Original Article

The efficacy and risk factors of mechanical thrombectomy for the treatment of vertebrobasilar artery occlusion: a single center study

Jun Yao[1#], Mingyang Xu[1#], Rujuan Zhou[1#], Yuan Zhu[2], Bingchun Yan[3], Jingye Lu[1], Chunqin Ding[1], Yan Li[1], Guomei Shi[1], Yan Yang[1], Feng Yang[1]

[1]Department of Neurology, Taixing People's Hospital, Taixing, China; [2]Department of Acupuncture, Longhua Hospital Shanghai Univerisity of Traditional Chinese Medicine, Shanghai, China; [3]Jiangsu Key Laboratory of Integrated Traditional Chinese and Western Medicine for Prevention and Treatment of Senile Diseases, Yangzhou University, Yangzhou, China

Contributions: (I) Conception and design: J Yao, M Xu, R Zhou, F Yang; (II) Administrative support: F Yang; (III) Provision of study materials or patients: J Yao, M Xu, R Zhou, Y Zhu, B Yan, J Lu, C Ding, Y Li, G Shi, Y Yang; (IV) Collection and assembly of data: J Yao, M Xu, R Zhou; (V) Data analysis and interpretation: J Yao, M Xu, R Zhou; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

[#]These authors contributed equally to this work.

Correspondence to: Feng Yang. Department of Neurology, Taixing People's Hospital, No.1 Changzheng Road, Taixing 225400, China.
Email: xmytxrmyy@163.com.

Background: The mortality of acute ischemic stroke patients caused by vertebrobasilar artery occlusion (VBAO) is high and mechanical thrombectomy has gradually become a promising treatment for acute ischemic stroke. This study analyzed the efficacy of mechanical thrombectomy and the risk factors associated with poor outcomes in VBAO patients caused by severe local atherosclerotic stenosis.

Methods: This retrospective study enrolled patients with acute ischemic stroke caused by VBAO between March 1, 2016 and August 31, 2019. Patient demographic and clinical data were collected retrospectively. All enrolled patients were retrospectively interviewed for at least 3 months. Patients with a modified Rankin scale (mRS) score between 0 and 3 points were defined as having satisfactory outcomes while those with more than 3 points were defined as having unsatisfactory outcomes. In-hospital mortality, the rates of recanalization, and the rates of intracerebral hemorrhage were also recorded. Multivariable logistic regression was used to determine the risk factors of unsatisfactory outcomes in enrolled patients.

Results: A total of 65 patients were enrolled in this study with a median age 69.0 (63.0–78.0) years and 48 patients (73.8%) were male. Approximately 50% of patients had a mRS score of 0 or 1 point within 90 days after treatment with mechanical thrombectomy and 14 patients had a mRS score of 6 points. A total of 11 patients died in hospital. Out of the 65 patients, 7 required recanalization and 9 patients suffered from intracerebral hemorrhage. Multivariate logistic regression analysis showed that older age, lower baseline posterior circulation acute stroke prognosis early CT score (pcASPECTS), higher baseline National Institutes of Health stroke scale (NIHSS) score, and residual stenosis were independent risk factors of both unsatisfactory outcomes and mortality of VBAO patients.

Conclusions: This study confirmed the important role of mechanical thrombectomy in the treatment of acute ischemic stroke caused by VBAO and may provide some guidance for improving the prognosis of patients.

Keywords: Mechanical thrombectomy; vertebrobasilar artery occlusion; efficacy; risk factors; single center

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Introduction

Acute stroke, including ischemic stroke and hemorrhagic stroke, is one of the most life-threatening diseases that leads to neurological disabilities (1). Previous studies have suggested that ischemic stroke is more common than hemorrhagic stroke (2). Ischemic stroke can be caused by the occlusion of different cerebral vessels, and vertebrobasilar artery occlusion (VBAO) accounts for approximately 20% of all acute ischemic strokes (3). Despite its relatively low incidence, acute VBAO is the most dangerous type of cerebral vessel occlusion and can be caused by severe local atherosclerotic stenosis or distant embolization (4), with the former being more common (5). Without any specific treatment, the mortality rate of patients with acute ischemic stroke caused by VBAO is approximately 80–90% (6). Therefore, effective treatments for VBAO have attracted much attention globally.

Unfortunately, antithrombotic agents yield poor rates of recanalization of cerebral vessels in ischemic stroke patients (7). Intravenous or intra-arterial thrombolysis is more commonly used for the treatment of ischemic stroke, however, the rates of recanalization are also not satisfactory, reaching only as high as 65% (8). In the recent decade, mechanical thrombectomy has emerged as a promising treatment for acute ischemic stroke. Nevertheless, the outcomes of mechanical thrombectomy may vary depending on the mechanism of cerebral vascular occlusion (9). The rate of reperfusion using mechanical thrombectomy may decrease slightly in patients with severe local atherosclerotic stenosis because the retrieval of the stent may result in damage to atherosclerotic plaques that then leads to the development of acute thrombosis (10). In addition, the resistance caused by atherosclerotic stenosis during the procedure of mechanical thrombectomy may tear some cerebral vessels and induce intracerebral hemorrhage (10). Despite these complications, mechanical thrombectomy has been reported to have a higher rate of recanalization and lower mortality in ischemic stroke patients compared to intravenous or intra-arterial thrombolysis (11-13). However, only a limited number of studies have investigated the efficacy of mechanical thrombectomy in acute ischemic stroke patients caused by VBAO, especially in the Chinese population.

This single-center report analyzed the efficacy of mechanical thrombectomy in VBAO patients. In addition, the risk factors of poor outcomes in these patients were identified. We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/apm-21-614).

Methods

Study design and patient selection

This retrospective study enrolled 65 patients with acute ischemic stroke caused by VBAO at the Department of Neurology in our hospital between March 1, 2016 and August 31, 2019. The following patients were included in this study: patients who were older than 18 years; patients diagnosed with acute ischemic stroke caused by VBAO due to severe local atherosclerotic stenosis; patients with a pc-ASPECTS (posterior circulation acute stroke prognosis early CT score) no less than 6 points; patients with a NIHSS score (National Institutes of Health stroke scale) no less than 6 points; and patients who had received mechanical thrombectomy treatment. Mechanical thrombectomy was performed dependent on the clinical judgement of experienced neurologists in our department. The following patients were excluded from this study: patient with intracerebral hemorrhage confirmed by computed tomography at diagnosis; patients with a history of intracerebral hemorrhage or cerebral tumor; patients with pc-ASPECTS score less than 6 points; patients with NIHSS score less than 6 points; and patients who had been diagnosed with renal dysfunction or failure. This study was reviewed and approved by the institutional review board of Taixing People's Hospital and all procedures were in accordance with the Declaration of Helsinki (as revised in 2013). Written informed consent from patients was not required due the retrospective nature of the study.

Data collection

Patient demographic and clinical data were collected retrospectively. Demographic data collated included patient age, gender, body mass index, previous history of stroke, and other comorbidities (such as hypertension, diabetes, hyperlipidemia, and chronic heart disease). Clinical data collated included the site of occlusion, baseline pcASPECTS and NIHSS scores, the duration of the occlusion, the duration of the treatment procedure, the use of angioplasty (balloon dilation and stent placement), and the rate of residual stenosis. The time of wake-up stroke onset was defined as the last normal time of the patient on the previous day. The collection of data and the

Table 1 Demographic and clinical data of all the enrolled patients in this study

Variables	Data
Number	65
Age, years	69.0 (63.0–78.0)
Male sex	48 (73.8%)
Body mass index	22.3 (20.4–24.4)
Previous history of stroke	9 (13.8%)
Hypertension	45 (69.2%)
Diabetes	12 (18.5%)
Hyperlipidemia	16 (24.6%)
Chronic heart disease	4 (6.2%)
Site of occlusion	
Distal basilar artery	26 (40.0%)
Middle basilar artery	13 (20.0%)
Proximal basilar artery	17 (26.2%)
Vertebral artery	9 (13.8%)
Baseline pcASPECTS	9.0 (8.0–10.0)
Baseline NIHSS	21.0 (11.0–24.5)
Duration of occlusion, hours	9.5 (7.0–13.5)
Duration of treatment procedure, minutes	94.0 (71.5–136.0)
Use of angioplasty	19 (29.2%)
Residual stenosis	28 (43.1%)

pcASPECTS, posterior circulation acute stroke prognosis early CT score; NIHSS, national institutes of health stroke scale.

scores of pcASPECTS and NIHSS were performed by two independent investigators and any disagreements were resolved by a third investigator.

All mechanical thrombectomy interventions were performed by skilled neurologists. In patients where mechanical thrombectomy failed to achieve successful reperfusion, transluminal angioplasty was performed using balloon dilation and stent placement. Tirofiban was intravenously administered during the angioplasty procedure.

Outcomes

All enrolled patients in this study were retrospectively interviewed by telephone or internet for at least 3 months. The primary outcome in this study was the modified Rankin scale (mRS) score within 90 days. Patients with a mRS score between 0 and 3 points were defined as having satisfactory outcomes while those with more than 3 points were defined as having unsatisfactory outcomes. Secondary outcomes included in-hospital mortality, the rate of recanalization, and the rate of intracerebral hemorrhage due to mechanical thrombectomy.

Statistical analysis

Statistical analyses were performed using SPSS 20.0 (IBM Corp., Armonk, New York, USA). Categorical variables were presented with frequencies and percentages, and continuous variables were presented with median and interquartile range (IQR). Comparisons between patients having satisfactory and unsatisfactory outcomes were performed using chi-square test for categorical variables and Manne-Whitney U test for continuous variables. The risk factors of satisfactory outcomes were assessed using logistic regression analysis. All collected variables were initially analyzed by univariate logistic regression to determine potential risk factors of satisfactory outcomes and these potential risk factors were then further analyzed using multivariate logistic regression to determine eventual risk factors. A P value <0.05 was considered statistically significant.

Results

According to the inclusion and exclusion criteria, 65 patients were finally enrolled in this study. All enrolled patients were diagnosed with acute ischemic stroke caused by VBAO due to severe local atherosclerotic stenosis. The demographic and clinical data are shown in *Table 1*. The median age of the patients was 69.0 (63.0–78.0) years and 48 patients (73.8%) were male. The majority of patients had a normal body mass index. A total of 9 patients had a previous history of stroke. There were 45, 12, 16, and 4 patients with hypertension, diabetes, hyperlipidemia, and chronic heart disease, respectively. The most common site of occlusion was the distal basilar artery, detected in 40.0% of patients, followed by the middle basilar artery, the proximal basilar artery, and the vertebral artery. Median baseline scores of pcASPECTS and NIHSS were 9.0 (8.0–10.0) and 21.0 (11.0–24.5), respectively. The median duration of occlusion was 9.5 (7.0–13.5) hours and the median duration of the treatment procedure was 94.0 (71.5–136.0) minutes. A

Table 2 Primary and secondary outcomes of the study

Variables	Data
Number	65
mRS score within 90 days	
0	20 (30.8%)
1	15 (23.1%)
2	7 (10.8%)
3	5 (7.7%)
4	2 (3.1%)
5	2 (3.1%)
6	14 (21.5%)
In-hospital mortality	11 (16.9%)
Recanalization	7 (10.8%)
Intracerebral hemorrhage	9 (13.8%)

mRS, modified Rankin scale.

total of 19 patients received angioplasty as mechanical thrombectomy failed to achieve successful reperfusion in these patients. There were 28 patients with residual stenosis of more than 50% after treatment with mechanical thrombectomy.

The mRS scores for the patients are listed in *Table 2*. Approximately 50% of patients had a mRS score of 0 or 1 point within 90 days after treatment with mechanical thrombectomy. A total of 14 patients died within 90 days and had a mRS score of 6 points. Secondary outcomes including in-hospital mortality, recanalization, and intracerebral hemorrhage are shown in *Table 2*. After treatment with mechanical thrombectomy, 11 patients died in hospital. A total of 7 patients required recanalization and 9 patients suffered from intracerebral hemorrhage.

Patients were divided into two groups according to the mRS score, patients with satisfactory outcomes and patients with unsatisfactory outcomes. Most of the demographic and clinical data between the two groups were not significantly different (*Table 3*). However, patients in the satisfactory outcome group were younger compared to patients in the unsatisfactory outcome group [65.5 (60.0–73.0) *vs.* 76.0 (65.5–82.0), P=0.010]. Fewer patients in the satisfactory outcome group had hypertension compared to those in the unsatisfactory outcome group [29 (66.0%) *vs.* 16 (88.9%), P=0.039]. Patients in the satisfactory outcome group had significantly higher baseline pcASPECTS scores and lower baseline NIHSS scores compared to the unsatisfactory outcome group [9.0 (9.0–10.0) *vs.* 9.0 (8.0–9.0), P=0.013; and 18.0 (14.0–21.5) versus 24.5 (23.0–26.0), P<0.001, respectively]. In addition, more patients in the unsatisfactory outcome group had residual stenosis after mechanical thrombectomy compared to the satisfactory outcome group [12 (66.7%) *vs.* 16 (38.3%), P=0.017].

Multivariate logistic regression was used to determine the risk factors of unsatisfactory outcomes (*Table 4*). Older age, lower baseline pcASPECTS score, higher baseline NIHSS score, and residual stenosis were related to a higher incidence of unsatisfactory outcomes. Hypertension was associated with the incidence of unsatisfactory outcomes in the univariate analysis, however no significant impact was observed during the multivariate analysis. Moreover, risk factors of in-hospital mortality were assessed by multivariate logistic regression (*Table 5*). Similar to risk factors of unsatisfactory outcomes, older age, lower baseline pcASPECTS, higher baseline NIHSS, and residual stenosis were related to in-hospital mortality. Primary and secondary outcomes of the patients are shown in *Table 6* according to age, baseline pcASPECTS, baseline NIHSS, and residual stenosis.

Discussion

Previous studies have investigated the efficacy of mechanical thrombectomy in patients with acute ischemic stroke caused by severe local atherosclerotic stenosis and distant embolization (3-5,8,10,14,15). However, it is possible that different mechanisms of acute ischemic stroke may results in different patient prognosis and hence this study only enrolled patients with acute ischemic stroke caused by VBAO due to severe local atherosclerotic stenosis. The results indicated that approximately 70% of patients in this study achieved a relatively satisfactory outcome. The risk factors of unsatisfactory outcomes included older age, lower baseline pcASPECTS, higher baseline NIHSS, and residual stenosis after mechanical thrombectomy. These results provided some evidence for the application of mechanical thrombectomy in the treatment of acute ischemic stroke caused by VBAO.

The application of mechanical thrombectomy in the treatment of acute ischemic stroke has been studied for many years. The incidence of satisfactory outcomes in this study was approximately 70%, which is similar to previous studies of acute ischemic stroke caused by occlusion of other arteries (16,17). Furthermore, in agreement with

Table 3 Comparisons of the demographic and clinical data between patients with satisfactory outcomes and patients with unsatisfactory outcomes

Variables	Unsatisfactory outcomes	Satisfactory outcomes	P value
Number	18	47	
Age, years	76.0 (65.5–82.0)	65.5 (60.0–73.0)	0.010
Male sex	13 (72.2%)	35 (74.5%)	0.854
Body mass index	22.5 (20.9–24.6)	21.8 (19.8–23.6)	0.403
Previous history of stroke	2 (11.1%)	7 (14.9%)	0.693
Hypertension	16 (88.9%)	29 (66.0%)	0.039
Diabetes	3 (16.7%)	9 (19.1%)	0.817
Hyperlipidemia	5 (27.8%)	11 (23.4%)	0.714
Chronic heart disease	2 (11.1%)	2 (4.3%)	0.305
Site of occlusion			0.957
Distal basilar artery	7 (38.9%)	19 (40.4%)	
Middle basilar artery	3 (16.7%)	10 (21.3%)	
Proximal basilar artery	5 (27.8%)	12 (25.5%)	
Vertebral artery	3 (16.7%)	6 (12.8%)	
Baseline pcASPECTS	9.0 (8.0–9.0)	9.0 (9.0–10.0)	0.013
Baseline NIHSS	24.5 (23.0–26.0)	18.0 (14.0–21.5)	<0.001
Duration of occlusion, hours	9.0 (7.0–14.0)	9.5 (6.5–14.0)	0.541
Duration of treatment procedure, minutes	102.0 (81.5–141.5)	85.5 (71.0–125.0)	0.137
Use of angioplasty	8 (44.4%)	11 (23.4%)	0.095
Residual stenosis	12 (66.7%)	16 (38.3%)	0.017

pcASPECTS, posterior circulation acute stroke prognosis early CT score; NIHSS, national institutes of health stroke scale.

Table 4 Multivariate logistic regression analysis for the risk factors of satisfactory outcomes

Variables	OR (95% CI)	P value
Age	1.052 (1.009–1.096)	0.017
Hypertension	2.387 (0.672–8.475)	0.178
Baseline pcASPECTS	0.491 (0.269–0.896)	0.021
Baseline NIHSS	2.085 (1.343–3.239)	0.001
Residual stenosis	3.875 (1.226–12.248)	0.021

pcASPECTS, posterior circulation acute stroke prognosis early CT score; NIHSS, national institutes of health stroke scale; OR, odds ratio; CI, confidence interval.

previous studies (18,19), the mortality rate in this study was 17% within 90 days after the procedure. These results indicated that the efficacy of mechanical thrombectomy in these patients is relatively stable despite the different sites of occlusion. Symptomatic intracerebral hemorrhage is the most significant postoperative complication of mechanical thrombectomy. The meta-analysis by Dmytriw *et al.* reported that the pooled rate of symptomatic intracranial hemorrhage was 5.9% in tandem acute ischemic stroke patients receiving mechanical thrombectomy (19). Wang

Table 5 Multivariate logistic regression analysis for the risk factors of in-hospital mortality

Variables	OR (95% CI)	P value
Age	1.077 (1.020–1.136)	0.007
Hypertension	5.429 (0.645–45.688)	0.120
Baseline pcASPECTS	0.356 (0.174–0.729)	0.005
Baseline NIHSS	1.543 (1.208–1.972)	0.001
Residual stenosis	8.289 (1.623–42.342)	0.011

pcASPECTS, posterior circulation acute stroke prognosis early CT score; NIHSS, national institutes of health stroke scale; OR, odds ratio; CI, confidence interval.

Table 6 Primary and secondary outcomes of enrolled patients according to age, baseline pcASPECTS, baseline NIHSS, and residual stenosis

Variables	Age		Baseline pcASPECTS		Baseline NIHSS		Residual stenosis	
	≤70	>70	≥9	<9	≤21	>21	No	Yes
Number	35	30	45	20	35	30	37	28
mRS score within 90 days								
0	13	7	17	3	14	6	12	8
1	9	6	13	2	11	4	11	4
2	5	2	5	2	4	3	3	4
3	3	2	4	1	3	2	3	2
4	0	2	1	1	1	1	2	0
5	1	1	1	1	0	2	2	0
6	4	10	4	10	2	12	4	10
In-hospital mortality	2	9	1	10	1	10	1	10
Recanalization	0	7	0	7	0	7	0	7
Intracerebral hemorrhage	1	8	1	8	0	9	1	8

pcASPECTS, posterior circulation acute stroke prognosis early CT score; NIHSS, national institutes of health stroke scale; mRS, modified Rankin scale.

et al. detected a rate of 8.7% in acute mild ischemic stroke patients with large vessel occlusion (20). Compared with these studies, the rate of intracranial hemorrhage in our study was relatively high, up to 13.8%. This may be related to the nursing care of postoperative patients in our hospital and could be improved in the future.

Numerous studies have confirmed that age is significantly associated with the prognosis of acute stroke patients (12,21,22). This current study further confirmed the important role of age in the unsatisfactory outcomes and in-hospital mortality. In practice, the age of patients in our study was relatively young compared with some other studies (23,24). Sojka *et al.* reported that the mortality after 90 days was as high as 47.4 % in acute ischemic stroke patients aged more than 90 years old (25). The baseline pcASPECTS and NIHSS scores represent the severity of stroke in patients, which in turn determines the prognosis of patients to a large extent, and this is confirmed by this study and previous investigations (12,16). Residual stenosis has seldomly been identified as a risk factor of unsatisfactory outcomes in stroke patients. However, this study found that residual stenosis may be detrimental to the prognosis of patients irrespective of whether stenosis was greater or less than 70%. Indeed, residual stenosis may be related to a higher occurrence of re-occlusion. Our study also identified some other variables as risk factors of unsatisfactory

outcomes in acute ischemic stroke patients caused by VBAO, however, these results were not statistically significant. Indeed, other reports have suggested that onset-to-recanalization time and being female may be risk factors of unsatisfactory outcomes in stroke patients (5,24). Further studies are needed to determine all the risk factors in the prognosis of acute ischemic stroke patients.

There are some limitations to this study. First, the retrospective design and the small number of patients were the most significant limitations, and may result in errors in the data collected and may not reflect the situation in a broader population. Second, this investigation was a single center study, and the results may only apply to this center. Third, some patients failed to achieve successful reperfusion by mechanical thrombectomy, and transluminal angioplasty was performed using balloon dilation and stent placement which may have affected the results in this study.

Conclusions

This study investigated the efficacy of mechanical thrombectomy in the treatment of patients with acute ischemic stroke caused by VBAO and identified potential risk factors of unsatisfactory outcomes within 90 days. These results further confirmed the important role of mechanical thrombectomy and may provide some basis for improving the prognosis of these patients.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/apm-21-614

Data Sharing Statement: Available at http://dx.doi.org/10.21037/apm-21-614

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/apm-21-614). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was reviewed and approved by the institutional review board of Taixing People's Hospital and all procedures were in accordance with the Declaration of Helsinki (as revised in 2013). Written informed consent from patients was not required due the retrospective nature of the study.

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