38%)	4.71	0.03
Hypertension, n (%)	(139, 63.5%)	(78, 78%)	7.12	0.008
Atrial fibrillation, n (%)	(37, 16.9%)	(7, 7%)	5.98	0.014
Hyperlipidemia n (%)	(100, 45.7%)	(44, 44%)	0.008	0.777
Hcy (%)	(58, 26.5%)	(22, 22%)	0.82	0.366

3.2. Comparison of NIHSS Scores

NIHSS scores did not differ significantly between the two groups at any of the three time points (before, 24 hours after, and 7 days after thrombolysis) ($P > 0.05$). See **Table 2**.

Table 2. NIHSS scores before thrombolysis, at 24 hours, and at 7 days after thrombolysis of two groups.

	ACS (n = 219)	PCS (n = 100)	Test value	P value
before thrombolysis NIHSS ($\bar{x} \pm s$)	5.99 \pm 4.16	5.68 \pm 5.00	0.54	0.295
24 h NIHSS ($\bar{x} \pm s$)	3.72 \pm 4.1	4.07 \pm 6.42	0.50	0.31
7 d NIHSS ($\bar{x} \pm s$)	2.52 \pm 3.75	3.39 \pm 6.56	1.24	0.109

3.3. Comparison of Clinical Efficacy (n, %)

The NIHSS improvement rate at 7 days after thrombolysis was calculated using the formula:

$$\text{NIHSS improvement rate (\%)} = (\text{NIHSS score before thrombolysis} - \text{NIHSS score after thrombolysis}) / \text{NIHSS score before thrombolysis} \times 100\%.$$

Therapeutic outcomes were categorized as follows:

Markedly effective: improvement rate $\geq 70\%$;

Effective: improvement rate 30% - 69%;

Ineffective: improvement rate $< 30\%$.

The clinical improvement rate (including markedly effective and effective cases improvement) showed no statistically significant difference between the two groups ($P > 0.05$). Details are presented in **Table 3**.

Table 3. Clinical Efficacy of two groups.

	ACS (n = 219)	PCS (n = 100)	Test value	P value
Markedly effective	125	52	0.716	0.397
Effective	52	24	0.002	0.960
Ineffective	42	24	0.972	0.324
Total effective	177 (80.1%)	76 (76%)	0.972	0.324

3.4. Comparison of Bleeding Events (n, %)

The incidence of intracranial hemorrhage was significantly higher in the ACS group than in the PCS group ($P < 0.05$). No significant intergroup differences were observed in other bleeding events or in the total bleeding rate (all $P > 0.05$). Detailed data are provided in **Table 4**.

Table 4. Bleeding events of two groups.

	ACS (n = 219)	PCS (n = 100)	Test value	P value
skin	11 (5.0%)	3 (3.0%)	0.274	0.600
gastrointestinal tract	2 (0.9%)	2 (2.0%)	0.07	0.789
intracranial	20 (9.1%)	3 (3.0%)	3.86	0.049
oral/gingival	4 (1.8%)	1 (1.0%)	0.004	0.948
total bleeding	37 (16.8%)	9 (9.0%)	3.467	0.063

3.5. Comparison of mRS Scores at Discharge and Mortality (n, %)

There were no significant differences in discharge mRS scores or mortality between the groups ($P > 0.05$). See **Table 5**.

Table 5. mRS Scores of two groups.

	ACS (n = 219)	PCS (n = 100)	Test value	P value
0 - 1	130	64	0.620	0.431
2 - 3	62	22	1.409	0.235

Continued

4 - 5	25	12	0.023	0.879
6	2	2	0.071	0.789

4. Discussion

Recombinant tissue plasminogen activator (rt-PA) administered intravenously within 4.5 hours constitutes a primary intervention for AIS. Posterior circulation stroke (PCS) is an important subtype, though it typically represents only 12% - 19% of thrombolysis recipients [7]. In the present five-year retrospective analysis from a single cerebrovascular center, 319 patients treated with intravenous rt-PA thrombolysis (without bridging therapy) were categorized into ACS (n = 219) and PCS (n = 100) groups based on infarct topography. The proportion of PCS in our series (31.3%) exceeded the commonly reported range. One possible explanation for this higher proportion is the deliberate exclusion of patients who underwent subsequent endovascular therapy.

Our study found a significantly higher prevalence of atrial fibrillation in the ACS group than in the PCS group. This aligns with established etiological differences between the two stroke subtypes. Prior studies report that cardiogenic embolism is less common in PCS than in ACS [8], and that vertebrobasilar infarctions are more frequently attributable to small vessel occlusion [9]. This pattern is likely attributable to the hemodynamic tendency for cardiogenic emboli to follow flow into the anterior circulation, which has a richer vascular supply. Although our study did not perform TOAST etiological subtyping, the existing literature consistently supports a higher frequency of cardioembolic mechanisms in ACS [10] [11]. Our finding of a higher prevalence of hypertension and diabetes in the PCS group aligns with established risk profiles for posterior circulation infarction. This pattern is supported by studies linking diabetes to a significantly increased risk of brainstem infarction [12] and hypertension to posterior circulation events [13] [14]. The specific vulnerability of the vertebrobasilar system to these metabolic and hemodynamic factors, while not fully understood, may contribute to a heightened risk of small vessel disease in this region.

Intracranial hemorrhage, the most serious complication of intravenous thrombolysis, occurred significantly more often in ACS than in PCS patients in our study ($P < 0.05$). No significant intergroup differences were found in other bleeding types or the overall bleeding rate. This discrepancy aligns with international reports [15] and may be attributed to several factors. First, the posterior circulation may benefit from superior collateral flow compared to the anterior circulation [16]. Robust collaterals are associated with a lower risk of major hemorrhage after acute recanalization therapies [17] [18]. Second, better collaterals may limit infarct growth in PCS, resulting in smaller final infarct volumes—a known predictor of lower hemorrhage risk [19]. Third, histopathological responses may differ between regions, with potential delay in blood-brain barrier disruption in PCS, further reducing reperfusion hemorrhage risk [20].

We observed no significant differences in NIHSS scores between ACS and PCS patients at any assessment point. The ACS group had only a non-significant trend toward greater NIHSS improvement at day 7 and a higher response rate. Functional outcomes (discharge mRS) and mortality were also similar. This finding of comparable short-term efficacy aligns with a shifting consensus on prognosis. Historically, PCS was associated with worse outcomes. In contrast, contemporary studies report that PCS patients receiving intravenous thrombolysis often have 3-month functional recovery that is comparable to, if not better than, that of ACS patients [4] [21].

5. Study Limitations

No follow-up assessments using the NIHSS or mRS were conducted beyond the 3-month time point; therefore, the medium- and long-term neurological functional outcomes could not be evaluated.

6. Conclusion

This study demonstrates distinct comorbidity profiles between anterior and posterior circulation cerebral infarction: anterior circulation infarction shows a stronger association with atrial fibrillation, while posterior circulation infarction is more closely related to hypertension and diabetes. Intravenous alteplase thrombolysis was equally effective in both groups. Furthermore, patients with posterior circulation infarction had a lower risk of intracranial hemorrhage, while other bleeding risks were comparable to those of anterior circulation infarction. Therefore, for eligible patients with acute cerebral infarction, intravenous thrombolysis should be actively implemented regardless of infarct location.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Sung, S., Chen, C., Chen, Y., Tseng, M., Shen, H. and Lin, H. (2013) Predicting Symptomatic Intracerebral Hemorrhage after Intravenous Thrombolysis: Stroke Territory as a Potential Pitfall. *Journal of the Neurological Sciences*, **335**, 96-100. <https://doi.org/10.1016/j.jns.2013.08.036>
- [2] Dornák, T., Král, M., Hazlinger, M., Herzig, R., Veverka, T., Buřval, S., *et al.* (2015) Posterior vs. Anterior Circulation Infarction: Demography, Outcomes, and Frequency of Hemorrhage after Thrombolysis. *International Journal of Stroke*, **10**, 1224-1228. <https://doi.org/10.1111/ijss.12626>
- [3] Mazyra, M.V., Lees, K.R., Collas, D., Rand, V., Mikulik, R., Toni, D., *et al.* (2015) IV Thrombolysis in Very Severe and Severe Ischemic Stroke. *Neurology*, **85**, 2098-2106. <https://doi.org/10.1212/wnl.0000000000002199>
- [4] Tong, X., Liao, X., Pan, Y., Cao, Y., Wang, C., Liu, L., *et al.* (2016) Intravenous Thrombolysis Is More Safe and Effective for Posterior Circulation Stroke. *Medicine*, **95**, e3848. <https://doi.org/10.1097/md.0000000000003848>

- [5] Pagola, J., Ribo, M., Alvarez-Sabin, J., Rubiera, M., Santamarina, E., Maisterra, O., *et al.* (2011) Thrombolysis in Anterior versus Posterior Circulation Strokes: Timing of Recanalization, Ischemic Tolerance, and Other Differences. *Journal of Neuroimaging*, **21**, 108-112. <https://doi.org/10.1111/j.1552-6569.2009.00462.x>
- [6] Chinese Society of Neurology and Chinese Stroke Society (2024) Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke 2023. *Chinese Journal of Neurology*, **57**, 523-559.
- [7] Sarikaya, H., Arnold, M., Engelter, S.T., Lyrrer, P.A., Mattle, H.P., Georgiadis, D., *et al.* (2011) Outcomes of Intravenous Thrombolysis in Posterior versus Anterior Circulation Stroke. *Stroke*, **42**, 2498-2502. <https://doi.org/10.1161/strokeaha.110.607614>
- [8] Zeng, Q., Tao, W., Lei, C., Dong, W. and Liu, M. (2015) Etiology and Risk Factors of Posterior Circulation Infarction Compared with Anterior Circulation Infarction. *Journal of Stroke and Cerebrovascular Diseases*, **24**, 1614-1620. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.03.033>
- [9] Chung, J., Park, S.H., Kim, N., Kim, W., Park, J.H., Ko, Y., *et al.* (2014) Trial of ORG 10172 in Acute Stroke Treatment (TOAST) Classification and Vascular Territory of Ischemic Stroke Lesions Diagnosed by Diffusion-Weighted Imaging. *Journal of the American Heart Association*, **3**, e001119. <https://doi.org/10.1161/jaha.114.001119>
- [10] Nair, S.S., Sylaja, P.N., Pandian, J., Srivastava, M.V.P., Khurana, D., Kaul, S., *et al.* (2021) Impact of Revascularization Therapies on Outcome of Posterior Circulation Ischemic Stroke: The Indo-Us Stroke Project. *Journal of the Neurological Sciences*, **427**, Article ID: 117499. <https://doi.org/10.1016/j.jns.2021.117499>
- [11] Zürcher, E., Richoz, B., Faouzi, M. and Michel, P. (2019) Differences in Ischemic Anterior and Posterior Circulation Strokes: A Clinico-Radiological and Outcome Analysis. *Journal of Stroke and Cerebrovascular Diseases*, **28**, 710-718. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2018.11.016>
- [12] Ichikawa, H., Kuriki, A., Kinno, R., Katoh, H., Mukai, M. and Kawamura, M. (2012) Occurrence and Clinicotopographical Correlates of Brainstem Infarction in Patients with Diabetes Mellitus. *Journal of Stroke and Cerebrovascular Diseases*, **21**, 890-897. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2011.05.017>
- [13] Cates, M.J., Paton, J.F.R., Smeeton, N.C. and Wolfe, C.D.A. (2012) Hypertension before and after Posterior Circulation Infarction: Analysis of Data from the South London Stroke Register. *Journal of Stroke and Cerebrovascular Diseases*, **21**, 612-618. <https://doi.org/10.1016/j.jstrokecerebrovasdis.2011.02.004>
- [14] Kim, J.S., Nah, H., Park, S.M., Kim, S., Cho, K.H., Lee, J., *et al.* (2012) Risk Factors and Stroke Mechanisms in Atherosclerotic Stroke: Intracranial Compared with Extracranial and Anterior Compared with Posterior Circulation Disease. *Stroke*, **43**, 3313-3318. <https://doi.org/10.1161/strokeaha.112.658500>
- [15] Halúsková, S., Herzig, R., Mikulík, R., Bělašková, S., Reiser, M., Jurák, L., *et al.* (2024) Intravenous Thrombolysis in Posterior versus Anterior Circulation Stroke: Clinical Outcome Differs Only in Patients with Large Vessel Occlusion. *Biomedicines*, **12**, Article 404. <https://doi.org/10.3390/biomedicines12020404>
- [16] Menon, B.K., O'Brien, B., Bivard, A., Spratt, N.J., Demchuk, A.M., Miteff, F., *et al.* (2012) Assessment of Leptomeningeal Collaterals Using Dynamic CT Angiography in Patients with Acute Ischemic Stroke. *Journal of Cerebral Blood Flow & Metabolism*, **33**, 365-371. <https://doi.org/10.1038/jcbfm.2012.171>
- [17] Bang, O.Y., Saver, J.L., Kim, S.J., Kim, G., Chung, C., Ovbiagele, B., *et al.* (2011) Collateral Flow Averts Hemorrhagic Transformation after Endovascular Therapy for Acute Ischemic Stroke. *Stroke*, **42**, 2235-2239.

- <https://doi.org/10.1161/strokeaha.110.604603>
- [18] Chuang, Y., Chan, L., Lai, Y., Kuo, K., Chiou, Y., Huang, L., *et al.* (2013) Configuration of the Circle of Willis Is Associated with Less Symptomatic Intracerebral Hemorrhage in Ischemic Stroke Patients Treated with Intravenous Thrombolysis. *Journal of Critical Care*, **28**, 166-172. <https://doi.org/10.1016/j.jcrc.2012.08.018>
- [19] Lee, S., Han, J.H., Jung, I. and Jung, J. (2020) Do Thrombolysis Outcomes Differ between Anterior Circulation Stroke and Posterior Circulation Stroke? A Systematic Review and Meta-Analysis. *International Journal of Stroke*, **15**, 849-857. <https://doi.org/10.1177/1747493020909634>
- [20] Singer, O.C., Humpich, M.C., Fiehler, J., Albers, G.W., Lansberg, M.G., Kastrup, A., *et al.* (2007) Risk for Symptomatic Intracerebral Hemorrhage after Thrombolysis Assessed by Diffusion-Weighted Magnetic Resonance Imaging. *Annals of Neurology*, **63**, 52-60. <https://doi.org/10.1002/ana.21222>
- [21] Taha, N.A., El Khawas, H., Tork, M.A. and Roushdy, T.M. (2021) Intravenous Thrombolysis Outcome in Posterior vs Anterior Circulation Stroke in a Tertiary Stroke Center in Egypt. *The Egyptian Journal of Neurology, Psychiatry and Neurosurgery*, **57**, Article No. 73. <https://doi.org/10.1186/s41983-021-00325-0>