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Original Article

Clinical curative effect of mechanical thrombectomy combined with catheter aspiration for treatment of senile acute middle cerebral artery occlusion

Bin Wang[1], Yingjia Li[2], Ruili Wu[3]

Departments of [1]Neurology, [2]Cardiology, [3]Traumatic Orthopedics, Yuncheng Central Hospital, Yuncheng City, Shanxi Province, China

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Abstract: Objective: To investigate the clinical efficacy of mechanical thrombectomy (MT) combined with catheter aspiration for the treatment of senile acute middle cerebral artery (MCA) occlusion. Methods: Sixty senile patients with acute MCA occlusion admitted in Yuncheng Central Hospital from May 2016 to May 2017 were enrolled in the study, and divided into two groups based on the surgical approach. Patients in the control group (n=28) underwent MT, and patients in the study group (n=32) underwent MT with catheter aspiration. Patients in both groups were compared on the basis of various clinical outcomes. Results: The recanalization rate of thrombectomy in the study group was significantly higher than that of the control group (59.38% vs. 28.57%; P<0.05). The time from onset to recanalization, and from puncture to recanalization were both significantly shorter in the study group compared to the control group (both P<0.05). Post treatment recanalization rate was only slightly higher in the study group compared to the control group (84.38% vs. 75.00%; P>0.05). The incidence of intracranial hemorrhage was significantly lower in the study group compared to the control group (9.38% vs. 32.14%; P<0.05). Furthermore, no symptomatic intracranial hemorrhage was seen in the study group, while the incidence rate in the control group was 21.43% (P<0.05). The recurrence rate during the follow-up period was significantly lower in the study group compared to the control group (6.25% vs. 35.71%; P<0.05), and that of good prognosis was significantly higher in the study group than that in the control group (71.88% vs. 42.86%; P<0.05). Conclusion: MT combined with catheter aspiration can achieve fast and effective recanalization, good prognosis and low recurrence rate in the treatment of senile acute MCA occlusion.

Keywords: Mechanical thrombectomy, catheter aspiration technique, acute middle cerebral artery occlusion

Introduction

The incidence of acute ischemic stroke is on the rise, and about 80% of the cases are caused by cerebral vascular occlusion [1]. Although the latter does not directly cause cerebral infarction, timely dredging of the occluded cerebral blood vessels to restore blood supply to the brain can effectively reduce the risk of disability and mortality resulting from cerebral infarction [2]. Acute middle cerebral artery (MCA) occlusion is one of the most common types of ischemic stroke, and has a high morbidity and lethality if not treated promptly [3]. Intravenous thrombolysis is the main method used to treat stroke but it is ineffective in the treatment of acute MCA occlusion, with a recanalization rate of less than one third [4].

Recent studies have shown that intravascular thrombectomy could significantly improve the recanalization rate of occluded blood vessels, recover blood supply to the brain tissues and improve patients' prognosis [5, 6]. However, broken emboli and mechanical stent damage to the vessel wall during the procedure may lead to re-occlusion of blood vessels, thus affecting their access [7]. The study of Jeong et al. also showed that the emboli could be effectively aspirated to avoid the risks of emboli breakage and blood vessel damage by aspiration method [8]. However, easily dislodged emboli can re-occlude blood vessels after entering the circulation. Wang et al. showed that So1itaire FR stent mechanical thrombectomy (MT) combined with 5F Navien catheter aspiration could safely and effectively increase the potency of acute vascular occlusion and reduce complications in treating acute MCA occlusion [9]. However, a large-scale randomized controlled study on the combination treatment of MT and catheter aspiration is still lacking.

In this study, we performed MT combined with catheter aspiration to treat senile acute MCA occlusion, and compared it with conventional MT on various indexes.

Materials and methods

Patient information

Sixty patients (41 males and 19 females) with acute MCA occlusion who were being treated in the Neurosurgical Department of Yuncheng Central Hospital from May 2016 to May 2017 were selected for the study. The average age of the patients was 69.51±14.92 years (ranging from 60-80 years), average time of onset was 3.71±1.55 h (ranging 3-6 h), and average National Institutes of Health Stroke Scale (NIHSS) score was 18.24±7.09 scores (ranging 8-26 scores) [10]. CT angiography (CTA) showed that 16 patients had obstruction in the M1 segment and 5 of them had the obstruction in terminal internal carotid artery.

Inclusion criteria: Patients who aged ≥ 60 years; patients whose duration of onset to treatment <6 h; patients with signs of MCA occlusion in CTA images and were compliant with the diagnostic criteria of cerebrovascular occlusion laid down in the 4th National Conference on Cerebrovascular Diseases (1995); patients with gradually aggravated neurological dysfunction, and NIHSS score ≥ 8; patients without bleeding or other severe parenchymal organ diseases (heart, liver, kidney etc.).

Exclusion criteria: Patients with abnormal coagulation function and multiple organ failure; patients with signs of cerebral hemorrhage and intracranial tumor in CTA images; patients with cerebral vascular malformation; patients with hemorrhagic stroke; patients with recent major surgery; patients with poor physical condition and inability to tolerate surgery; patients who lacked family support.

The study was approved by the Ethics Committee of Yuncheng Central Hospital, and all patients and their families had signed the informed consent.

Methods

The patients were divided into the study group (n=32) and the control group (n=28) based on the surgical intervention.

Patients in the study group underwent MT combined with catheter aspiration technique. After local or general anesthetization and a successful Seldinger puncture, a SFr guiding catheter (Cordis, USA) was placed in the internal carotid artery proximal to the diseased artery with the help of a 5Fr Navien middle catheter (ev3 Inc., USA). At the same time, a Transcend microwire (Boston Scientific, USA) and a Rebarls microcatheter (ev3, USA) were placed in the distal end of the occluded vessel. The position of the occlusion was determined by microcatheter angiography, and thrombectomy was performed using a Solitaire AB stent (ev3, USA). The success of thrombectomy was evaluated based on blood flow recovery and the thrombus body in the effective segment of the stent, as seen by a middle catheter angiography. After successful thrombectomy, the middle catheter was placed at the proximal end of the thrombus after standing for 3 minutes, and the stent and thrombus were put into the middle catheter. The stent system, intermediate catheter, and microcatheter were then withdrawn, and aspiration was continuously performed with the middle catheter and guiding catheter during withdrawal. After the middle catheter was completely withdrawn, another 40-50 mL was aspirated by the guiding catheter [9].

The patients in the control group underwent MT. After anesthesia and puncture, the guiding catheter was placed in the internal carotid artery to open the Solitaire AB stent for thrombectomy. The stent was partially recovered into the microcatheter to clamp the thrombus. Then the thrombus was withdrawn and continuously aspirated through a guiding catheter with a 50 mL syringe. After the Solitaire AB stent was completely withdrawn, another 40-50 mL was aspirated by the guiding catheter.

Complications and their management were as follows. In the event of distal embolism in the lesion area during surgery which does not relieve blockage in the occluded blood vessels, the stent thrombectomy can be repeated with stent replacement. For severe cases, tirofiban should be given by intravenous pump after sur-

Table 1. Comparison of two groups of general information

Item	Study group (n=32)	Control group (n=28)	χ^2/t/Z	P
Male/female	24/8	17/11	0.368	0.847
Age	65.25±3.34	65.50±3.71	-0.274*	0.526
Onset time (h)	3.58±1.69	3.50±1.71	0.181*	0.517
NIHSS score	15.09±5.21	14.86±4.91	0.175*	0.862
Hypertension (case)	22	21	0.209	0.711
Coronary heart disease (case)	10	5		
Diabetes (case)	18	13		
Combined disease types			0.201	0.840
0 specie	1	1		
1 specie	25	21		
≥2 species	6	6		

Note: *represented the value of t; χ^2 test was used to compare the number of males and females and the type of diseases. The type of comorbidity was ranked data, and denoted by Z.

gery. In case of new arterial vascular dissection, anti-platelet aggregation therapy can be performed and 200,000 U urokinase should be given for thrombolysis to recover vascular recanalization. For intracranial hemorrhage and symptomatic intracranial hemorrhage, blood pressure should be monitored closely and anti-hypertensive drugs should be administered intravenously for high BP (blood pressure). If intracranial hemorrhage and symptomatic intracranial hemorrhage are seen in the head CT, 20% mannitol and furosemide could be given for lowering intracranial pressure, and the anticoagulant and anti-fibrin drugs should be reduced. If arterial vasospasm occurs, venous catheterization can be managed with intravenous injection of 0.4 mg/h nimodipine. If BP is not reduced, the dose can be increased to 0.8 mg/h and pumped continuously for 3 to 4 days till the patient is stable, followed by oral dose of 60 mg three times a day for one week. The dynamic change in BP should be monitored during medication [11]. If a secondary cerebral infarction occurs, 75 mg clopidogrel should be administered orally once a day along with 40 mg atorvastatin calcium at night. After cerebral angiography, another intervention or thrombolysis could be performed if necessary.

The medications given to the two groups of patients in the perioperative period were in accordance with standard guidelines [12]. Patients in the intravenous time window were treated with 0.9 mg/kg alteplase (Boehringer Ingelheim Pharmaceuticals, Germany), and were followed up for 3 months after operation.

Observation indexes

Primary observation indexes were as follows. First, vascular recanalization of thrombectomy was evaluated by grading cerebral infarction [4]. Grade 0-2a indicates vascular non-patency and grade 2b-3 indicates recanalization. The recanalization of thrombectomy, recanalization after treatment, the time from puncture to recanalization, and the time from onset to recanalization were recorded. Second, perioperative complications including distal embolization, new arterial dissection, intracranial hemorrhage, symptomatic intracranial hemorrhage, arterial vasospasm, and secondary cerebral infarction were observed in both groups. Third, NIHSS scores were used to evaluate the recovery of neurological functions of patients before surgery, and 7 days, 14 days, and 1 month after surgery.

Secondary observation indexes were as follows. Patients were followed-up for 3 months' post-surgery to observe recurrence and prognosis. The prognosis was evaluated using the modified Rankin scoring system consisting of 6 points: 0, asymptomatic; 1 point, mild neurological symptoms without apparent dysfunction and the ability to complete daily tasks; 2 points, mild disability and inability to complete all pre-illness activities, but retaining the ability to complete daily tasks without external care; 3 points, moderate disability requiring external help but retaining the ability to walk independently; 4 points, moderate to severe disability including inability to walk, and requiring external help for daily activities; 5 indicated serious disability and requiring extensive care; 6 points, death. A score of >2 points indicates poor prognosis, and a score of 0-2 points indicates good prognosis [13].

Statistical analysis

Data analysis was performed using SPSS 19.0 statistical software. Measurement data are

Table 2. Comparison of treatment conditions between the two groups ($\overline{x}$ ± sd)

Item	Vascular recanalization after treatment (n, %)	One-time thrombectomy and recanalization (n, %)	Onset to recanalization time (min)	Piercing to recanalization time (min)
Study group (n=32)	27 (84.38)	19 (59.38)	274.12±89.67	69.40±38.94
Control group (n=28)	21 (75.00)	8 (28.57)	365.49±87.35	92.77±39.58
χ^2/t	0.820	5.725	-3.993	2.688
P	0.365	0.016	0.029	0.043

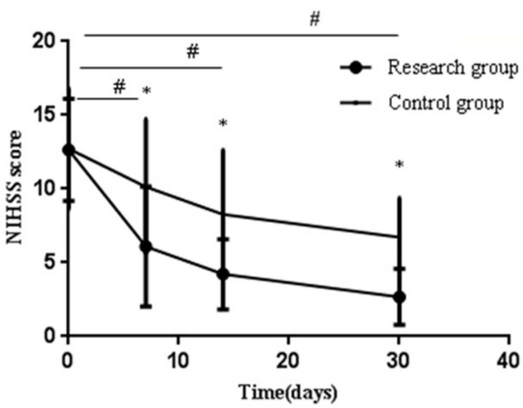

Figure 1. Comparison of neurological deficits in the two groups. Comparison between study group and control group, *P<0.05; compared with before treatment, #P<0.05. NIHSS, National Institutes of Health Stroke Scale.

expressed as mean ± standard deviation ($\overline{x}$ ± sd). The t-test was used compare data following normal distribution, and denoted by t; the χ^2 test and Fisher's exact Probability test were used for count data, and denoted by χ^2. The rank sum test was used for ranked data, and denoted by Z. P<0.05 is considered statistically significant.

Results

Comparison of patient data

No significant differences were observed in the patient data of the two groups, but comparable (**Table 1**).

Recanalization rate

The recanalization rate of the study group was significantly higher than that of the control group (P<0.05). The time from onset to recanalization and from puncture to recanalization were significantly shorter in the study group compared to the control group (both P<0.05). After treatment, the recanalization rate of the study group was slightly higher than that of the control group, although it was not statistically significant (P>0.05) as shown in **Table 2**.

Recovery of neurological function deficits

There were no significant difference in preoperative NIHSS scores between the two groups (P>0.05). The NIHSS scores gradually decreased after operation in both groups, and the difference was statistical significance (all P<0.05). In addition, the postoperative NIHSS scores at all time points were significantly lower in the study group compared to the control group (all P<0.05) as shown in **Figure 1**.

Complications

No severe complications such as distal embolization in the lesion area, new arterial dissection, or secondary cerebral infarction occurred during the perioperative period in either group. However, the incidences of intracranial hemorrhage, symptomatic intracranial hemorrhage, and vasospasm were significantly lower in the study group than in the control group (all P<0.05) as shown in **Table 3**.

Recurrence and prognosis

At the end of the follow-up period, the recurrence rate was significantly lower and the rate of good prognosis was significantly higher in the study group compared to the control group (both P<0.05) as shown in **Table 4**.

Discussion

Acute MCA occlusion can cause severe cerebral infarction, with high mortality and disability rates. Since drug based thrombolytic therapy has a very narrow time window and many complications, clinical outcomes are seldom satisfactory [14]. In addition, acute MCA occlusion

Table 3. Comparison of complications in the two groups (n, %)

Item	Intracranial hemorrhage	Symptomatic intracranial hemorrhage	Vasospasm
Study group (n=32)	3 (9.38)	0	0
Control group (n=28)	9 (32.14)	6 (21.43)	6 (21.43)
χ^2	4.838	7.619	7.619
P	0.027	0.005	0.005

Table 4. Comparison of recurrence rate and prognosis in follow-up period (n, %)

	Good prognosis	Relapse
Study group (n=32)	23 (71.88)	2 (6.25)
Control group (n=28)	12 (42.86)	10 (35.71)
χ^2	5.173	8.102
P	0.022	0.004

affects the anterior circulation which is at a higher risk of developing complications from thrombolytic therapy compared to posterior circulation [15]. MT is a new method for treating acute cerebral infarction without the restricted time window and inappropriate thrombolysis [16]. However, a simple MT also has its limitations, such as modest recanalization rate, embolism risk etc. [17].

MT combined with catheter aspiration has a synergistic, double thrombectomy effect [9, 18]. In addition, the placement of middle catheter into the proximal end of occluded blood vessel reduces the aspiration distance and acts directly on the thrombus resulting in a better aspiration compared to that of the simple guided catheter. The stent is placed in the middle catheter to allow the thrombus into the effective segment of the stent during retraction of the catheter, stent, etc. This prevents thrombus shedding by poor adherence in the siphon segment, as well as dislodging due to the change of the stent diameter that causes incomplete aspiration. The recanalization rate of the study group was 59.38%, which was significantly higher than that of the control group (28.57%). Furthermore, the time from onset to recanalization and from puncture to recanalization were both significantly shorter in the study group compared to the control group, indicating that inclusion of catheter aspiration could effectively enhance the success rate of a single MT, shorten the operation time, and rapidly restore blood supply to the MCA. Furthermore, NIHSS scores at all time points were significantly lower in the study group compared to the control group, suggesting that recovery of cerebral neurological deficit in patients undergoing combination surgery was significantly better than in those receiving simple MT. This is possibly because the combined surgery rapidly restores cerebral artery blood flow, alleviates the ischemic and hypoxic state of local brain tissues, and restores neurological functions.

A large number of emboli may be generated during the MT of the stent, which can easily lead to distal occlusion of related surgical area [19]. During the embolization process, the stent may damage the atherosclerotic vessel wall leading to arterial dissection, and if the emboli fall off, embolism can recur [20-22]. In the catheter aspiration technique, emboli are directly aspirated through the tip of the catheter, which can effectively reduce vascular injury during thrombectomy but cannot provide the same access to blood vessels as stent thrombectomy. This study combines two techniques with good clinical effect, and no serious perioperative complications in either group. The incidences of intracranial hemorrhage, symptomatic intracranial hemorrhage, vasospasm, and secondary cerebral infarction were significantly lower in the study group than in the control group, suggesting that the combination treatment is safer and can reduce the occurrence of these complications. In addition, the recurrence rate in the follow-up period in the study group was 6.25%, which was significantly lower than that in the control group (35.71%). The improved prognosis in the study group (71.88%) compared to the control group (42.86%) was consistent with the findings of Pan et al. [23]. There are two likely reasons for this observation: first, simultaneous stent thrombectomy and catheter aspiration effectively reduces the diameter of the stent and the drag distance of emboli in the blood vessels, which reduces embolism and blood vessel wall damage to a great extent. Second, the aspiration catheter can be used as a thrombectomy tool and save operation time [24, 25].

In summary, MT combined with catheter aspiration can achieve a good revascularization effect, significantly reduce the time to revascularization, reduce the incidence of complications and recurrence rate, and improve prognosis in senile patients with acute MCA occlusion. However, since this study is only a preliminary controlled clinical trial with small sample size, bias is possible. For example, we did not observe complications like distal embolization in the lesion area, new arterial dissection, vasospasm etc., which is possibly related to milder symptoms and shorter observation time in the selected cases. Subsequent studies with larger sample size and extended observation periods should be conducted to explore the safety and long-term curative effect of stent MT combined with catheter aspiration.

Disclosure of conflict of interest

None.

Address correspondence to: Bin Wang, Department of Neurology, Yuncheng Central Hospital, No.3690 Hedong East Street, Yuncheng City 044000, Shanxi Province, China. Tel: +86-0359-6397801; Fax: +86-0359-6397801; E-mail: binwang0411@163.com

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