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Clinical Study of Endovascular Treatment of Severe Middle Cerebral Artery Stenosis or Occlusion and Vascular Cognitive Impairment

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ABSTRACT

It is very important to study the factors affecting the incidence, progress and prognosis of patients with vascular dementia. 50 cases of severe middle cerebral artery stenosis or occlusion underwent endovascular treatment (25 cases of mild cognitive dysfunction, 25 cases of moderate cognitive dysfunction) were divided into two groups, where a medical drug treatment group and a control group established with 25 cases in each group. The cognitive function of each group of patients was evaluated before operation, 7 days after operation, 30 days after operation, and 180 days after operation. CTP was used to compare the hemodynamic changes in patients before and after operation. The severe stenosis or occlusion of the middle cerebral artery in patients can be improved, and the intracranial blood supply of patients with poorly compensated medial cranial circulation and hypoperfusion can be restored to a certain extent. Meanwhile, improvement of cognitive function was definitive in some patients with cognitive dysfunction. To guide the formulation of treatment plans for patients with severe middle cerebral artery stenosis or occlusion.

1. Introduction

In recent years, vascular cognitive dysfunction has become the second most common cause of Alzheimer's disease in China, and the incidence is only lower than Alzheimer's disease. Non-dementia vascular cognitive dysfunction refers to early or mild cognitive impairment caused by cerebrovascular injury, and does not necessarily progress to vascular dementia; if it can be diagnosed and treated early in the VCIND stage, the course of the disease may reverse. Intracranial artery stenosis is closely related to the incidence of cognitive dysfunction, and endovascular treatment can better improve cerebral ischemia. The middle cerebral artery mainly supplies blood to the temporal lobe, parietal lobe and basal nucleus of the brain. The more severe the stenosis of the middle cerebral artery segment, the higher the degree of cognitive impairment. Insufficient cerebral perfusion may be an important cause of cognitive impairment in patients with cerebral artery stenosis [1]. The mechanism of cognitive dysfunction caused by cerebral hypoperfusion may include: long-term ischemia leading to chronic cerebral ischemia, hypoxia, and anaerobic glycolysis, which induces phosphorous metabolism disorders in the brain hippocampal neuron membrane, producing excessive free radicals and releasing a large amount of excitatory amino acids, leading to intracellular calcium ion overload and other problems, resulting in hippocampus neurotransmitter disorder and neuron loss, causing cognitive impairment; white matter

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lesions are independent risk factors for cognitive dysfunction, long-term chronic ischemia and hypoxia can lead to diffuse demyelination changes in the white matter of the brain and accelerate cognitive decline; cerebral ischemia and hypoxia promote the production of β-amyloid, accelerate the aging and apoptosis of nerve cells, and lead to the decline of cognitive function. In addition, decreased cerebrovascular reserve capacity is also related to declined cognitive function. The pathogenesis of VCI is more complicated and the incidence is high. The incidence of VCI is increasing year by year, and the cost of treatment is relatively high. However, it is currently the only cognitive impairment disease that can be intervened. Recanalization of blood vessels may restore blood supply to brain tissue, and patients with severe stenosis or occlusion of the middle cerebral artery with cognitive impairment may benefit from it.

2. Materials and Methods

2.1 Materials

50 patients with severe stenosis or occlusion of the middle cerebral artery (25 cases with mild cognitive impairment, 25 cases with moderate cognitive impairment) and 50 patients who received internal medications, hospitalized in provincial Grade III Level A hospitals from January 2019 to April 2020 were selected.

2.2 Methods

From January 2019 to April 2020, 25 patients with mild to moderate cognitive impairment with severe stenosis or occlusion of one middle cerebral artery were included. The group receiving endovascular treatment was assigned as treatment group and the group receiving non-endovascular treatment was assigned as control group. CTP inspection was conducted. Inclusion criteria: ① Diagnosed with mild to moderate cognitive dysfunction by Montreal Cognitive Assessment (MOCA) screening (MOCA score <26 points); ② DSA showed severe unilateral middle cerebral artery stenosis or occlusion; ③ Indications for endovascular treatment. Exclusion criteria: ① Have a history of dementia and psychiatric diseases; ② Severe middle cerebral artery stenosis or occlusion causes blood supply area infarction; ③ Severe systemic diseases or neurological deficits such as severe aphasia, unable to cooperate with cognitive function examination; History of alcohol, drug abuse, and psychotic drug abuse.

2.3 Examination Methods and Standards

With the subject's consent and cooperation, the Montreal Cognitive Assessment (MoCA) was used to evaluate and diagnose the subject's cognitive function. The assessment was arranged to take place in a quiet room whenever possible, and an experienced and professionally trained neurorehabilitation physician was appointed to conduct the assessment and record the assessment score. MOCA was conducted 1 week before operation, 7 days after operation, 3 months and 6 months after operation on the treatment group and control group during the same period. The MOCA scoring of cognitive function was evaluated by senior neurologists. The total score of MOCA score is 30 points. If the score is less than 26, it is considered that there is cognitive dysfunction. If number of years of education is less than 12 years, 1 point is added to the original score. Meanwhile, ReHo analysis was applied to the preprocessed resting state functional magnetic resonance imaging (MRI) data, and the data analysis was performed with the brain function data processing software developed by Beijing Normal University. Calculation was performed until each voxel of the whole brain reached consistency in time series with its 26 neighboring voxels in the surrounding. In the CTP examination, a CT scanner was used to determine cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time (MTT) and peak time (TTP), and then the CBF ratio (rCBF) of the affected side to the healthy side, CBV ratio (rCBV), MTT difference (dMTT) and TTP difference (dTTP) were calculated respectively.

2.4 Statistical Analysis

SPSS statistical analysis software was used. The measurement data are expressed as x±s. The independent sample t-test was used for comparison between the treatment group and the control group, and $P<0.05$ was considered as statistically significant.

3. Results

（1）Comparison of Treatment Efficacy

Table 1. Comparison of Treatment Efficacy

Group	90dmRS Score [Cases (%)]		mTICI Grading [Cases (%)]		Reocclusion Rate [Cases (%)]
	≤2 pts	>2 pts	≥2b	<2b	
Treatment (n=20)	13(65.00)	7(35.00)	17(85.00)	3(15.00)	2(10.00)
Control (n=20)	9(45.00)	11(55.00)	1	/	/
zX2	-1.	704			
P	0.	88			

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（2）MOCA Score Comparison

Table 2. Comparison of each Item in MOCA Scoring

Item	Treatment Group	Control Group	P
Visual Spatial and Execution	2.8±1.0	4.7±0.5	0.00
Naming	2.6±0.5	2.9±0.3	0.14
Concentration	5.1±0.9	5.7±0.5	0.07
Language	2.1±0.7	2.9±0.3	0.01
Abstraction	1.8±0.4	1.8±0.4	1
Delayed Recall	2.9±1.0	4.2±0.6	0.00
Direction	4.8±0.6	5.2±0.8	0.23
MOCA	22.1±2.6	27.4±1.3	0.00

（3）Comparison of Difference in CTP between Groups

Table 3. Comparison of the CTP in the Mild Stenosis Group

	Affected Side	Healthy Side	P
CBV(m1/100g)	1.33±0.56	2.20±0.97	0.002
CBF(ml/100g/min)	20.17±7.94	30.67±13.39	0.023
TTP(s)	15.68±3.61	14.81±3.76	0.263
MTT(s)	3.58±0.78	3.52±1.04	0.842

Table 4. The Comparison of CTP in the Moderate Stenosis Group

	Affected Side	Healthy Side	P
CBV(m1/100g)	1.17±0.68	1.85±1.15	0.011
CBF(ml/100g/min)	16.57±9.13	24.06±14.62	0.054
TTP(s)	16.55±5.81	12.54±2.46	0.003
MTT(s)	3.81±0.84	2.89±0.51	0.005

（4）Comparison of Difference in ReHo Value between Groups

Table 5. Regions with Significant Drop in ReHo Value in the Treatment Group

Brain Region	BA Area	Talairach Coordinate			t	Volume (mm)
		X	Y	z		
-Left Central Frontal Gyrus	6	-53	-12	64	-12.87	54
Left Frontal Gyrus	10	-15	55	12	-15.77	46
Lingual Gyrus of Right Occipital Lobe	17	12	-89	-3	-13.23	28
Lingual Gyrus of Left Occipital Lobe	17	-9	-89	0	-13.33	30
Left Middle Temporal Gyrus	21	-54	1	-19	-9.40	18
Left Precuneus	39	33	-65	36	-22.64	28
Left Posterior Cerebellum	-	-27	-69	-21	-34.06	48
Right Anterior Cerebellum	-	28	-37	-36	-11.46	31
Right Posterior Cerebellum	-	28	-80	42	-13.70	28

Table 6. Regions with Significant Drop in ReHo Value in the Control Group ReHo

Brain Region	BA Area	Talairach Coordinate			t	Volume (mm)
		X	Y	Z		
Left Medial Frontal Gyrus	6	-6	-9	61	9.93	36
Right Superior Temporal Gyrus	22	51	-18	0	27.75	33
Right Superior Temporal Gyrus	38	45	16	-27	21.29	29
Left Hippocampus	-	-19	-14	-24	18.89	38

4. Discussions

At this stage, patients with severe middle cerebral artery stenosis or occlusion have mainly three treatment options: endovascular treatment, surgical treatment and medical drug treatment. In recent years, with the development of endovascular treatment technology, continuous improvement of interventional devices and improvement of operational proficiency, the status of endovascular treatment in the middle cerebral artery is being valued by more and more scholars [2]. However, there are not many studies on the intravascular treatment of the middle cerebral artery. The follow-up time is short, so the patients' long-term patency is not clear, and the long-term follow-up of hemodynamics is insufficient, especially the cognitive dysfunction is rarely assessed in some patients. Experimental and clinical studies have shown that for mild to moderate middle cerebral artery stenosis, the use of drug therapy and stenting can improve cognitive function; for severe middle cerebral artery stenosis or even occlusion, drug treatment cannot improve the cognitive function. However, interventional therapy can significantly improve intracranial blood supply, thereby improving human cognitive function. After patients with severe middle cerebral artery stenosis or occlusion underwent endovascular treatment, their executive and memory ability may be significantly improved [3].

Vascular cognitive impairment refers to cognitive impairment syndrome, which ranges from mild cognitive impairment to dementia caused by cerebrovascular incidents. In many studies, the detection sensitivity of MOCA for mild vascular cognitive impairment is much higher than that of MMSE, which helps in the early diagnosis of vascular cognitive impairment and prevent vascular dementia in time. Therefore, in this study, we used the Montreal Cognitive Assessment Scale to assess the cognitive function of the subjects. The Montreal Assessment Scale showed that there were significant differences in visual spatial, executive function, language and delayed recall

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between the treatment group and the control group, but the two groups had no significant difference in naming, concentration, abstraction and direction [4]. In this study, central arteriovenous occlusion was assigned as the treatment group and endovascular treatment was performed. The blood flow of the middle cerebral artery was improved, but the patients' left-side visual spatial, executive, language and memory dysfunction, and concentration were not significantly different from those of the control group. Therefore, in this study, we found that patients with acute central arteriovenous occlusion have been successfully treated and recovered. Although they still have cognitive impairment, their concentration has been improved.

Current research shows that cerebral hemodynamic diseases caused by cerebral artery stenosis can be divided into four stages; stage 0 means that cerebral hemodynamics is completely normal; stage 1 means that as the cerebral perfusion pressure decreases, the body performs differently in level of actions. Cerebrovascular self-regulation dilates cerebral arterioles to reduce vascular resistance, and then reduce the ability of normal CBF by maintaining brain tissue, but at the expense of cerebrovascular reserve and CVR; the second stage is the further reduction of cerebral perfusion pressure. The cerebrovascular bed has reached the maximum expansion state, but the self-regulation ability of the cerebrovascular still cannot maintain the normal CBF of the brain tissue, and it is accompanied by the reduction in CBF and CVR failure. However, at this stage, the normal metabolism of brain tissue can be maintained by increasing oxygen intake. In the third stage, the oxygen uptake could not be maintained, but the decreased cerebral blood flow showed that it could not meet the continuous decrease of cerebral perfusion pressure of normal brain tissue.

Cognitive function is a complex high-level brain function activity, accomplished not through a single brain area or neural structure but through multiple brain functional areas and neural structures [5]. Studies have shown that memory functions involve many cortex and cortical structures. When brain damage occurs, the frontal lobe, temporal lobe, hippocampus, target gyrus, thalamus and midbrain reticular structure may further reduce [6]. Another study showed that the visual spatial function is accomplished by the frontal, temporal, parietal and occipital lobes, thalamus, basal ganglia and cerebellum in the two cerebral hemispheres [7]. The results of this study show that middle cerebral artery infarction can impair visual spatial, executive, language and memory functions, and it supports cortical and subcortical structures to participate in related cognitive activities through specific neural networks or circuits formed. Cerebral artery infarction can cause cognitive impairment in multiple areas [8].

Secondly, there is little difference in the good prognosis of neurological function between the two groups in this study, which may be affected by the sample size. Due to the relatively small sample size, the difference is unclear, but it can be seen that the endovascular treatment group has a higher good prognosis than the non-vascular treatment group. The study found that the speech score of the treatment group was lower compared with the control group, which indicates that patients receiving endovascular treatment and those who have recovered from acute middle cerebral artery occlusion still have language disorders.

5. Conclusions

There is no obvious breakthrough in the treatment of acute middle cerebral artery occlusion and ischemic stroke, and the clinical prognosis of patients after medication is often not ideal. Therefore, in the real world, many neurologists perform endovascular treatment on these patients according to the guidelines, and the results are mixed. Among them, patients with middle cerebral artery occlusion recovered well after endovascular treatment, but their cognitive function was significantly lower than that of the control group. The two groups had significant differences in visual space, executive function, language and delayed recall, but no significant differences in naming, concentration, and direction. Compared with previous studies, the concentration of patients with acute middle cerebral artery occlusion who were successfully treated and recovered has improved. The functional strength of patients with middle cerebral artery occlusion after endovascular treatment is different from that of the control group.

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