Neurology Asia 2026; 31(3) : 915 – 923

Erdun-Ujile plus tirofiban for progressive ischemic stroke: a single-centre retrospective cohort from Inner Mongolia

Wuyingga Bao, Nu'enjiya Zhao, Yuehui Liu, Xinhong Zhang, Dongwei Zhang, Yang Liu

Second Department of Neurology, Affiliated Hospital of Inner Mongolia Minzu University, Tongliao, Inner Mongolia, China.

Abstract

Background & Objective: Progressive ischaemic stroke (PIS) is associated with early neurological worsening and poor outcome, and optimal acute management remains uncertain. In some centres, tirofiban is used as an off-label rescue antiplatelet strategy in selected patients, but evidence is still evolving. We evaluated the efficacy and safety of adding the Mongolian medicine Erdun-Ujile to tirofiban in patients with PIS in Inner Mongolia, China. *Methods:* We retrospectively analysed 140 patients with PIS admitted between October 2022 and October 2024. Patients received Erdun-Ujile plus tirofiban (n=70) or tirofiban alone (n=70) for 14 days. Day-14 neurological deficit (NIHSS), disability (mRS), swallowing function (Kubota test), and overall clinical response were compared, together with changes in platelet-to-lymphocyte ratio (PLR), triglyceride–glucose (TyG) index, haemoglobin, and adverse events. *Results***:** Compared with tirofiban alone, Erdun-Ujile plus tirofiban was associated with greater 14-day improvement in NIHSS, mRS and Kubota scores and a higher overall response rate, without an increase in bleeding or other adverse events. Declines in PLR and TyG tended to favour the combination group, although between-group differences were not statistically significant.
Conclusions: In this retrospective cohort, adding Erdun-Ujile to tirofiban improved short-term neurological, functional and swallowing outcomes with acceptable safety. Erdun-Ujile may be a useful adjunctive therapy for progressive ischemic stroke in Asian settings and warrants confirmation in prospective trials.

Keywords: Erdun-Ujile; progressive ischemic stroke; triglyceride-glucose (TyG) index; platelet-to-lymphocyte ratio (PLR)

INTRODUCTION

Stroke is associated with high rates of disability and mortality. In China, the overall lifetime risk of stroke is as high as 39.9%, and in recent years the age of onset has shown a clear trend toward younger patients.[1,2] Acute ischemic stroke (AIS) is the most common subtype of stroke, accounting for approximately 69.6%–72.8% of new-onset stroke cases nationwide.[3,4] Among these, progressive ischemic stroke (PIS) refers to neurological deterioration occurring within a defined time window after the onset of AIS. Its reported incidence is 16%–43%, and it is associated with even higher disability and mortality rates. PIS has a complex pathophysiological basis with multiple contributing factors, and no definitive, effective treatment strategy is currently established.[5,6]

Tirofiban, a glycoprotein IIb/IIIa inhibitor, has been used in some centres as an off-label rescue antiplatelet agent for early neurological deterioration/progressive ischaemic stroke; however, it is not an established standard of care and practice varies across institutions. However, despite standardized Western medical therapy, patients still show heterogeneous clinical responses, indicating a need to explore rational combination strategies. Inner Mongolia is a region with a high burden of AIS in China, where

Address correspondence to: Yang Liu, MD, Second Department of Neurology, Affiliated Hospital of Inner Mongolia Minzu University, Tongliao, Inner Mongolia 028005, China. Email: liuyang_0520@163.com

Date of Submission: 6 December 2025; Date of Acceptance: 6 March 2026

https://doi.org/10.54029/2026iiu

traditional Mongolian medicine has been used extensively and has shown favorable clinical benefit.

Erdun-Ujile (额尔敦–乌日勒), a classical prescription in Mongolian medicine, is believed to exert multiple pharmacological effects, including improving hemorheology, suppressing inflammatory responses, and promoting repair of neurological injury. It has been widely used in Mongolian medical practice for both prevention and treatment of AIS and has shown promising clinical efficacy.[7,8]

Based on this background, the present study aims to evaluate the clinical efficacy, underlying mechanisms, and safety of Erdun-Ujile in combination with tirofiban for the treatment of PIS, with the goal of providing theoretical support for effective therapeutic strategies in progressive ischemic stroke.

METHODS

Study design and participants

A total of 140 patients with progressive ischemic stroke admitted to the Affiliated Hospital of Inner Mongolia Minzu University between October 2022 and October 2024 were included and divided into an intervention group and a control group (70 patients each). The group sizes were not prespecified or determined a priori. The final numbers (70 vs 70) reflected the eligible consecutive patients managed with each treatment strategy during the study period in routine clinical practice, rather than deliberate sampling to equalize group sizes. Baseline data collected included demographics (sex, age, ethnicity), BMI, comorbidities (hypertension, diabetes, coronary heart disease, hyperlipidemia, prior stroke), smoking and alcohol history, infarct location, complete blood count, fasting triglycerides, and fasting glucose. We additionally extracted the onset-to-worsening time (hours; from symptom onset/last-known-well to the first documented neurological worsening) and length of hospital stay (days) from the electronic medical records. We additionally extracted baseline ASPECTS scores, admission blood pressure (SBP/DBP), and TOAST etiologic classification from the medical records. After neurological worsening, all patients underwent MRI with DWI plus MRA within 1–2 hours as part of the institutional stroke pathway.

Patient screening and exclusions

Using the hospital stroke registry and electronic medical records, we screened consecutive patients with progressive ischemic stroke during October 2022 to October 2024. A total of 180 patients were identified as having progressive ischemic stroke during the study period. Patients were excluded if they had major surgery or severe trauma within the previous 30 days (n=15), suspected or confirmed aortic dissection (n=2), a history of stroke within the previous 30 days (n=13), or a known allergy to tirofiban and/or Erdun-Ujile (n=10). After applying these criteria, 140 patients were finally included in the analysis and divided into an Erdun-Ujile plus tirofiban group and a tirofiban-only group (70 patients each). No randomization, matching, or quota sampling was used to achieve a 1:1 ratio.

Eligibility criteria

Inclusion criteria: (1) Meeting the diagnostic criteria for ischemic stroke as defined in the "Chinese Guidelines for the Diagnosis and Treatment of Acute Ischemic Stroke (2023),"[9] with neurological worsening occurring within 7 days after onset, defined as an increase of ≥2 points in the National Institutes of Health Stroke Scale (NIHSS) score;[9] To reduce potential misclassification related to inter-/intra-rater variability, suspected NIHSS deterioration was promptly re-assessed by trained neurologists and recorded as neurological worsening only when clinically consistent with newly developed focal deficits. (2) No prior intravenous thrombolytic therapy; (3) Infarct location confirmed by cranial CT and/or MRI imaging.

Exclusion criteria: (1) Having received endovascular treatment; (2) Concomitant severe cardiac insufficiency, hepatic or renal insufficiency, malignant tumor, hemorrhagic disorder, or thrombocytopenia; (3) Concomitant severe cognitive impairment or psychiatric disorder. (4) Patients with large vessel occlusion (LVO) requiring endovascular thrombectomy were not included in the present cohort.

Treatment protocols

Both groups received standard baseline care (antiplatelet therapy, lipid control/plaque stabilization, circulation support, collateral circulation promotion, and free radical

scavenging). After neurological worsening, the control group received tirofiban hydrochloride sodium chloride injection (initial infusion 0.4 μg/kg/min for 30 min, then 0.1 μg/kg/min for 48–72 h). In our institutional stroke workflow, a dedicated neuro-interventional team evaluates vascular imaging to determine eligibility for large-vessel thrombectomy. As noted above, patients with LVO were not included in this study. After completion of tirofiban infusion, secondary prevention was individualized according to stroke mechanism. For large-artery atherosclerosis, patients received dual antiplatelet therapy with aspirin 100 mg once daily plus clopidogrel 75 mg once daily for 3 months; thereafter, antiplatelet intensity (dual vs single) was re-evaluated at follow-up. For small-vessel occlusion, single antiplatelet therapy was generally used. For cardioembolism, elective oral anticoagulation was initiated after bleeding-risk assessment, predominantly rivaroxaban. Statin therapy was prescribed in all patients at a routine dose (rosuvastatin 10 mg once daily). The intervention group received the same tirofiban regimen plus the traditional Mongolian medicine Erdun-Ujile, given orally as 15 pills at bedtime (crushed and given via nasogastric tube if swallowing was impaired). Treatment lasted 14 days in both groups.In our centre, intravenous tirofiban is considered for progressive neurological deterioration in the absence of contraindications. Therefore, some patients with progressive neurological deterioration did not receive tirofiban because of contraindications, including major surgery/severe trauma within 30 days, aortic dissection, recent stroke within 30 days, or known allergy to tirofiban and/or Erdun-Ujile; these patients were excluded from the present cohort as described above.

Because of the retrospective, real-world nature of this study, the decision to add Erdun-Ujile was made by the attending neurologist according to routine practice and patient/family acceptance after explanation, rather than by random allocation. All study medications were administered during hospitalization under nursing supervision (or via nasogastric tube when dysphagia was present), and adherence was assessed using medication administration records. In our centre, intravenous tirofiban is commonly considered for progressive neurological deterioration in the absence of contraindications; however, practice may vary across institutions. In our centre, intravenous tirofiban is used off-label as a rescue antiplatelet strategy for selected patients with neurological deterioration after careful bleeding-risk assessment; this reflects local practice rather than a universally accepted standard.

Erdun-Ujile formulation and quality control

Erdun-Ujile is a hospital-prepared compound granular formulation based on a traditional Mongolian prescription and produced in our hospital's Mongolian Medicine Preparation Laboratory under approved in-house standards. Each batch undergoes quality control (appearance, content uniformity, microbial limits, heavy metals), with retained samples and full traceability (batch number, production date, expiry date).The formula contains 29 ingredients, including mineral, herbal, and animal-derived components (e.g., gypsum, clove, Terminalia chebula, Melia toosendan fruit, gardenia fruit, safflower, nutmeg, cardamom, cassia seed, Tsaoko, Nigella sativa seed, agarwood, artificial musk, artificial bezoar, processed pearl, etc.).

The clinical regimen is 15 pills orally at bedtime; in patients with dysphagia, the medication is ground and given via nasogastric tube. Treatment lasts 14 days. Administration is stopped if bleeding signs or severe adverse reactions appear.

Outcome measures

Neurological status was assessed using the NIHSS (0–42; higher scores indicate more severe neurological deficit). During hospitalization, the NIHSS was assessed three times daily by trained neurologists and additionally whenever neurological change was suspected. Whenever neurological worsening was suspected/identified, the NIHSS was re-assessed promptly. Repeat non-contrast cranial CT was mandatory and was performed in all patients (100%) within 30–60 min after worsening to exclude intracranial hemorrhage/hemorrhagic transformation. Following CT to exclude hemorrhage, MRI (DWI) plus MRA was performed within 1–2 hours after worsening. Stroke progression versus a new ischemic event was determined by integrating (1) the pattern of new neurological deficits and (2) DWI/MRA findings: lesion enlargement in the same vascular territory was considered progression, whereas a new DWI lesion in a different territory (with corresponding vascular findings when present) suggested a new ischemic event. For the present analysis,

NIHSS scores were recorded at admission, after neurological worsening, at tirofiban discontinuation, and on day 14. Clinical efficacy at day 14 was defined by NIHSS improvement rate: basic recovery (≥75%), markedly effective (≥50%–<75%), effective (≥25%–<50%), or ineffective (<25%); overall effective rate = (basic recovery + markedly effective + effective) / total ×100%. Functional outcome and independence were assessed with the modified Rankin Scale (mRS, 0–6; higher = worse) at the same four time points. Swallowing was assessed using the Kubota Water Swallow Test (1–5; lower = better) at the same time points. Blood biomarkers were taken fasting at baseline and day 14: hemoglobin, platelet count, absolute lymphocyte count, glucose, and triglycerides. Platelet-to-lymphocyte ratio (PLR) was platelet count / lymphocyte count. The triglyceride-glucose (TyG) index, a surrogate of insulin resistance/atherometabolic stress, was ln[triglycerides (mg/dL) × fasting glucose (mg/dL) / 2]. Safety outcomes included gingival, cutaneous/mucosal, and gastrointestinal bleeding, and symptomatic intracranial hemorrhage.

Statistical analysis

Continuous variables were summarized as mean ± standard deviation (SD). Between-group differences were tested with Welch's t test, reporting the mean difference (MD) and 95% confidence interval (CI); within-group (pre–post) changes used paired t tests. Categorical variables were summarized as n (%), compared using Pearson's x^2 test; if expected counts were <5, Fisher's exact test was used, and risk difference (RD), relative risk (RR), and 95% CI were reported. Sensitivity analyses with ANCOVA were performed, adjusting for baseline scores, and showed consistent results (data not shown). All tests were two-sided with α=0.05. Missing data were analyzed on an available-case basis. Analyses were performed in R 4.5.1.

RESULTS

Baseline characteristics

There were no statistically significant differences between the two groups in terms of sex, age, ethnicity, body mass index (BMI), smoking or alcohol use, history of hypertension/diabetes/atrial fibrillation, infarct location or laterality, admission NIHSS/mRS scores, or routine hematologic and metabolic parameters. The onset-to-worsening time was comparable between groups (48.89±13.87 vs 48.56±13.75 hours; P=0.888), as was length of stay (14.67±4.78 vs 14.01±4.17 days; P=0.386). Overall, the baseline profiles were balanced and comparable, providing a valid premise for subsequent efficacy comparisons. Baseline imaging severity (ASPECTS), admission blood pressure, refined infarct locations including internal capsule and cortical involvement, and TOAST subtypes were comparable between groups (Table 1).

Primary clinical outcomes at day 14

At 14 days, the intervention group performed better than the control group. NIHSS scores were lower (MD = −1.03, 95% CI −1.92 to −0.14, P = 0.024, SMD = −0.39), mRS scores were lower (MD = −0.43, 95% CI −0.73 to −0.12, P = 0.006, SMD = −0.47), and Kubota Water Swallow Test scores were lower (MD = −0.34, 95% CI −0.67 to −0.01, P = 0.042, SMD = −0.35). The overall effective rate was also higher (91.43% vs 71.43%; RD 20.00%, 95% CI 7.55% to 32.45%; RR 1.28, 95% CI 1.09 to 1.51; x^2 = 9.258, P = 0.002). See Table 2.

At 14 days after treatment, the combination therapy group showed significantly better NIHSS scores, mRS scores, and Kubota Water Swallow Test scores compared with the control group (all P < 0.05; see Figure 1).

Biomarker changes and safety outcomes

Both groups showed decreases in PLR and TyG from baseline to day 14, with a larger decline in the combination group, but the between-group differences were not statistically significant (PLR ΔΔ = −13.997, 95% CI −31.318 to 3.324, P = 0.112; TyG ΔΔ = −0.171, 95% CI −0.399 to 0.057, P = 0.141). The change in HGB was also not significantly different between groups (ΔΔ = +0.96, 95% CI −6.68 to 8.59, P = 0.805).

In terms of safety, In the intervention group, 2/70 patients (2.86%) had adverse events (1 gingival bleed, 1 cutaneous/mucosal bleed; no gastrointestinal or symptomatic intracranial hemorrhage). In the control group, 4/70 patients (5.71%) had adverse events (1 gingival bleed, 1 cutaneous/mucosal bleed, 2 gastrointestinal bleeds; no symptomatic intracranial hemorrhage). All patients underwent repeat non-contrast cranial CT within 30–60 min after neurological

Table 1: Comparison of baseline characteristics between the two groups

Variable	intervention group (n=70)	Control group (n=70)	*P* value
Sex [n (%)]			0.366
Male	50（71.43）	45（64.29）	
Female	20（28.57）	25（35.71）	
Age (years, $\bar{x} \pm s$)	63.87±10.37	65.91±10.49	0.249
Ethnicity [n (%)]			0.608
Han	42（60.00）	39（55.71）	
Mongolian	28（40.00）	31（44.29）	
BMI（kg/m^2，$\bar{x} \pm s$）	25.77±3.04	26.29±3.04	0.310
Comorbidities [n (%)]			
Hypertension	47（67.14）	52（74.29）	0.353
Diabetes mellitus	18（25.71）	25（35.71）	0.200
Coronary heart disease	13（18.57）	11（15.71）	0.654
Hyperlipidemia	33（47.14）	26（37.14）	0.231
Atrial fibrillation	8（11.43））	9（12.86）	0.796
Prior stroke	29（41.43）	20（28.57）	0.111
Personal history [n (%)]			
Smoking history	34（48.57）	32（45.71）	0.735
Alcohol use	32（45.71）	28（40.00）	0.495
Infarct location on imaging [n (%)]			0.903
Basal ganglia region	38（54.29）	35（50.00）	
Brainstem	19（27.14）	25（35.71）	
Thalamus	5（7.14）	3（4.29）	
internal capsule	4（5.71）	3（4.29）	
cortical area(s)	3（4.29）	3（4.29）	
Other locations	1（1.43）	1（1.43）	
Stroke scales (score, $\bar{x} \pm s$)			
NIHSS score	4.84±2.70	4.03±2.28	0.056
mRS score	1.96±1.03	1.86±0.97	0.447
Kubota water swallow test score	1.63±1.08	1.57±0.89	0.733
Hematologic / metabolic indices ($\bar{x} \pm s$)			
HGB（g/L）	134.70 ± 16.53	134.97 ± 16.03	0.922
PLR	154.24±33.51	154.79±39.76	0.930
TyG index	9.91±0.40	9.98±0.48	0.350
Onset-to-worsening time (hours)	48.89±13.87	48.56±13.75	0.888
Length of stay (days)	14.67±4.78	14.01±4.17	0.386
ASPECTS score	8.34 ± 1.34	8.45 ± 1.35	0. 629
Admission SBP	151.67 ± 33.87	150.98 ± 33.98	0.904
Admission DBP	95.89 ± 23.67	95.07 ± 24.01	0.839
TOAST classification			0. 999
LAA	34 (48.57)	35 (50.00)	
CE	8 (11.43)	9 (12.86)	
SVO	20 (28.57)	19 (27.14)	
Other determined	7 (10.00)	7 (10.00)	
Undetermined	1 (1.43)	1 (1.43)	

Note: NIHSS, National Institutes of Health Stroke Scale; mRS, modified Rankin Scale; HGB, hemoglobin; PLR, platelet-to-lymphocyte ratio; TyG index, triglyceride-glucose index；ASPECTS，Alberta Stroke Program Early CT Score；SBP，Systolic Blood Pressure；DBP，Diastolic Blood Pressure；TOAST，Trial of Org 10172 in Acute Stroke Treatment (classification)；LAA，Large-Artery Atherosclerosis；CE，Cardioembolism；SVO，Small-Vessel Occlusion

Table 2: Primary clinical outcomes (14 days after treatment)

Outcome	intervention group (n=70)	Control group (n=70)	MD (95% CI)	SMD (Cohen's d)	P value
NIHSS（14 d）	3.96 ± 2.58	4.99 ± 2.75	-1.03 (-1.92, -0.14)	-0.39	0.024
mRS（14 d）	1.60 ± 0.81	2.03 ± 1.01	-0.43 (-0.73, -0.12)	-0.47	0.006
Kubota score（14 d）	1.67 ± 0.97	2.01 ± 1.00	-0.34 (-0.67, -0.01)	-0.35	0.042
Overall response rate（14 d）	64/70 (91.43%)	50/70 (71.43%)	RD = 20.00% (7.55%, 32.45%)	RR = 1.28 (1.09, 1.51)	0.002

Note: Welch t-test for continuous data (mean±SD, MD, 95% CI, Cohen's d); ORR = (cured+markedly effective+effective)/total; proportions by Pearson x^2 with RD/RR (95% CI); all P two-sided.

worsening, and no intracranial hemorrhage was detected.The difference in overall adverse event rate was not statistically significant (x^2 = 0.697, P = 0.404; Fisher P = 0.681). See Table 3.

DISCUSSION

Significance of the study

Progressive ischemic stroke causes early neurological worsening and is linked to higher disability and mortality, often involving inflammation, metabolic dysregulation, and microcirculatory impairment.[10,11] Antiplatelet intensification strategies, including off-label tirofiban in selected patients, may rapidly inhibit platelet aggregation and potentially improve microvascular perfusion; however, the evidence base remains limited and heterogeneity by stroke mechanism is expected.[12,13] This single-center real-world study evaluated tirofiban plus the traditional Mongolian medicine Erdun-Ujile, using two accessible systemic markers: platelet-to-lymphocyte ratio (PLR, inflammation) and triglyceride-glucose (TyG) index (metabolic/atherosclerotic risk). This "antiplatelet + anti-inflammatory/metabolic modulation" model, integrating Mongolian and Western medicine, may provide added benefit and offers preliminary evidence for incorporating traditional Mongolian therapy into modern acute stroke management in regional practice.

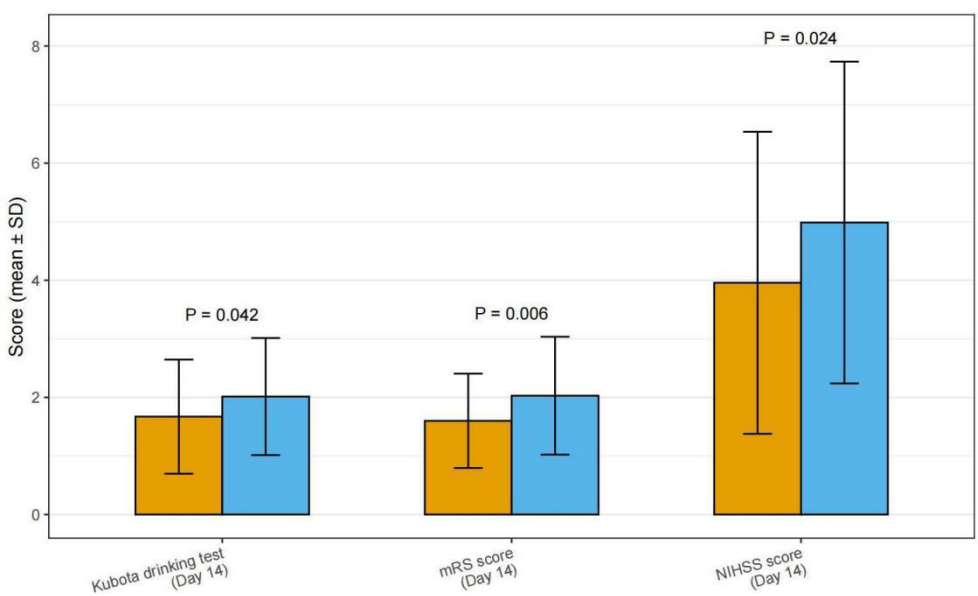

Figure 1. Clinical outcomes at day 14. At day 14, the Erdun-Ujile + tirofiban group had significantly better neurological function, less disability, and better swallowing than tirofiban alone.

Table 3: Changes in biomarkers and safety (baseline to Day 14)

	Intervention group Baseline	Control group Baseline	Intervention group Day 14	Control group Day 14	Δ (Intervention)	Δ (Control)	ΔΔ=Δ1−Δ0 (95% CI)	P value
HGB (g/L)	134.70 ± 16.53	134.97 ± 16.03	136.66 ± 16.56	135.97 ± 15.96	1.96 ± 22.54	1.00 ± 23.13	0.96 (-6.67, 8.59)	0.805
PLR	154.24 ± 33.51	154.79 ± 39.76	130.24 ± 33.51	144.79 ± 39.76	-24.00 ± 46.42	-10.00 ± 56.68	-14.00 (-31.32, 3.32)	0.112
TyG index	9.91 ± 0.40	9.98 ± 0.48	8.63 ± 0.48	8.87 ± 0.51	-1.28 ± 0.68	-1.11 ± 0.68	-0.17 (-0.40, 0.06)	0.141
Safety: any adverse event	2/70 (2.86%)	4/70 (5.71%)					RD = -2.86% (-9.55%, 3.84%)	0.404 / 0.681

Note: Δ = Day 14 − Baseline; ΔΔ compares the difference in mean change between the two groups (Welch's t test) with the corresponding 95% CI. Because safety events were few, both Pearson's χ^2 test and Fisher's exact test are reported. All P values are two-sided.

Main findings

(1) Adding Erdun-Ujile to tirofiban increased the 14-day overall clinical response rate (91.43% vs 71.43%, $P < 0.05$). (2) The combination group had better neurological and functional outcomes, with lower NIHSS and mRS scores (both $P < 0.05$). (3) Swallowing function was better in the combination group, with a lower Kubota Water Swallow Test score ($P < 0.05$). (4) Inflammatory and metabolic markers (PLR and TyG) showed numerically greater reductions in the combination group; however, the between-group differences in change (ΔΔ) were not statistically significant (both $P > 0.05$; Table 3). (5) Hemoglobin levels were similar ($P > 0.05$), and adverse event rates were low and not different between groups ($P > 0.05$), with no signal of excess bleeding. Overall, in this real-world cohort in which tirofiban was used off-label as a rescue antiplatelet strategy, the addition of Erdun-Ujile was associated with improved neurological, functional and swallowing outcomes, with concurrent favorable changes in inflammatory and metabolic indices, without an apparent increase in bleeding events. These findings should be interpreted cautiously and warrant confirmation in prospective randomized studies.

Comparison with existing knowledge

Progressive ischemic stroke (PIS) is driven not only by platelet activation but also by inflammatory cascades, endothelial dysfunction, and metabolic abnormalities, which together worsen microcirculatory perfusion and infarct progression.[14] Tirofiban rapidly inhibits platelet aggregation and improves reperfusion, but has limited effect on inflammation and metabolism. In this study, adding Erdun-Ujile to tirofiban further improved clinical efficacy, neurological and swallowing function, and biomarkers (PLR, TyG), suggesting added benefit beyond antiplatelet therapy alone and supporting a multimodal rather than single-target approach.[15,16] No increase in adverse events was observed, indicating short-term feasibility and acceptable safety.

Possible mechanistic considerations

PLR and the TyG index are commonly used surrogate markers of systemic inflammatory status and metabolic/insulin-resistance burden, and prior studies have linked lower PLR and lower TyG to more favorable stroke outcomes.[17–20] In our cohort, PLR and TyG showed numerically greater reductions in the combination group; however, the between-group differences were not statistically significant (PLR: $P = 0.112$; TyG: $P = 0.141$; Table 3). Therefore, these biomarker findings should be interpreted as hypothesis-generating trends rather than confirmatory mechanistic evidence. The concurrent improvements in neurological and functional outcomes may reflect combined effects on platelet activity and microcirculatory function, while the similar hemoglobin changes between groups ($P = 0.805$) argue against a primary role of oxygen-carrying capacity or blood viscosity. Further adequately powered studies with biomarker-focused endpoints are warranted to clarify these mechanisms.

Safety and risk control

Although combining a GPIIb/IIIa inhibitor with an herbal compound could raise bleeding

concerns, no significant increase in hemorrhagic events was observed in the combination group, and overall adverse event rates were low and similar to the control group. This suggests acceptable short-term safety with strict selection and monitoring. Clinically, bleeding risk should still be assessed individually (e.g., age, prior bleeding, liver/renal function, concomitant anticoagulants/thrombolytics), with ongoing monitoring of platelets and bleeding signs.

Clinical implications

For patients with progressive ischemic stroke (PIS) who show evidence of inflammatory activation and/or metabolic dysregulation in the acute phase (i.e., elevated PLR and/or elevated TyG phenotypes), adding Erdun-Ujile on top of tirofiban may yield a higher short-term response rate and better functional recovery, without increasing short-term bleeding risk. This strategy provides a practical model for integrating regional traditional Mongolian medicine into modern stroke management and may be extendable to patients with metabolic syndrome or a high atherosclerotic burden.

As for the strengths and limitations of this study, this single-center study used a standardized clinical pathway, reducing variability in baseline management, and evaluated multidimensional endpoints, including clinical outcomes (NIHSS, mRS, swallowing) and biological markers (PLR, TyG), at two key time points (end of infusion and day 14), allowing assessment of early clinical and mechanistic changes. However, it was retrospective and single-center, with potential selection bias and unmeasured confounding, and it did not include stratified analyses by TOAST subtype, perfusion/collateral status, or vessel recanalization. The study focused on short-term outcomes only, without ≥90-day data on function, recurrence, or re-occlusion, and because Erdun-Ujile is a multi-component formulation, specific active components and mechanistic pathways were not separately identified. Practice patterns for tirofiban after neurological deterioration reflect local protocol and may differ elsewhere. In addition, the effect of tirofiban may vary by stroke mechanism (e.g., branch atheromatous disease/perforator atherosclerosis versus other etiologies); however, etiologic classification such as TOAST/BAD was not consistently available in this retrospective cohort for stratified analyses. Future prospective studies should predefine stroke subtype and imaging markers to clarify which subgroups benefit most.

Conclusions

In this single-centre retrospective cohort, in which tirofiban was used off-label as a rescue antiplatelet strategy for progressive ischaemic stroke, adjunctive Erdun-Ujile was associated with better short-term neurological, functional and swallowing outcomes and a higher overall clinical response, without an apparent increase in bleeding or other adverse events. Favorable changes in PLR and TyG suggested potential anti-inflammatory and metabolic modulation, but causal inference cannot be made due to the observational design and possible residual confounding. Prospective, adequately powered randomized trials with predefined stroke subtype/imaging markers and longer follow-up are required to confirm efficacy, clarify the target population, and establish the safety profile for broader clinical use.

DISCLOSURE

Ethics: The study protocol was approved by the Medical Ethics Committee of the Affiliated Hospital of Inner Mongolia Minzu University (Approval No. NM-LL-2024-12-04-01). Given the retrospective design and use of anonymised data, the requirement for written informed consent was waived.

Availability of data: The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Financial support: This work was supported by the Natural Science Foundation of Inner Mongolia Autonomous Region, Doctoral Research Project (Grant No. 2021BS08025), the Natural Science Foundation of Inner Mongolia Autonomous Region, General Program (Grant No. 2023MS08060), and the Open Project of the Basic Research and Translational Innovation Center for Integrated Mongolian and Western Medicine in Chronic Diseases, Inner Mongolia Autonomous Region (Grant No. 2024FYK004).

Conflict of interest: None

REFERENCES

1. Gao Y, Liu K, Fang S. Changing patterns of stroke and subtypes attributable to high systolic blood pressure

in China from 1990 to 2019. *Stroke* 2024;55(1):59-68. doi: 10.1161/STROKEAHA.123.044505.
2. Li W, Lan J, Wei M, *et al*. Normobaric hyperoxia combined with endovascular treatment for acute ischaemic stroke in China (OPENS-2 trial): a multicentre, randomised, single-blind, sham-controlled trial. *Lancet* 2025;405(10477):486-97. doi: 10.1016/S0140-6736(24)02809-5.
3. Zhu ZK, Jiang YY, Yang X, *et al*. Clinical characteristics, in-hospital management, and outcomes among patients hospitalized for acute ischemic stroke in rural versus urban hospitals in China: a nationwide hospital-based study. *Int J Stroke* 2025;20(1):53-63. doi: 10.1177/17474930241286709.
4. Dong Y, Jiang K, Li Z, *et al*. Tongxinluo and functional outcomes among patients with acute ischemic stroke: a randomized clinical trial. *JAMA Netw Open* 2024;7(9):e2433463. doi: 10.1001/jamanetworkopen.2024.33463.
5. Tudor T, Spinazzi EF, Alexander JE, *et al*. Progressive microvascular failure in acute ischemic stroke: a systematic review, meta-analysis, and time-course analysis. *J Cereb Blood Flow Metab* 2024;44(2):192-208. doi: 10.1177/0271678X231216766.
6. Werring DJ, Ozkan H, Doubal F, et al. Early neurological deterioration in acute lacunar ischemic stroke: systematic review of incidence, mechanisms, and prospects for treatment. *Int J Stroke* 2025;20(1):7-20. doi: 10.1177/17474930241273685.
7. Narenmandula, Siqin, Yang A. Effect of the Mongolian medicine Erdun-Ujile on the pre-thrombotic state and quality of life in elderly patients with hypertension. China Medicine. 2025;20(4):591-596.
8. Sarina. Evaluation of the efficacy of the Mongolian medicine Erdun-Ujile in the treatment of ischemic stroke using ASL imaging. Inner Mongolia Minzu Univ. 2022. [Dissertation].
9. Neurology Branch of the Chinese Medical Association; Cerebrovascular Disease Group. Chinese guidelines for the diagnosis and treatment of acute ischemic stroke 2023. *Chin J Neurol* 2024;57(6):523-59. doi: 10.3760/cma.j.cn113694-20240410-00221.
10. Eilertsen RK, Midtbo H, Sindre RB, *et al*. Factors associated with progression of arterial stiffness in ischemic stroke survivors: the Norwegian Stroke in the Young Study. *Blood Press* 2024;33(1):2298308. doi: 10.1080/08037051.2023.2298308.
11. Hou Z, Cui R, Yu Y, *et al*. Endovascular thrombectomy for a progressive stroke patient with a high-burden carotid free-floating thrombus. *Ann Neurol* 2024;95(2):362-364. doi: 10.1002/ana.26820.
12. Yang Q, He Q, Mao X, *et al.* Evaluation of safety and efficacy of tirofiban injection for treating acute ischemic stroke beyond standard time window. *Sci Rep* 2025;15(1):27399. doi: 10.1038/s41598-025-11882-2.
13. Liu J, Oorloff MD, Nadella A, *et al.* Tirofiban-induced acute profound thrombocytopenia in endovascular therapy for acute ischemic stroke: a rare case report. *BMC Neurol* 2025;25(1):355. doi: 10.1186/s12883-025-04368-1.
14. Zhu X, Guo Z, Tian L, *et al*. Efficacy and safety of tirofiban combined with endovascular therapy for basilar artery occlusion stroke due to large artery atherosclerosis. *J Stroke Cerebrovasc Dis* 2024;33(2):107526. doi: 10.1016/j.jstrokecerebrovasdis.2023.107526.
15. Guo ZN, Zhang KJ, Zhang P, *et al.* Early tirofiban administration after intravenous thrombolysis in acute ischemic stroke (ADVENT): study protocol of a multicenter, randomized, double-blind, placebo-controlled clinical trial. *Eur Stroke J* 2024;9(2):510-4. doi: 10.1177/23969873231225069.
16. Garayzade R, Berlis A, Schiele S, *et al.* Efficacy and safety outcomes for acute ischemic stroke patients treated with intravenous infusion of tirofiban after emergent carotid artery stenting. *Clin Neuroradiol* 2024;34(1):163-72. doi: 10.1007/s00062-023-01350-7.
17. Li W, Wang Z, Gao M, *et al.* Relationship between neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio in neurosurgery and the occurrence and prognosis of progressive hemorrhagic brain injury in patients with traumatic brain injury. *BMC Neurol* 2024;24(1):484. doi: 10.1186/s12883-024-03986-5.
18. Paracino R, De Domenico P, Di Rienzo A, *et al.* Radiologic and blood markers predicting long-term neurologic outcome following decompressive craniectomy for malignant ischemic stroke: a preliminary single-center study. *J Neurol Surg A Cent Eur Neurosurg* 2025;86(3):219-29. doi: 10.1055/a-2312-9448.
19. Sun W, Shen H, Wu X, *et al*. Influence of TyG index on large vessel occlusive stroke following endovascular treatment. *CNS Neurosci Ther* 2024;30(12):e70143. doi: 10.1111/cns.70143.
20. Pu Y, Xing N, Wang Y, *et al*. Differential impact of TyG and TyG-BMI indices on short- and long-term mortality in critically ill ischemic stroke patients. *BMC Cardiovasc Disord* 2024;24(1):754. doi: 10.1186/s12872-024-04450-5.