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Original Article

Treatment efficacy of arterial urokinase thrombolysis combined with mechanical thrombectomy for acute cerebral infarction and its influence on neuroprotective factors and factors for neurological injury

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Abstract: Objective: This study was designed to explore the treatment efficacy of arterial urokinase thrombolysis combined with Solitaire AB stent for acute cerebral infarction (ACI) and its influence on neuroprotective factors and factors for neurological injury. Methods: We randomly assigned 90 patients with ACI to receive arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy (observation group, OG) or to receive arterial urokinase thrombolysis (control group, CG). The two groups were compared in the National Institutes of Health Stroke Scale (NIHSS) score, activities of daily living (ADL) score, vascular recanalization rate 1 month after treatment, and serum levels of neuroprotective factors (insulin-like growth factor-I (IGF-1), neurotrophic factor (NTF), vascular endothelial growth factor (VEGF), and brain-derived neurotrophic factor (BDNF)) and factors for neurological injury (neuron-specific enolase (NSE), S100B protein (S100B), ubiquitin carboxyl-terminal hydrolase L1 (UCH-L1), glial fibrillary acidic protein (GFAP)) before treatment and the day after treatment. Results: The overall treatment response rate and vascular recanalization rate 1 month after treatment were markedly higher in OG than in CG ($P<0.05$). The NIHSS score decreased and the ADL score in both groups increased after treatment, with a lower NIHSS score and a higher ADL score in OG than in CG (all $P<0.001$). The difference in the complication rate between the two groups was not statistically significant ($P>0.05$). The day after treatment, serum levels of IGF-1, NTF, VEGF, and BDNF in both groups increased while levels of NSE, S100B, UCH-L1, and GFAP in them decreased, with higher levels of IGF-1, NTF, VEGF, and BDNF, and lower levels of NSE, S100B, UCH-L1, and GFAP in OG than in CG (all $P<0.05$). Conclusion: Arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy can enhance the treatment efficacy for ACI, stimulate the release of neuroprotective factors, and suppress the release of factors for neurological injury, without aggravating the treatment risk.

Keywords: Arterial urokinase thrombolysis, Solitaire AB, acute cerebral infarction, neurological injury

Introduction

Cerebral stroke is a disease manifested as temporary or permanent neurological deficits or defects following local blood supply interruption in the brain tissue caused by various reasons, which can be fatal in severe cases. It is the third leading cause of disability and death in developed countries such as the United States [1]. Ischemic stroke accounts for approximately 85% of all stroke cases, of which acute cerebral infarction (ACI) is the most common type clinically [2]. Occluded blood vessels due to ACI onset interrupt the blood flow of the brain tissue and make it ischemic, which may cause irreversible neurological damage to the brain tissue if the blood vessel cannot be opened in time to restore blood perfusion [3]. Continuous advancements in pre-hospital emergency measures and interventional techniques allow an increasing number of patients with ACI the access to timely admission and interventional treatment after the onset. Arterial thrombolysis is a common interventional treatment option for ACI, which dissolves the thrombi by injecting thrombolytic drugs (such as urokinase) into the thrombus site. Mechanical thrombectomy with a stent is a novel inter-

ventional treatment for ACI developed in recent years, which places a stent in the culprit vessel to facilitate thrombus removal and quickly open the blockage, and can use thrombolytic drugs as an adjuvant treatment to further dissolve the residual micro-thrombosis to better improve the blood perfusion of the culprit vessel [4, 5]. Studies suggest that nerve cells are damaged during the development and progression of ACI, leading to massive release of factors related to neurological injury into the blood circulation, including neuron-specific enolase (NSE), S100B protein (S100B), ubiquitin carboxyl-terminal hydrolase L1 (UCH-L1), and glial fibrillary acidic protein (GFAP) [6, 7]. A variety of neuroprotective factors are important for the regeneration and recovery of nerve cells, such as brain-derived neurotrophic factor (BDNF), neurotrophic factor (NTF), insulin-like growth factor-I (IGF-1), and vascular endothelial growth factor (VEGF) [8, 9]. Patients with cerebral infarction might have lower peripheral expression levels of neuroprotective factors in the peripheral blood (such as BNDF) than normal individuals before the occurrence of infarction, which further decrease at infarction onset and might then increase as the disease progresses or the blood flow of ischemic and hypoxic brain cells is restored [10, 11]. The levels of some neuroprotective factors, such as IGF-1 and VEGF, may be subject to dynamic changes during the development of cerebral infarction due to ischemia and reperfusion of brain cells [12, 13]. So far, there have been few studies on the effects of arterial thrombolysis and mechanical thrombectomy on the expression of neuroprotective factors and factors for neurological injury in patients with ACI. Here, we explored the treatment efficacy of arterial urokinase thrombolysis combined with Solitaire AB stent for ACI and its influence on neuroprotective factors and factors for neurological injury.

Materials and methods

General information

This study has obtained ethical approval from the Ethics Committee of Affiliated Hospital of Hebei University, Baoding, Hebei Province. Totally 90 patients with ACI treated in Affiliated Hospital of Hebei University, Baoding, Hebei Province from January 2018 to January 2020 were recruited into this study. We randomly assigned 44 patients to receive arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy (observation group, OG) and the other 46 patients to receive arterial urokinase thrombolysis (control group, CG). Inclusion criteria: Patients diagnosed with ACI by head CT or MRI; patients with an initial onset duration ≤6 hours; patients with indications for arterial thrombolysis and mechanical thrombectomy; patients whose guardian signed the written informed consent. Exclusion criteria: Patients with simple sensory disturbance or ataxia; patients with active cerebral hemorrhage; patients with a history of coagulation dysfunction or hemorrhagic disease (except for patients previously treated with oral anticoagulant or antiplatelet drugs); patients complicated with intracranial tumors or intracranial vascular malformations; patients who have undergone intracranial surgery in the past 2 months; patients with impaired functions of the heart, liver, kidney, lung, or other important organs; patients with severe infections; patients with surgical contraindications; patients with poor compliance or incomplete clinical data.

Experimental methods

Clinical data of patients: Clinical data of patients was collected and recorded, including age, sex, body mass index (BMI), hypertension, diabetes, hyperlipidemia, smoking/drinking, vital signs (respiration, pulse, blood pressure, and heart rate) and results of general laboratory tests (blood routine, blood coagulation, biochemistry) on admission, and scores of the National Institutes of Health Stroke Scale (NIHSS) and the activities of daily living (ADL) on admission and 1 month after discharge [14, 15].

Treatment methods

Patients from CG were treated with arterial urokinase thrombolysis. Following local anesthesia with 10 mL 1.0% lidocaine and puncture of the right femoral artery using the Seldinger method, the 6F arterial sheath (Beijing Wanhonghengye Medical Equipment Co., Ltd., China) was inserted. Digital subtraction angiography (DSA) was performed for the common carotid artery, internal carotid artery, and vertebral artery to identify the location and severi-

ty of blockage. The Tracess micro-guidewire (Medtronic, Inc., USA) was sent to the identified blockage site under the guidance of the guide wire. Urokinase (Wuhan Humanwell Pharmaceutical Co., Ltd., China) was pumped with a micro-pump at 10,000 U/min. Angiography was performed to check the recanalization of blood vessels after every 100,000 unit was given until the maximal amount of 750,000 U. The catheter was removed after the treatment, and the wound was then bandaged.

Patients from OG were treated with arterial urokinase thrombolysis combined with mechanical thrombectomy. Following local anesthesia with 10 mL 1.0% lidocaine and puncture of the right femoral artery using the Seldinger method, the 6F arterial sheath was inserted. Under DSA fluoroscopy, 5F Navien catheter (Medtronic, Inc., USA) was placed at the proximal end of the occluded blood vessel, and then the Tracess micro-guidewire was sent cross the occluded artery to its distal end under the help of the Rebar micro-catheter (Medtronic, Inc., USA). The micro-guidewire was removed when the Rebar micro-catheter was located into the true lumen of the blood vessel under the angiography, and then the Solitaire AB stent (EV3, USA, 4 mm * 20 mm) was introduced to the vascular occlusion and was released to completely cover the occluded vascular segment. After 3-5 minutes, the guiding catheter was removed together with the micro-catheter. Meanwhile, the plunger of a 20 mL syringe was withdrawn to form negative pressure in the guiding catheter to prevent the thrombi from falling off in the skull. After that, the antegrade flow was checked under the DSA, if it was not smooth, the above thrombus removal operation was repeated 2-3 times. After the angiography, urokinase was locally injected to dissolve the residual micro thrombi until the maximal amount of 750,000 U, the same operation as for patients from CG. After the operation, the wound was bandaged and the patient's nerve function, blood pressure, respiration, heart rate, body temperature, and other indicators were closely monitored.

Both groups of patients were given aspirin enteric-coated tablets (Bayer, Germany) at 100 mg/d combined with clopidogrel (Sanofi (Hangzhou) Pharmaceutical Co., Ltd., China) at 75 mg/d for antiplatelet aggregation from the day after surgery to 1 month after surgery, and then patients received oral clopidogrel alone at 75 mg/d.

Tests of neuroprotective factors and factors for neurological injury: On admission and on the day after treatment, 5 mL peripheral venous blood was sampled from each patient in the two groups on an empty stomach in the morning and stored in a disposable anticoagulation tube, followed by centrifugation at 3000 r/min for 10 minutes. Then the supernatant was collected and stored at -80°C. Serum concentrations of NSE, S100B, UCH-L1, GFAP, BDNF, NTF, IGF-1, and VEGF were tested using enzyme-linked immunosorbent assay (ELISA) on an automatic microplate reader (Nanjing Detie Laboratory Equipment Co., Ltd., China). All operations were carried out by strictly following the kit instructions. All ELISA kits were purchased from Shanghai Huyu Biotechnology Co., Ltd., China.

Complications after treatment: Complications in the two groups 1 month after discharge were recorded, including cerebral hemorrhage, gastrointestinal hemorrhage, and skin and mucosal hemorrhage.

Outcome measures

Primary outcome measures: 1. The NIHSS scores on admission and 1 month after discharge in the two groups and the treatment responses were recorded. A complete response referred to a decrease in the NIHSS score by >90% after treatment and basically disappeared symptoms. A marked response referred to a decrease in the NIHSS score by 46-89% after treatment, significantly relieved symptoms, and markedly increased muscle strength of the affected limb. A moderate response referred to a decrease in the NIHSS score by 18-45% after treatment, moderately relieved symptoms and increased muscle strength of the affected limb. No response referred to a decrease in the NIHSS score by <18% after treatment and no relieving or even worsening of symptoms. The overall treatment response rate represented the percentage of the number of cases with a complete/marked/moderate response to the total case number. The ADL scores in the two groups on admission and 1 month after discharge were also record-

Table 1. Comparison of general information of the two groups of patients (n)

Item	Observation group (n=44)	Control group (n=46)	χ^2/t	P
Age (years)	55.4±7.6	56.1±7.4	1.049	0.656
Gender (male/female)	26/18	26/20	0.061	0.805
BMI (kg/m^2)	25.74±3.74	25.88±3.48	1.155	0.855
Smoking	26	29	0.385	0.701
Drinking	24	26	0.189	0.850
With hypertension	30	32	0.142	0.887
With diabetes	22	18	1.037	0.300
With hypercholesterolemia	24	22	0.638	0.524
With cardiovascular disease	27	30	0.379	0.705
Where the thrombus is				
The thrombus is located in the middle cerebral artery	20	24	0.202	0.904
The thrombus is located in the branch of the middle cerebral artery	12	12		
The thrombus is located in the internal carotid artery	7	6		
The thrombus is located in the anterior cerebral artery	3	2		
The thrombus is located in the posterior cerebral artery	2	2		
Onset time (h)	3.18±0.46	3.22±0.52	1.278	0.701
NIHSS score at admission	25.82±5.43	26.33±4.96	0.466	0.643
ADL score at admission	33.88±6.13	32.57±5.88	1.035	0.304

Note: BMI: body mass index; NIHSS: the National Institutes of Health Stroke Scale; ADL: the activities of daily living.

ed. 2. Serum expression levels of neuroprotective factors and factors for neurological injury on admission and on the day after treatment in the two groups were determined and recorded.

Secondary outcome measures: 1. The vascular recanalization rates on admission and 1 month after discharge in the two groups were recorded. Vascular recanalization was graded under angiography by the Thrombolysis in Myocardial Infarction (TIMI) scale: Grade 0 and 1 indicated failed recanalization, grade 2 indicated partial recanalization, and grade 3 indicated complete recanalization. The overall recanalization rate marked the ratio of the number of cases reaching TIMI grade 2/3 to the total case number. 2. Complications occurring in the two groups after treatment and the difference between the two groups in the number of patients suffering from complications were recorded.

Statistical analysis

Statistical analysis of data was performed on SPSS 26.0. The measurement data was represented by the mean ± standard deviation ($\bar{x}$ ± sd). The independent sample t-test was used for its comparison between the two groups and the paired sample t-test for its comparison before and after treatment within the group. The count data was represented by the percentage and its comparison was analyzed by the χ^2 test.

Results

Comparison of basic data of patients

The comparison between 44 patients in OG and 46 patients in CG showed no notable differences in age, sex, BMI, smoking, drinking, complicated hypertension, diabetes, hypercholesterolemia, cardiovascular disease, site of thrombosis, onset time of illness, and scores of NIHSS and ADL at admission (all P>0.05), as shown in **Table 1**.

Comparison of NIHSS score, ADL score, vascular recanalization rate, and treatment efficacy between groups before and after treatment

One month after discharge, the NIHSS score markedly decreased while the ADL score markedly increased in both groups (all P<0.001), with a markedly lower NIHSS score and a markedly higher ADL score in OG than in CG (all P<0.001). The overall treatment response rate and the overall vascular recanalization rate

Table 2. Comparison of NIHSS score and ADL score between the two groups of patients before and after treatment and 1 month after treatment and discharge

Groups	NIHSS score	ADL score
Observation group (n=44)		
On admission	25.82±5.43	33.88±6.13
1 month after discharge	7.85±1.12***,###	45.86±5.83***,###
Control group (n=46)		
On admission	26.33±4.96	32.57±5.88
1 month after discharge	10.35±0.98***	37.05±4.96***

Note: Compared with the same group when admitted to the hospital, ***P<0.001; compared with the control group 1 month after discharge, ###P<0.001. NIHSS: the National Institutes of Health Stroke Scale; ADL: the activities of daily living.

were markedly higher in OG than in CG (all P<0.05), as shown in **Tables 2**-**4**.

Comparison of serum expression levels of neuroprotective factors and factors for neurological injury before and after treatment

Serum expression levels of neuroprotective factors (IGF-1, NTF, VEGF, BDNF) and factors for neurological injury (NSE, S100B, UCH-L1, GFAP) were not different between the two groups on admission (all P>0.05). The day after treatment, serum levels of all tested neuroprotective factors increased in both groups, while serum levels of all tested factors for neurological injury decreased (all P<0.05), with a stronger increase/decrease in OG than in CG (all P<0.05), as shown in **Tables 5**, **6** and **Figures 1**, **2**.

Comparison of complications between groups 1 month after treatment

During the 1-month follow-up after discharge, the comparison of the overall complication rate between the two groups showed no notable difference (P>0.05), as shown in **Table 7**.

Discussion

Arterial thrombolysis, a prevalent interventional therapy for clinical treatment of ACI, achieves its treatment response by injecting urokinase locally to dissolve thrombi in the culprit vessel for vascular recanalization and perfusion [16, 17]. However, it takes a long time for arterial thrombolysis to open blood vessels (usually 2-3 hours), which increases the risk of ischemia-reperfusion injury and cerebral hemorrhage [18]. Mechanical thrombectomy using a stent is a novel interventional treatment developed in recent years, which achieves faster recanalization than arterial thrombolysis, and if supplemented by thrombolytic drugs, can better dissolve thrombi in tiny blood vessels, reduce the risk of bleeding, and improve blood perfusion [19, 20]. Therefore, the combination of arterial thrombolysis and mechanical thrombectomy can promote vascular recanalization in patients with ACI. In this study, the overall treatment response rate and the overall vascular recanalization rate 1 month after discharge were markedly higher in OG than that in CG, which is consistent with the results as reported by previously [21]. The NIHSS score markedly decreased in both groups, while the ADL score markedly increased 1 month after treatment, with a stronger decrease in the NIHSS score and a stronger increase in the ADL score in OG than those in CG, suggesting better treatment responses by arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy than by arterial urokinase thrombolysis alone.

The brain tissue is extraordinarily sensitive to ischemia and hypoxia. During the development and progression of ACI, ischemia and hypoxia directly damage cell structure and further impair brain cells by inhibiting neuroprotective factors. Various neuroprotective factors such as BDNF, NTF, IGF-1, and VEGF can protect brain cells from injury and apoptosis. BNDF, a crucial member of the neurotrophin family that plays an essential role in various brain activities and brain functions, can stimulate the development and differentiation of neurons, promote cell survival and synaptic plasticity, and exert neuroprotective effects such as anti-apoptosis, anti-oxidation, and inhibition of autophagy, therefore, its loss may induce many neurodegenerative diseases [22-24]. Previous studies suggest that serum BNDF level markedly decreases in patients with ACI on the first day of onset and then gradually mounts [10, 11]. There are two possible reasons for this situation. One is that the basic expression level of serum BNDF is lower in patients with ACI than in normal individuals, and the other is that the onset of ACI stimulates peripheral BNDF to transfer to the injured brain tissue to play its

Table 3. Comparison of the effective rate of treatment between the two groups of patients 1 month after discharge (n)

Groups	Cure	Markedly effective	Effective	Invalid	Total effective rate (%)	χ^2	P
Observation group (n=44)	19	12	8	5	88.64	4.013	0.045
Control group (n=46)	15	11	7	13	71.74		

Table 4. Comparison of vascular recanalization between the two groups of patients 1 month after discharge (n)

Groups	Complete recanalization	Partial recanalization	Failed to pass	Reconnection rate (%)	χ^2	P
Observation group (n=44)	24	14	6	86.36	5.445	0.020
Control group (n=46)	16	14	16	65.22		

Table 5. Comparison of serum neuroprotective factors between the two groups of patients on admission and the day after treatment

Groups	IGF-1 (ng/mL)	NTF (ng/mL)	VEGF (pg/mL)	BDNF (ng/mL)
Observation group (n=44)				
On admission	82.57±8.68	3.45±0.83	69.47±7.78	2.08±0.28
Next day of treatment	153.64±14.36$^{***,\#\#\#}$	5.78±0.92$^{***,\#\#\#}$	117.54±9.32$^{***,\#\#\#}$	4.02±0.34$^{***,\#\#\#}$
Control group (n=46)				
On admission	83.95±9.02	3.04±0.69	71.04±8.36	2.14±0.33
Next day of treatment	132.84±15.24***	4.24±0.82***	94.38±8.92***	3.22±0.41***

Note: Compared with the same group when admitted to the hospital, ***P<0.001; compared with the control group on the next day of treatment, $^{\#\#\#}$P<0.001. IGF-1: insulin-like growth factor-I; NTF: neurotrophic factor; VEGF: vascular endothelial growth factor; BDNF: brain-derived neurotrophic factor.

Table 6. Comparison of serum neurological impairment-related factors between the two groups of patients on admission and the day after treatment

Groups	NSE (ng/mL)	S100B (ng/mL)	UCH-L1 (pg/mL)	GFAP (ng/mL)
Observation group (n=44)				
On admission	26.14±3.25	2.63±0.42	135.77±14.32	35.42±5.08
Next day of treatment	15.87±2.87$^{***,\#\#\#}$	1.53±0.36$^{***,\#\#\#}$	70.55±11.47$^{***,\#\#\#}$	16.14±4.56$^{***,\#\#\#}$
Control group (n=46)				
On admission	25.83±2.98	2.57±0.38	128.46±15.76	34.77±5.42
Next day of treatment	19.31±2.86***	1.84±0.49***	94.38±12.92***	23.45±4.41***

Note: Compared with the same group when admitted to the hospital, ***P<0.001; compared with the control group after the next day of treatment, $^{\#\#\#}$P<0.001. NSE: neuron-specific enolase; S100B: S100B protein; GFAP: glial fibrillary acidic protein; UCH-L1: ubiquitin carboxyl-terminal hydrolase L1.

repair role and then promotes it to transfer back to the peripheral blood after the brain tissue is reperfused. NTF can promote regeneration and restoration after neuronal injury and prevent neuronal degeneration [25]. A unified report has not been made on the temporal and spatial distribution of NTF expression after cerebral ischemia. It is commonly agreed that NGF expression is increased after brain damage caused by diversifying causes, and its expression time course depends on the length and degree of ischemia [26]. IGF-1 can promote the growth of nerve cells and glial cells and the recovery of nerve function. Its expression in the brain tissue is related to the degree of intracranial injury and can be restored to the level before ischemia after cerebral ischemia reperfusion, along with a stepwise increase in the peripheral IGF-1 level. However, IGF-1 levels in brain tissue and peripheral blood may change

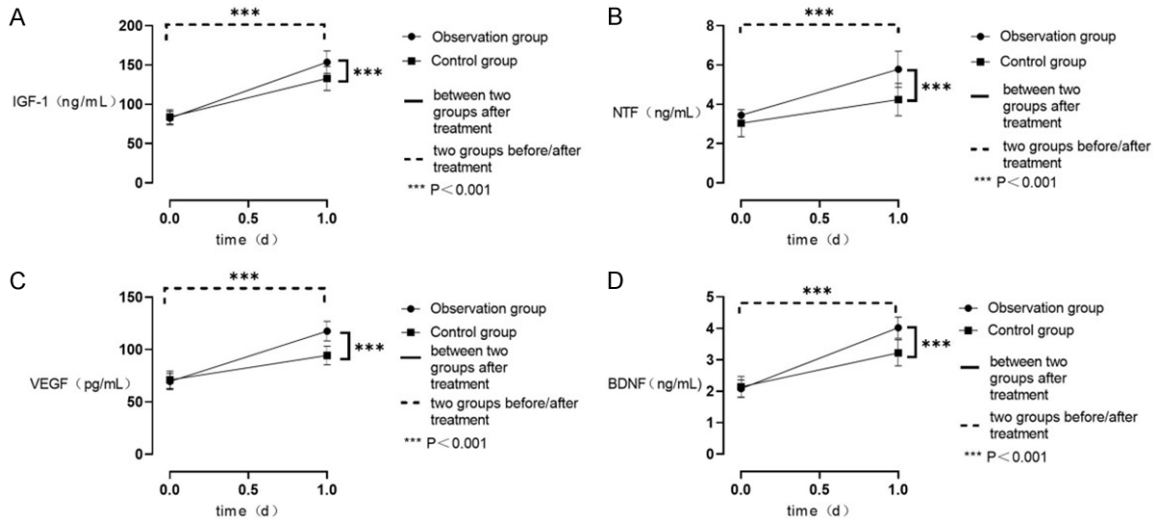

Figure 1. Changes of serum neuroprotective factor levels before and after treatment in the two groups of patients. A: IGF-1; B: NTF; C: VEGF; D: BDNF. Compared with the same group before treatment, ***P<0.001; compared between the two groups after treatment, ***P<0.001. IGF-1: insulin-like growth factor-I; NTF: neurotrophic factor; VEGF: vascular endothelial growth factor; BDNF: brain-derived neurotrophic factor.

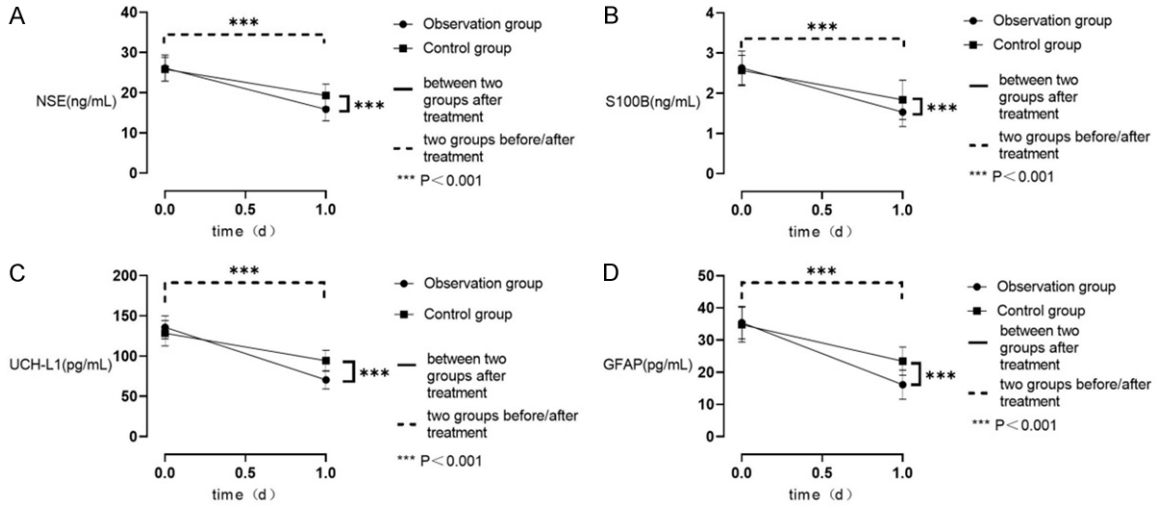

Figure 2. Comparison of serum levels of neurological impairment-related factors before and after treatment in the two groups. A: NSE; B: S100B; C: UCH-L1; D: GFAP. Compared with the same group before treatment, ***P<0.001; compared between the two groups after treatment, ***P<0.001. NSE: neuron-specific enolase; S100B: S100B protein; GFAP: glial fibrillary acidic protein; UCH-L1: ubiquitin carboxyl-terminal hydrolase L1.

over time due to local injuries [27]. For example, Gustafson K et al. reveal that the IGF-1 level in the brain tissue of rats with cerebral ischemia and hypoxia markedly increases on the 3rd day of the onset and then gradually decreases until an increase again on the 14th day [12]. In this study, IGF-1 levels increased on the next day after treatment. VEGF is a protein produced by smooth muscle cells and pituitary follicle-shaped cells, which can induce the proliferation and migration of vascular endothelial cells, inhibit cell apoptosis under hypoxic-ischemic conditions, affect the progression of cerebral edema, and promote the repair from ischemia-reperfusion injury [28-30]. A previous animal study suggests that in hypoxic rat models, VEGF mRNA levels increase at 12 hours after the hypoxia of the brain tissue, peak at the 1st-3rd days, and then begin to decrease after 7 days [31]. Impaired blood-brain barrier after

Table 7. Comparison of complications between the two groups of patients 1 month after discharge (n)

Items	Observation group (n=44)	Control group (n=46)	χ^2	t
Intracranial hemorrhage	4	5	0.079	0.779
Gastrointestinal bleeding	2	2	1.000	0.675
Skin and mucous membrane bleeding	3	4	0.111	0.740
Total incidence (%)	20.45	23.91	0.156	0.693

brain injury results in a compensatory increase in VEGF expression, which may be caused by the effects of VEGF and 3,5-cyclic phosphate on the solute penetration time of the blood-brain barrier [32]. A study reveals that serum VEGF levels in patients with ACI increase significantly on the first day of onset and are subject to a mounting trend [13]. In summary, in this study, the expression levels of neuroprotective factors increased on the day after treatment in the two groups. The reason may be that the ischemic and hypoxic cerebral cells are reperfused after the culprit vessel is opened and that those neuroprotective factors transfer from the injured brain tissue to the peripheral blood. During the development and progression of ACI, destructed nerve cells stimulate the massive release of various nerve injury-related factors such as NSE, S100B, UCH-L1, and GFAP into the blood circulation [6, 7]. NSE is separated from actin and advances into the intercellular space and cerebrospinal fluid when neuronal cells are edema and necrotic, and then enters the blood circulation through the blood-brain barrier. NSE is involved in the pathological process of hypoxic encephalopathy and is of great value in determining the degree of nerve damage [33]. S100B protein, a member of the S100 family of low molecular weight calcium binding proteins, can stimulate neurite extension, protect neuron survival, and affect neuronal maturation and glial cell proliferation in vitro, and protect nerve cell from death and mitochondrial dysfunction caused by glucose deprivation [34]. UCH-L1 plays a crucial role in the development and progression of neurodegenerative diseases. When ischemia and hypoxia occur, it can prevent abnormally aggregated proteins from being degraded by autophagy-lysosomes and can thereby affect the self-repair of nerve cells [35]. GFAP, mainly presenting in the glial cells of the central and peripheral nervous system, is involved in the composition of the cytoskeleton structure and maintains its tension. Serum concentration of GFAP increases in patients with brain injury [36]. A previous study suggests that the detection of serum GFAP level can screen patients affected by craniocerebral injury with normal CT results but abnormal MRI results [37]. Here, in both groups, serum levels of the above-mentioned neuroprotective factors were higher after treatment than before treatment but serum levels of factors for neurological injury were lower after treatment, with a stronger increase in concentrations of neuroprotective factors and a stronger decrease in concentrations of factors for neurological injury in OG than in CG, suggesting that arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy is superior to arterial urokinase thrombolysis alone in relieving brain cell damage in patients with ACI and promoting the protection and repair of brain cells. Such combined therapy is of a certain clinical significance.

In the present study, we only tested serum levels of related biochemical markers, but did not determine their expression levels in the cerebrospinal fluid. It is reported that S100B and NSE concentrations increase first in the cerebrospinal fluid and then increase in the peripheral blood during brain injury [38]. Suggesting the potential value of S100B and NSE for predicting the severity, treatment response, and prognosis of patients with cerebral infarction [39, 40]. Besides, the small sample size of this study may lead to biases in the research conclusions. We should widen the sample size in the following research.

In conclusion, arterial urokinase thrombolysis combined with Solitaire AB stent thrombectomy can enhance the treatment efficacy for ACI, stimulate the release of neuroprotective factors, and suppress the release of factors for neurological injury, without aggravating the treatment risk.

Disclosure of conflict of interest

None.

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