 DOI: 10.19600/j.cnki.issn2152 – 3924.2026.03.014

Effect of Shenfu Injection on Regional Cerebral Blood Flow in Rats with Acute Cerebral Infarction

Zhaojun XIANG, Xia ZHANG*, Chaoyang TANG, Qianqian LUO, Shengyueqin GONG, Hui HU, Chaoyan ZHU

Department of Neurosurgery, Taihe Hospital (Affiliated Hospital of Hubei University of Medicine), Shiyan 442000, China

Abstract [**Objectives**] To observe the effect of Shenfu Injection on regional cerebral blood flow (RCBF) in a rat model of acute cerebral infarction. [**Methods**] Thirty Sprague-Dawley (SD) rats were randomly assigned to three groups: control group, model group, and Shenfu Injection group (administered via tail vein injection at 2 mL/100 g body weight). The model was established using the middle cerebral artery occlusion (MCAO) method, and electroencephalogram (EEG) spike amplitude and RCBF were measured at 0, 30, and 60 min, as well as 1, 3, and 6 d post-reperfusion. [**Results**] Compared with the model group, the Shenfu Injection group exhibited significantly increased RCBF on day 3 and 6 ($P<0.05$) and significantly decreased EEG spike amplitude on day 1, 3, and 6 ($P<0.05$). [**Conclusions**] Shenfu Injection improves regional cerebral blood flow in rats with acute cerebral infarction, potentially through mechanisms involving suppression of abnormal electrical discharges and dilatation of microvessels.

Key words Shenfu Injection, Acute cerebral infarction, Regional cerebral blood flow, Electroencephalogram, Spike, Rats

1 Introduction

Shenfu Injection is a formulation produced using modern extraction techniques from red ginseng and black aconite, renowned for its effects in nourishing yin, replenishing qi, and stabilizing vitality; its primary components include aconitine, ginsenosides, and polysaccharides[1]. This injection markedly suppresses oxidative stress and inflammatory responses while protecting the blood-brain barrier through vasodilation and enhancement of cerebral blood flow, thereby preventing ischemic-hypoxic encephalopathy; it is clinically employed as an adjunct therapy for conditions such as cerebral ischemic diseases, shock, and viral myocarditis[2]. This experiment aimed to examine the impact of Shenfu Injection on regional cerebral blood flow in rats modeling acute cerebral infarction (ACI), thereby investigating its protective mechanisms against cerebral ischemia-reperfusion injury.

2 Materials and methods

2.1 Experimental animals Thirty female SD rats, weighing 160 – 210 g, were obtained from the Hubei Provincial Laboratory Animal Center; the facility usage license number was SYXK (Hubei) 2025-0031, and the production license number was SCXK (Hubei) 2025-0008.

2.2 Instruments and reagents The BL-420I Biological Signal Acquisition System (TaiMeng Co., Ltd., Chengdu) and Shenfu Injection (China Resources Sanjiu Pharmaceutical Co., Ltd., national drug approval number: Z20093647) were utilized.

2.3 Acute cerebral infarction model and grouping The 30 rats were randomly divided into three groups using a random number table: control group ($n=10$), model group ($n=10$), and Shenfu Injection group ($n=10$). Both the model and Shenfu Injection groups underwent middle cerebral artery occlusion (MCAO) modeling as described in reference[3]: anesthesia was induced by intraperitoneal injection of 3% pentobarbital sodium (10 mg/100 g), followed by occlusion of the Willis circle blood flow in the middle cerebral artery for 60 min, after which perfusion was restored to establish acute cerebral infarction. The control group received anesthesia and disinfection only, without surgical intervention. All three groups received injections 24 h pre-surgery via the tail vein: the Shenfu Injection group was administered Shenfu Injection at 2 mL/100 g body weight, while the control and model groups received equivalent volumes of physiological saline; injections were administered once daily for one week.

2.4 Measurement of EEG spike amplitude and regional cerebral blood flow Regional cerebral blood flow (RCBF) [unit: mL/(100 g · min)] was measured using an electrolytic tissue blood flow meter (FBR-1) produced by Nippon Biopharmaceutical, Japan. During the experiment, silver wire electrodes were implanted subcutaneously into the right parietal region of the rats; EEG spike amplitude was recorded via the BL-420I system, and both EEG amplitude and RCBF were measured at six time points: 0, 30, and 60 min, as well as 1, 3, and 6 d post-reperfusion.

2.5 Statistical methods Statistical analyses were performed using SPSS 27.0; data are presented as ($\bar{x} \pm s$), with EEG and RCBF across different time points examined via repeated-measures ANOVA; statistical significance was defined as $P<0.05$.

3 Results and analysis

3.1 RCBF results in acute cerebral infarction rats In the control group, RCBF exhibited no significant changes throughout the experimental period or at any time point. Compared with the control group, the model group showed significantly reduced RCBF at all six time points (0, 30, and 60 min; and 1, 3, and 6 d) ($P<0.05$), with statistically significant differences. In contrast, compared with the model group, the Shenfu Injection group demonstrated significantly increased RCBF on day 3 and 6 ($P<0.05$), with significant differences (Table 1).

Received: March 13, 2026 Accepted: May 13, 2026

* Corresponding author. Xia ZHANG, bachelor's degree.

Table 1 Comparison of RCBF at different time points [mL/(100g · min), $\bar{x} \pm s$, $n = 10$]

Group	0 min	30 min	60 min	1 d	3 d	6 d
Control	37.59 ± 3.45	36.90 ± 3.56	37.70 ± 2.21	36.59 ± 2.51	37.08 ± 2.32	36.91 ± 3.48
Model	18.53 ± 1.32[a]	16.35 ± 0.97[a]	17.26 ± 1.43[a]	18.67 ± 1.54[a]	20.21 ± 1.57[a]	20.77 ± 1.57[a]
Shenfu Injection	18.49 ± 1.37[a]	17.78 ± 1.32[a]	18.57 ± 1.65[a]	19.87 ± 1.21[a]	30.29 ± 2.95[b]	35.59 ± 2.70[b]

NOTE [a]$P < 0.05$ vs. control group; [b]$P < 0.05$ vs. model group. The same below.

3.2 EEG spike amplitude results in acute cerebral infarction rats EEG spike amplitude in the control group showed no significant changes across the experiment or at any time point. Compared with the control group, the model group maintained high EEG spike amplitude at five time points (30 and 60 min; and 1, 3, and 6 d) ($P < 0.05$), with statistically significant differences. In contrast, compared with the model group, the Shenfu Injection group showed significantly reduced EEG spike amplitude on day 1, 3, and 6 ($P < 0.05$), with significant differences (Table 2).

Table 2 Comparison of EEG spike amplitude at different time points (mV, $\bar{x} \pm s$, $n = 10$)

Group	0 min	30 min	60 min	1 d	3 d	6 d
Control	28.30 ± 2.74	29.06 ± 1.58	29.07 ± 1.53	29.18 ± 1.92	29.50 ± 2.29	30.21 ± 2.51
Model	28.40 ± 1.54	70.19 ± 4.76[a]	74.39 ± 5.43[a]	69.52 ± 5.50[a]	64.80 ± 4.39[a]	58.70 ± 3.76[a]
Shenfu Injection	29.09 ± 2.09	70.20 ± 5.54[a]	73.39 ± 6.07[a]	57.20 ± 4.00[a]b	44.31 ± 3.65[a]b	31.59 ± 1.19[b]

4 Discussion

Acute cerebral infarction (ACI), also known as acute ischemic stroke, falls under the category of large-vessel occlusive ischemic cerebrovascular diseases; it is frequently accompanied by acute functional deficits and accounts for approximately 40% of all acute ischemic strokes. Patients with ACI exhibit severe neurological impairments, abrupt onset, and high rates of disability and mortality[2,4]. Epidemiological data indicate that over 2 million new stroke cases occur annually in China, with approximately 1 million deaths; consequently, stroke prevention and treatment have become urgent priorities[2,5]. While clinical reports have documented Shenfu Injection's use in treating acute myocardial infarction, studies in the realm of acute cerebral infarction remain relatively scarce[6]. RCBF and EEG abnormalities commonly arise during acute ischemic stroke episodes, and diagnostic evaluations can reveal ischemic necrotic changes in brain tissue[7].

Shenfu Injection functions to invigorate qi and stabilize collapse, clinically applied for syncope collapse syndromes (wherein yang qi suddenly depletes), as well as palpitations, restlessness, dyspnea, diarrhea, gastric pain, and arthralgia stemming from yang deficiency or qi deficiency. In this experiment, following ACI induction in the Willis circle of the middle cerebral artery, rats exhibited a rapid rise in EEG spike amplitude and a substantial decline in RCBF. After tail-vein administration of Shenfu Injection, the treated group demonstrated a gradual reduction in EEG spike amplitude and a progressive recovery of RCBF; by day 3 and 6, EEG spike amplitude and RCBF approached baseline levels. These findings suggest that Shenfu Injection suppresses abnormal electrical discharges in ischemic infarct regions while markedly enhancing RCBF, thereby ameliorating energy metabolism in affected brain tissues and alleviating ischemic and edematous conditions; they also indirectly confirm that Shenfu Injection facilitates cellular energy metabolism and functional recovery of neuronal cells in infarct zones, mitigating cerebral tissue damage.

In summary, this study demonstrates that Shenfu Injection confers protective effects against cerebral ischemia-reperfusion injury in rats modeling acute cerebral infarction; the mechanism for microcirculatory improvement likely involves suppression of abnormal post-reperfusion brain discharges, subsequently leading to microvascular dilation and enhanced microcirculation.

References

[1] HUANG LD, DENG HX. Research progress on molecular mechanism of Shenfu Injection regulating autophagy and apoptosis to improve nerve injury after cerebral ischemia-reperfusion[J]. Journal of Emergency in Traditional Chinese Medicine, 2026, 35(2): 245 – 248. (in Chinese).

[2] ZUO X, CHEN HY, CHEN DS, *et al.* Effect of Danshen injection on cerebral ischemia-reperfusion injury in rats[J]. Global Traditional Chinese Medicine, 2015, 8(4): 407 – 410. (in Chinese).

[3] XU YW, SUN L, LIANG H, *et al.* The regulatory effect of 12/15-lipoxygenase on peroxisome proliferator-activated receptors γ in rats with cerebral ischemia[J]. Chinese Journal of Neurology, 2014, 47(2): 123 – 127. (in Chinese).

[4] PEI S, SUN J, WANG N, *et al.* Correlation between serum PLR, SII, and Cys C levels and the vascular recanalization after mechanical thrombectomy in patients with acute cerebral infarction due to large vessel occlusion [J]. Basic and Clinical Medicine, 2026, 46(2): 256 – 260. (in Chinese).

[5] WANG T, YAN YM, CAO Y, *et al.* Clinical study of Shenfu Injection in the treatment of apoplexy (recovery stage) with blood stasis blocking syndrome[J]. Chinese Journal of Integrative Medicine on Cardio-Cerebrovascular Disease, 2014, 12(2): 148 – 149. (in Chinese).

[6] TANG, YJ, ZHANG S, CAO H. Study on the effect of Shenfu injection on the NLRP3/CASP1 signaling pathway and prognosis of acute myocardial infarction[J]. Drug Evaluation, 2025, 7(7): 857 – 861. (in Chinese).

[7] SHEN B, DONG GP, FANG JQ, *et al.* Observation on curative effect of early application of Danshen Injection combined with high-dose naloxone in treatment of severe craniocerebral injury[J]. Modern Journal of Integrated Traditional Chinese and Western Medicine, 2011(22): 2761 – 2762. (in Chinese).