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Retrospective Study

Bridging therapy and direct mechanical thrombectomy in the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion

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Patients were not required to give informed consent to the study because the analysis used anonymous clinical data that were obtained after each patient agreed to treatment by written consent.

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Abstract

BACKGROUND

Intravenous thrombolysis is an important treatment for cerebral infarction. However, it is difficult to achieve good results if the patient is complicated with anterior circulation macrovascular occlusion. In addition, the vascular recanalization rate is low, so mechanical thrombectomy, that is, bridging therapy, is needed

AIM

To investigate the efficacy and safety of bridging therapy and direct mechanical thrombectomy in the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion.

METHODS

Ninety-six patients in our hospital with cardiogenic cerebral infarction with anterior circulation macrovascular occlusion from January 2017 to July 2020 were divided into a direct thrombectomy group ($n = 48$) and a bridging group ($n = 48$). Direct mechanical thrombectomy was performed in the direct thrombectomy group, and bridging therapy was used in the bridging treatment group. Comparisons were performed for the treatment data of the two groups (from

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admission to imaging examination, from admission to arterial puncture, from arterial puncture to vascular recanalization, and from admission to vascular recanalization), vascular recanalization rate, National Institutes of Health Stroke Scale (NIHSS) and Glasgow Coma Scale (GCS) scores before and after treatment, prognosis and incidence of adverse events.

RESULTS

In the direct thrombectomy group, the time from admission to imaging examination was 24.32 ± 8.61 min, from admission to arterial puncture was 95.56 ± 37.55 min, from arterial puncture to vascular recanalization was 54.29 ± 21.38 min, and from admission to revascularization was 156.88 ± 45.51 min, and the corresponding times in the bridging treatment group were 25.38 ± 9.33 min, 100.45 ± 39.30 min, 58.14 ± 25.56 min, and 161.23 ± 51.15 min; there were no significant differences between groups ($P=0.564, 0.535, 0.426$, and 0.661 , respectively). There was no significant difference in the recanalization rate between the direct thrombectomy group (79.17%) and the bridging group (75.00%) ($P = 0.627$). There were no significant differences between the direct thrombectomy group (16.69 ± 4.91 and 12.12 ± 2.07) and the bridging group (7.13 ± 1.23 and 14.40 ± 0.59) in preoperative NIHSS score and GCS score ($P = 0.200$ and 0.203 , respectively). After the operation, the NIHSS scores in both groups were lower than those before the operation, and the GCS scores were higher than those before the operation. There was no significant difference in NIHSS and GCS scores between the direct thrombectomy group (6.91 ± 1.10 and 14.19 ± 0.65) and the bridging group (7.13 ± 1.23 and 14.40 ± 0.59) ($P = 0.358$ and 0.101 , respectively). There was no significant difference in the proportion of patients who achieved a good prognosis between the direct thrombectomy group (52.08%) and the bridging group (50.008%) ($P = 0.838$). There was no significant difference in the incidence of adverse events between the direct thrombectomy group (6.25%) and the bridging group (8.33%) ($P = 0.913$).

CONCLUSION

Bridging therapy and direct mechanical thrombectomy can safely treat cardiogenic cerebral infarction with anterior circulation macrovascular occlusion, achieve good vascular recanalization effects and prognoses, and improve the neurological function of patients.

Key Words: Bridging therapy; Direct mechanical thrombectomy; Cardiogenic cerebral infarction; Anterior circulation macrovascular occlusion

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Core Tip: Mechanical thrombectomy can be used directly to treat patients with cerebral infarction in order to avoid the problems of bridging therapy. We explored the efficacy and safety of bridging therapy and direct mechanical thrombectomy.

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INTRODUCTION

Cardiogenic cerebral infarction is an important pathological type of cerebral infarction. It is mainly caused by emboli of the middle cerebral arterioles formed by the heart/aorta. The disease can further cause brain edema, resulting in compression of the blood vessels around the infarction and brain tissue as well as midline displacement. Brain stem compression causes displacement, which will affect the

outcome of the disease if the patient does not receive timely and effective intervention [1].

Intravenous thrombolysis is an important treatment for cerebral infarction. However, it is difficult to achieve good results if the patient is complicated with anterior circulation macrovascular occlusion. In addition, the vascular recanalization rate is low, so mechanical thrombectomy, that is, bridging therapy, is needed [2]. Studies have pointed out that bridging treatment refers to intravenous thrombolysis and subsequent arterial thrombolysis within the treatment time window during the acute phase of cerebrovascular disease. Cerebral infarction is an acute cerebrovascular disease. The only treatment that can open arterial vessels is intravenous and arterial lysis. In the acute phase, intravenous thrombolysis has a treatment time window of within 3 h from the onset of anterior circulation infarction and within 4.5 h from the onset of posterior circulation infarction. After the relevant examinations are completed in the hospital, intravenous thrombolysis can be directly performed with alteplase. If the enzyme is not dissolved, it will directly bridge arterial thrombus removal [3]. However, a study found that intravenous thrombolysis can affect the mechanical thrombectomy treatment time, delay the reperfusion time, and greatly affect the prognosis of cerebral infarction [4].

Some studies suggest that mechanical thrombectomy can be used directly to treat patients with cerebral infarction to avoid the problems of bridging therapy. Direct mechanical thrombus removal is mainly performed through femoral artery puncture. The thrombus removal device is passed through the blood vessel to the vascular occlusion site and through the occluded blood vessel. The thrombus is removed through the thrombus removal device or thrombectomy catheter to restore blood flow in the blood vessel. However, the difference between direct mechanical thrombectomy and bridging therapy in treating cerebral infarction with anterior circulation macrovascular occlusion still needs to be further explored and confirmed [5,6]. As a consequence, 96 patients with cardiogenic cerebral infarction with anterior circulation macrovascular occlusion in our hospital were selected, and the efficacy and safety of bridging therapy and direct mechanical thrombectomy were explored.

MATERIALS AND METHODS

General data

In this study, ninety-six patients with cardiogenic cerebral infarction with anterior circulation macrovascular occlusion in our hospital from January 2017 to July 2020 were retrospectively selected and divided into a direct thrombectomy group ($n = 48$) and a bridging group ($n = 48$) according to the treatment plan. There were 26 males and 22 females in the direct thrombectomy group, with an average age of 67.35 ± 10.93 years; there were 11 patients with hyperlipidemia, 19 patients with hypertension, 6 patients with diabetes, 11 patients with valvular heart disease, 18 patients with myocardial infarction and 19 patients with atrial fibrillation, and the time from onset to treatment ranged from 1.1 to 4.4 h, with an average of 2.75 ± 1.09 h. In the bridging group, there were 29 males and 19 females, with an average age of 68.01 ± 11.33 years; there were 10 patients with hyperlipidemia, 22 patients with hypertension, 4 patients with diabetes, 13 patients with valvular heart disease, 19 patients with myocardial infarction and 16 patients with atrial fibrillation, and the time from onset to treatment ranged from 0.8 to 4.5 h, with an average of 2.90 ± 1.13 h. As a result, the clinical data, such as sex, age, concomitant disease, type of primary heart disease and time from onset to treatment, were comparable between the two groups ($P > 0.05$).

Selection criteria

Inclusion criteria: (1) In line with the diagnostic criteria of cardiogenic cerebral infarction [7], the existence of anterior circulation macrovascular occlusion was confirmed by magnetic resonance angiography or computed tomography angiography; (2) The time from onset to treatment was ≤ 4.5 h; (3) The patient was aged ≤ 80 years; and (4) The family members of the patients were aware of this study and signed the consent form.

Exclusion criteria: (1) Previous history of hemorrhagic cerebrovascular disease; (2) coma; (3) organic lesions of the kidney, liver or other organs; (4) coagulation dysfunction; (5) central nervous system injury; (6) malignant tumor; and (7) anticoagulation therapy before inclusion in the study and international normalized ratio > 1.5 .

Treatment methods

Direct thrombectomy group: Direct mechanical thrombectomy was adopted. Appropriate anesthetic methods were selected according to the patients' condition and degree of cooperation. Blood pressure was controlled to be under 180/105 mmHg; then, the patients were placed in a horizontal position, the groin area was disinfected on both sides, the right femoral artery was punctured, a vascular sheath (8F) placed, cerebral angiography was performed, and the vascular occlusion and compensatory status of the collateral circulation was evaluated. The responsible vessel was defined, a guide catheter (8F) + intermediate catheter (6F) was inserted in the responsible vessel, the microcatheter was inserted in the occlusive segment of the responsible vessel with the assistance of a micro-guidewire, the micro-guidewire was removed, and microcatheterization was performed. If the distal blood vessels were unobstructed, the Solitaire AB stent was sent to the thrombus site and released. After the stent was in place, the stent was held in place for approximately 5 min and then fully opened. When the stent was withdrawn, the flow through the intermediate catheter and guide catheter was terminated. In addition, the middle catheter and guide catheter were maintained for continuous negative pressure suction to control blood flow. If necessary, the thrombus could be removed many times.

Bridging treatment group: Bridging treatment was adopted. The condition was first evaluated by a plain CT scan or MRI examination, intravenous thrombolytic therapy was implemented, alteplase was selected with a dose of 0.9 mg/kg (maximum dose \leq 80 mg), and 10% of the alteplase was first intravenously injected in 1 min, and then the remaining 90% of alteplase was continuously pumped in 60 min; then, mechanical thrombectomy was carried out.

Observation indexes

(1) The treatment parameters of the two groups were recorded, including the time from admission to imaging examination, the time from admission to arterial puncture, the time from arterial puncture to vascular recanalization, and the time from admission to vascular recanalization; (2) The recanalization of blood vessels in the two groups was graded according to the "Chinese expert consensus on endovascular treatment of acute macrovascular occlusive ischemic stroke (2017)": no perfusion was grade 0; only a small amount of blood flow through the occlusive site, and little or no perfusion was grade 1; forward partial perfusion $< 50\%$ downstream of the ischemic area was grade 2a; forward partial blood flow perfusion $\geq 50\%$ downstream of the ischemic area was grade 2b; and an ischemic area downstream of complete perfusion of forward blood flow was grade 3. Grades 2b and 3 were defined as vascular recanalization[8]; (3) The National Institutes of Health Stroke scale (NIHSS) and Glasgow Coma Scale (GCS) scores of the two groups before and after treatment. The highest possible NIHSS score was 42, with lower scores indicating better neurological function; the highest possible GCS score was 15, with higher scores being better[9]; (4) The prognostic effects of treatment in the two groups were evaluated by the modified Rankin scale at discharge. Completely asymptomatic was scored as 0, mild symptoms as 1, mild disability as 2, moderate disability as 3, severe disability as 4, severe disability as 5, and death as 6; in this scale, scores from 0-2 were considered good, and scores from 3-6 were considered poor[10]; and (5) The incidence of adverse events in the two groups, including symptomatic intracranial hemorrhage, death, and reocclusion after reestablishing vascular flow, was calculated.

Statistical analysis

The data were analyzed by SPSS 22.0; the measurement data are described by mean \pm SD and were compared with *t*-tests, and the counting data are described by frequency and constituent ratio (%) were compared with the χ^2 test. A nonparametric test was used to compare the measurement data that did not follow a normal distribution. $P < 0.05$ indicated that the difference was statistically significant.

RESULTS

Basic information

There were no statistically significant differences between the two groups in clinical data, such as sex, age, comorbid diseases, primary heart disease type, and time from onset to treatment ($P > 0.05$) (Table 1).

Table 1 Comparison of general information between the two groups

Group	n	Sex (Male/Female)	Age (year of age)	Combined with Diseases			Primary heart disease type			Time of onset to treatment (h)
				Hyperlipidemia	Hypertension	Diabetes mellitus	Heart valve disease	Myocardial infarction	Atrial fibrillation	
Direct bolt group	48	26/22	67.35 ± 10.93	11	19	6	11	18	19	2.75 ± 1.09
Bridge therapy group	48	29/19	68.01 ± 11.33	13	22	4	13	19	16	2.90 ± 1.13
t/χ^2 value		0.383	0.290	0.222	0.383	0.447	0.451			0.662
P value		0.536	0.772	0.637	0.536	0.504	0.798			0.510

Treatment condition

There was no significant difference between direct thrombectomy group and bridging therapy group (the time from admission to the imaging examination, from admission to arterial puncture, from arterial puncture to vascular recanalization, and from admission to vascular recanalization in the two groups were 24.32 ± 8.61 min, 95.56 ± 37.55 min, 54.29 ± 21.38 min, 156.88 ± 45.51 min *vs* 25.38 ± 9.33 min, 100.45 ± 39.30 min, 58.14 ± 25.56 min, 161.23 ± 51.15 min ($P = 0.564, 0.535, 0.426$ and 0.661 , respectively), as shown in Table 2.

Vascular recanalization

There was no significant difference in the recanalization rate between the direct thrombectomy group (79.17%) and the bridging group (75.00%) ($P = 0.627$), as shown in Table 3.

NIHSS and GCS scores

There was no significant difference between the direct thrombectomy group (16.69 ± 4.91 and 12.12 ± 2.07) and the bridging group (7.13 ± 1.23 and 14.40 ± 0.59) in preoperative NIHSS and GCS scores ($P = 0.200$ and 0.203 , respectively). After the operation, the NIHSS scores of both groups were lower than those before the operation, and the GCS scores were higher than those before the operation. There was no significant difference in the NIHSS and GCS scores between the direct thrombectomy group (6.91 ± 1.10 and 14.19 ± 0.65) and the bridging group (7.13 ± 1.23 and 14.40 ± 0.59) ($P = 0.358$ and 0.101 , respectively), as shown in Table 4.

Prognostic effect

There was no significant difference in the proportion of patients who achieved a good prognosis between the direct thrombectomy group (52.08%) and the bridging group (50.005%) ($P = 0.838$), as shown in Table 5.

Incidence of adverse events

There were 3 cases of symptomatic intracranial hemorrhage in the direct thrombectomy group and 4 cases in the bridging group. There was no significant difference in the incidence of adverse events between the direct thrombectomy group (6.25%) (3/48) and the bridging group (8.33%) (4/48) ($\chi^2 = 0.110$).

DISCUSSION

Approximately 3/4 of the emboli originating in the heart can cause infarctions in the brain due to blood flow patterns. This will result in an insufficient blood supply to the brain tissue if the embolus causes blood flow occlusion of the cerebral artery. Infarction can also cause hypoxic-ischemic changes in brain cells if collateral circulation is not established, resulting in swelling and necrosis of brain cells[11,12]. In recent years, the incidence of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion has been increasing, and how to treat this condition safely and effectively is still an ongoing research focus.

Table 2 Comparison of treatment between the two groups (mean \pm SD, min)

Group	Number	Time from admission to imaging examination	Time from admission to arterial puncture	Time from arterial puncture to vascular re-use	Time from admission to vascular re-use
Direct thrombectomy group	48	24.32 \pm 8.61	95.56 \pm 37.55	54.29 \pm 21.38	156.88 \pm 45.51
Bridging treatment group	48	25.38 \pm 9.33	100.45 \pm 39.30	58.14 \pm 25.56	161.23 \pm 51.15
<i>t</i>		0.578	0.623	0.800	0.440
<i>P</i> value		0.564	0.535	0.426	0.661

Table 3 Comparison of vascular recanalization between the two groups, *n* (%)

Group	<i>n</i>	Grade 0	Grade 1	Grade 2a	Grade 2b	Grade 3	Vascular recanalization
Direct thrombectomy group	48	2 (4.17)	3 (6.25)	5 (10.42)	18 (37.50)	20 (41.67)	38 (79.17)
Bridging treatment group	48	0 (0.00)	4 (8.33)	8 (16.67)	17 (35.42)	19 (39.58)	36 (75.00)
χ^2							0.236
<i>P</i> value							0.627

Table 4 Comparison of National Institutes of Health Stroke Scale and Glasgow Coma Scale scores between the two groups (mean \pm SD)

Group	<i>n</i>	NIHSS	GCS
Before treatment			
Direct thrombectomy group	48	16.69 \pm 4.91	12.12 \pm 2.07
Bridging treatment group	48	18.01 \pm 5.11	11.59 \pm 1.98
<i>t</i>		1.290	1.282
<i>P</i> value		0.200	0.203
After treatment			
Direct thrombectomy group	48	6.91 \pm 1.10	14.19 \pm 0.65
Bridging treatment group	48	7.13 \pm 1.23	14.40 \pm 0.59
<i>t</i>		0.924	1.657
<i>P</i> value		0.358	0.101

NIHSS: National Institutes of Health Stroke Scale; GCS: Glasgow Coma Scale.

Table 5 Comparison of prognostic effects between the two groups, *n* (%)

Group	<i>n</i>	0	1	2	3	4	5	6	Rate of good prognosis
Direct thrombectomy group	48	10 (20.83)	5 (10.42)	10 (20.83)	12 (25.00)	9 (18.75)	2 (4.17)	0 (0.00)	25 (52.08)
Bridging treatment group	48	11 (22.92)	6 (12.50)	7 (14.58)	13 (27.08)	7 (14.58)	3 (6.25)	1 (2.08)	24 (50.00)
χ^2									0.042
<i>P</i> value									0.838

Intravenous thrombolysis is an important method for the clinical treatment of cerebral infarction. However, the recanalization rate is low in patients with anterior circulation macrovascular occlusion, and their prognosis is poor[13]. For this reason, bridging therapy is often used to intervene in patients with cerebral infarction with

anterior circulation macrovascular occlusion. However, the clinical value of bridging therapy is variable, mainly because intravenous thrombolytic therapy can recanalize the blood flow of some patients before thrombectomy, restore cerebral blood flow early, improve prognosis, soften blood clots, improve the effect of vascular recanalization for intravascular interventional therapy, more effectively dissolve distal emboli and ensure brain tissue reperfusion[14]. However, for patients who failed thrombectomy and some alternative circulation approaches, intravenous thrombolytic therapy is the only treatment that can achieve vascular recanalization. In addition, intravenous thrombolytic therapy can move benign emboli distally (e.g., from the M1 to the M2 segment of the middle cerebral artery and from the basilar artery to the P2 segment of the posterior cerebral artery), thus reducing the ischemic area[15]. However, some studies have pointed out that intravenous thrombolytic therapy can cause partial thrombus disintegration, affecting thrombectomy stents and resulting in thrombus aspiration devices absorbing thrombi. This leads to difficulty with complete recanalization of the blood vessels. In addition, intravenous thrombolytic therapy may delay the timing of endovascular interventional therapy, increase the time until the blood vessels are revascularized, and thus affect the outcome of the disease; additionally, this method may cause thrombus dissolution and fragmentation, lead to distal vascular embolism, or cause a secondary embolism (e.g., from the proximal internal carotid artery to the T bifurcation or the M1 segment of the middle cerebral artery, or from the vertebral artery to the basilar artery), thus increasing the ischemic area[16,17]. Intravenous thrombolytic therapy may also cause allergic reactions, such as potential neurotoxicity, blood-brain barrier damage, blood coagulation disorders, hypotension, angiogenic edema, *etc.*, affecting the use of other antithrombotic drugs and increasing the cost of treatment[18]. Bridging therapy can improve the effect of vascular recanalization and improve the clinical prognosis better than direct mechanical thrombectomy.

Merlino *et al*[19] pointed out that bridging therapy can improve the short-term clinical symptoms and long-term prognosis of patients with cerebral infarction and reduce the risk of death better than direct mechanical thrombectomy. Behme *et al*[20] confirmed that bridging therapy for patients with acute cerebral infarction with middle cerebral artery occlusion can improve the effect of vascular recanalization and promote good disease outcomes. Fredrickson *et al*[21] found contrasting results: they included 116 patients with acute anterior circulation macrovascular occlusive stroke who received bridging therapy and direct mechanical thrombectomy. There was no significant difference in the effective recanalization rate (79.3% *vs* 69.8%), proportion of patients who achieved a good prognosis 3 mo after the operation (31.9% *vs* 28.6%), bleeding conversion rate (17.0% *vs* 34.9%) or mortality (17.0% *vs* 22.2%) between the two groups. Bridging therapy and direct mechanical thrombectomy can achieve good results in patients with acute anterior circulation macrovascular occlusive stroke. Moreover, these approaches have a high safety rate. The results of this study also showed that there was no significant difference in vascular recanalization, NIHSS score or GCS score between the direct thrombectomy group and the bridging group, which was consistent with the results of the above studies. This result indicated that bridging therapy and direct mechanical thrombectomy are equally effective and safe in the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion. The reasons for the differences between these findings and the above international research results may be related to the differences in physique or illnesses of patients among different countries.

Symptomatic intracranial hemorrhage is the most concerning type of complication during the treatment of cerebral infarction with circulatory vascular occlusion. At present, there is no consensus on whether intravenous thrombolysis will increase the risk of symptomatic intracranial hemorrhage during mechanical thrombectomy[22]. In this study, there was no significant difference in the incidence of symptomatic intracranial hemorrhage between the direct thrombectomy group and the bridging group ($P > 0.05$). The results showed that the incidence of symptomatic intracranial hemorrhage caused by direct mechanical thrombectomy in the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion was similar to that of bridging therapy. In addition, some studies suggest that intravenous thrombolytic therapy can reduce the difficulty of mechanical thrombectomy, reduce the number of thrombectomies, and shorten the time from operation to revascularization[23]. However, there was no significant difference between the direct thrombectomy group and bridging group in the time from arterial puncture to vascular recanalization, from admission to vascular recanalization, *etc.* This result indicated that direct mechanical thrombectomy does not prolong the time until vascular recanalization and can ensure the early recovery of brain perfusion, achieving the purpose of

treatment.

CONCLUSION

Generally, bridging therapy and direct mechanical thrombectomy for the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion are both safe interventions that can achieve good vascular recanalization effects and improve the prognosis and neurological function of patients. However, this study still has certain limitations; that is, this study was a single-center study, and the sample size was small. Therefore, whether the research results can be broadly generalized still needs to be further investigated and confirmed by expanding the sample selection range and increasing the sample size.

ARTICLE HIGHLIGHTS

Research background

Cardiogenic cerebral infarction is an important pathological type of cerebral infarction.

Research motivation

The difference between direct mechanical thrombectomy and bridging therapy in treating cerebral infarction with anterior circulation macrovascular occlusion still needs to be further explored and confirmed.

Research objectives

This study aimed to investigate the efficacy and safety of bridging therapy and direct mechanical thrombectomy in the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion.

Research methods

Total 96 patients with cardiogenic cerebral infarction with anterior circulation macrovascular occlusion were retrospectively selected and divided into a direct thrombectomy group and a bridging group according to the treatment plan.

Research results

There was no significant difference in the recanalization rate between the direct thrombectomy group and the bridging group.

Research conclusions

Bridging therapy and direct mechanical thrombectomy for the treatment of cardiogenic cerebral infarction with anterior circulation macrovascular occlusion can achieve good vascular recanalization effects and improve the prognosis and neurological function of patients.

Research perspectives

Whether the research results can be broadly generalized still needs to be further investigated and confirmed by expanding the sample selection range and increasing the sample size.

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