Effect of endovascular treatment on high-risk patients with chronic carotid artery occlusion

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OBJECTIVE: *This study aims to discuss the safety and short-term efficacy of endovascular treatment on high-risk patients with chronic carotid artery occlusion.*
METHODS: *A retrospective analysis was performed on the clinical data of 16 high-risk patients with chronic carotid artery occlusion who received endovascular treatment at the Department of Neurosurgery of the First Affiliated Hospital of Xinjiang Medical University from November 2013 to July 2016. The incidence of adverse events at 1 week, 30 days and six months post-operation were observed, and NIHSS was adopted to assess the neurological function of patients six months before and after the operation. Follow-up time was 6-26 months, with an average of 18.4 months.*
RESULTS: *The degree of carotid artery stenosis of these 16 patients was 100%. The degree of which after the operation was 24.9 ± 17.0%; and the difference was statistically significant (P<0.05). Iatrogenic carotid artery dissection occurred in one case, and persistent hypotension and sinus bradycardia occurred in one case. Furthermore, one case of endovascular treatment was not approved to be opened. Afterwards, temporal artery-STA-MCA bypass was performed; upon postoperative head CTA and DSA, the result showed that the perfusion was good. One case refused to undergo surgical treatment. The NHSS score of 14 cases of endovascular treatment that were successfully opened six months after the operation was 2.0 ± 1.36, which improved (P<0.05) compared with that of pre-operation.*
CONCLUSION: *Endovascular treatment on high-risk patients with chronic carotid artery occlusion is safe and effective. And it has obvious curative effect in short mid-term.*

KEY WORDS: Arterial occlusive disease, Carotid artery, Endovascular treatment, Treatment outcome

Introduction

Ischemic stroke is one of the major diseases that cause death and disability to the elderly, and the main mechanism of which is hypoperfusion [1]. Fifty percent of patients with ischemic stroke have ipsilateral carotid artery stenosis or occlusion. Hence, it is important to strengthen the prevention and treatment of ipsilateral carotid artery stenosis and occlusion [2]. Drug treatment on carotid artery occlusive disease has been feeble. Endovascular treatment is theoretically the best way to treat chronic carotid artery occlusion, and this approach has become more viable owing to the progress of intervention techniques and the improvement of cerebral embolism protection devices. However, given that patients with chronic carotid artery occlusion are at high risk, endovascular treatment on patients with chronic carotid artery occlusion has not been extensive clinically. At the same time, IC-EC bypass surgery can improve

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the blood supply to the brain [3], which can be used as a supplement for endovascular treatment. In this article, a retrospective study was conducted on the clinical data of 16 high-risk patients with chronic carotid artery occlusion who underwent endovascular treatment, and the safety and short-term efficacy of endovascular treatment for patients with chronic carotid artery occlusion were discussed.

Data and Method

Inclusion Criteria

(1) According to the guidelines of the interventional treatment of carotid stenosis, noninvasive imaging or angiographic findings revealed the carotid artery occlusion.
(2) It has the following indications for endovascular treatment: 1) Infarct related symptomatic stroke or transient ischemic attack (TIA); 2) The presence of radiographic intracranial hypoperfusion; 3) Segmental occlusions at the internal carotid arteries and regurgitant blood of the distal occlusions were diagnosed through DSA, in which the regurgitant blood reached the intrapetrous carotid artery; 4) Occlusive artery-related ischemic symptoms continued to recur after standardized medical treatment, and the distal end of these vessel occlusions did not exceed the ophthalmic artery segment. (3) Patients according with high-risk carotid artery occlusion criteria. According to the SAPPHIRE study [4] and the 2007 American carotid artery stenting clinical expert consensus [5], high-risk factors include: restenosis in clinically significant heart diseases [severe coronary heart disease, unstable angina III/IV grade, near-term myocardial infarction(<30 days), and congestive heart failure III/IV grade], renal insufficiency, severe lung disease, contralateral carotid artery stenosis or occlusion, contralateral laryngeal nerve palsy, carotid endarterectomy after the operation, previously underwent cervical surgery or neck radiotherapy, lesions located at the C2 or carotid artery stenosis of higher parts, and the recommended age in the latest AHA/ASA stroke and TIA secondary prevention guidelines is over 70 years old [6].

Clinical Materials

A total of 78 patients with chronic carotid artery occlusion were admitted and treated in the Department of Neurosurgery of the First Affiliated Hospital of Xinjiang Medical University from October 2014 to July 2016. Among them, 16 high-risk patients with chronic carotid artery occlusion were included based on the inclusion criteria; among which, 13 patients were male, three were female, aged from 48 to 76 years old, with an average of 63 ± 11 years old. The clinical manifestations were as follows: 3 cases of acute cerebral infarction; 15 cases of lateral appendage somasthenia, dizziness and repeated TIA caused by Occlusion, among which: 13 cases of lateral appendage somasthenia, and 5 cases of amaurosis fugax. Furthermore, 6 cases of lateral carotid artery stenosis and occlusion caused by combination, 6 cases of arteria subclavia and vertebral artery disease caused by combination, 5 cases of severe coronary heart disease caused by combination, 2 cases of chronic kidney disease, seven cases were >70 years old, 4 cases of diabetes, 9 cases of hypertension, 8 cases of hyperlipidemia, and 8 cases were smokers.

Imaging Data

All patients have undergone MRI examination, suggesting that there are varying degrees of old cerebral infarction in the carotid artery blood supply areas. ECT cerebral blood flow tomography imaging revealed cerebral blood perfusion in the occlusion side had varying degrees of decline. DSA results suggested that 16 cases had carotid artery occlusion, vertebral artery and (or) carotid artery anastomosis that compensated for internal carotid artery, 9 cases had posterior communicating artery compensation, 10 cases had anterior communicating artery compensation, and 5 cases had posterior corpus arterial and soft membrane vascular compensation.

Therapeutic Method

All patients received 100 mg/d of aspirin and 75 mg/d of clopidogrel for three days before the operation. In the local anesthesia, an 8F arterial sheath was placed through the Seldinger puncture at the right arteria cruralis, systemic heparinization and an 8F guiding catheter (Johnson & Johnson) was placed in the caecum of the initiative carotid artery at the assistance of an ultra-smooth guide-wire (Japan Terumo Corporation), a microcatheter with a strong support force was used (Echelon-10, American EV3), a micro-guide wire (Pilot 0.014 in × 190 cm, US Boston Scientific) and a rotating micro-guide wire was used to transport, with the assistance of the micro-guide wire, carefully inserted through the occluded blood vessels after gently breaking the blocked fibrous cap, and microcatheter angiography confirmed that the distal end of the microcatheter is located at the normal lumen. A super selective PT microwire was inserted into internal carotid artery distal under the guidance of the road map, withdrawal was performed from the conduit, and transported the umbrella (Spider, EV3, USA) into place along the micro-wire before releasing it into the carotid artery neck or petrous bone segment. The occlusive artery was expanded from far to near to select the appropriate size of the saccule, and routine DSA assessment was conducted on blood flow

after expansion to detect the presence of vessel dissections and complications. Then, the Protégé self-expanding stent (EV3, USA) was released after balloon dilatation from far to near. The umbrella was recovered, and the drainage-tube was slowly retracted. The operation was completed when DSA indicated that the stent was released well and the distal end of the blood flow was smooth. Non-neutralizing heparin after the operation, and indwelling arterial sheath to partial thromboplastin time (APTT) recovered to normal. Next, low molecular heparin was injected under the skin (4,000 IU/12 hours for three days) at the same time of being treated with anti-platelet aggregation after the operation. Aspirin enteric-coated tablets were given for the patient by oral administration (100 mg/d) for a lifetime and clopidogrel (75 mg/d) for at least six months after the operation.

Follow-Up

The follow-up time was 6-26 months, averaged 18.4 months.

Methods

Were clinical follow-up, telephone follow-up, and imaging follow-up. The neurological function of the patient was assessed six months before and after the operation by adopting The National Institute of Health Stroke Scale (NIHSS).

Statistical Method

Statistical software SPSS 17.0 was used for statistical analysis. The measurement data subject to the normal distribution were expressed as ± standard deviation (SD). The degree of coronary artery stenosis of the stent before and after operation, and the NIHSS scores before and after operation, were compared by paired sample t-test. $P<0.05$ was considered statistically significant.

Results

Surgical Results And Complications

Among the 16 high-risk patients with chronic carotid artery occlusion, 14 patients underwent endovascular treatment with a success rate of 87.5%. A total of 20 stents were implanted. The degree of carotid artery stenosis was 100%, while the degree of carotid artery stenosis after the operation was 24.9 ± 17.0%; and the difference was statistically significant ($P<0.05$). 2 cases underwent endovascular treatment were not successful. One case underwent a superficial temporal artery-MCA bypass operation in the later stage, and one patient refused to have surgical surgery. Iatrogenic carotid artery dissection occurred in one patient with long-term segmental occlusions during the operation (Fig. 1). One patient underwent subclavian artery balloon dilatation in

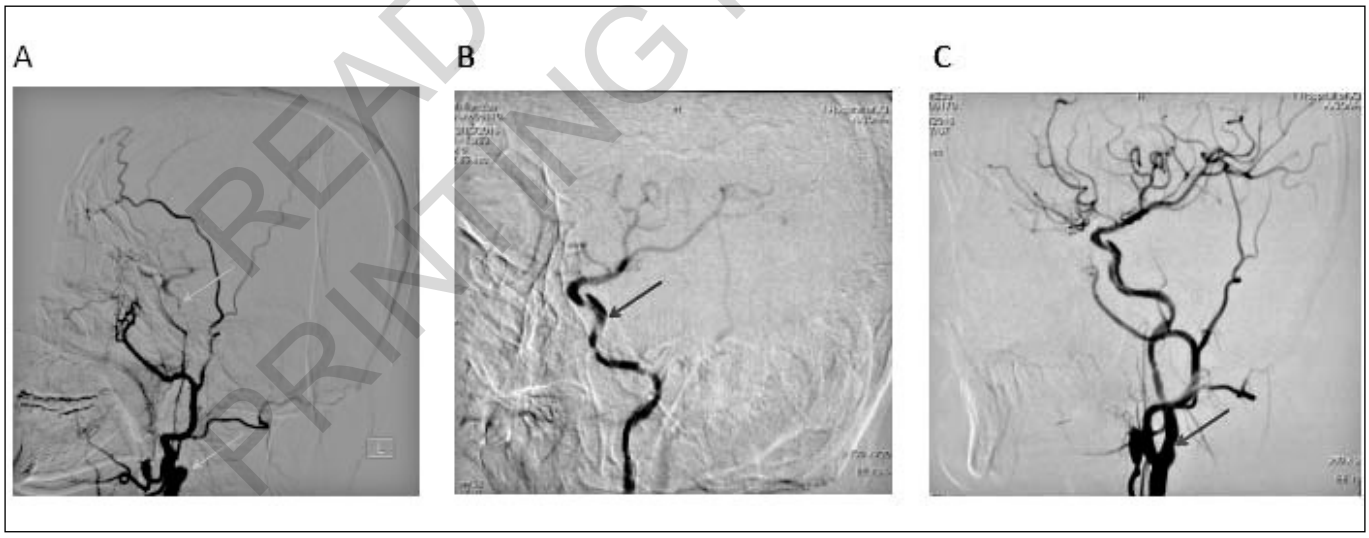

Fig. 1: Imaging data of patients with left internal carotid occlusion. (A) Preoperative left common carotid angiography revealed an occlusion at the original segment of the internal carotid, and the internal carotid was antidromic and filled (as indicated by the arrow). (B) Under the support of the 8F guiding catheter and 5F multifunctional catheter, a synchro-2 guide wire was selected and inserted through the occlusion, which gives rise to vascular dissection at the cavernous sinus segment of the left internal carotid. Furthermore, a Boston 2.0 × 40 mm balloon was used to dilate the stenosis segment during the operation. (C) Under the premise of protective umbrella placement, a 5.0 × 40 mm balloon was used. After that, a 6.0 × 40 mm balloon was used to dilate the original occlusion segment, the inner diameter of carotid artery was measured, and a self-expanding stent (9.0 × 20.0 mm) was used to release the original occlusion segment. The stent formed well and the carotid artery had an unblocked blood flow. Follow-up was performed on the vascular dissection at the cavernous sinus segment in the later period, and stent implantation would be performed when necessary.

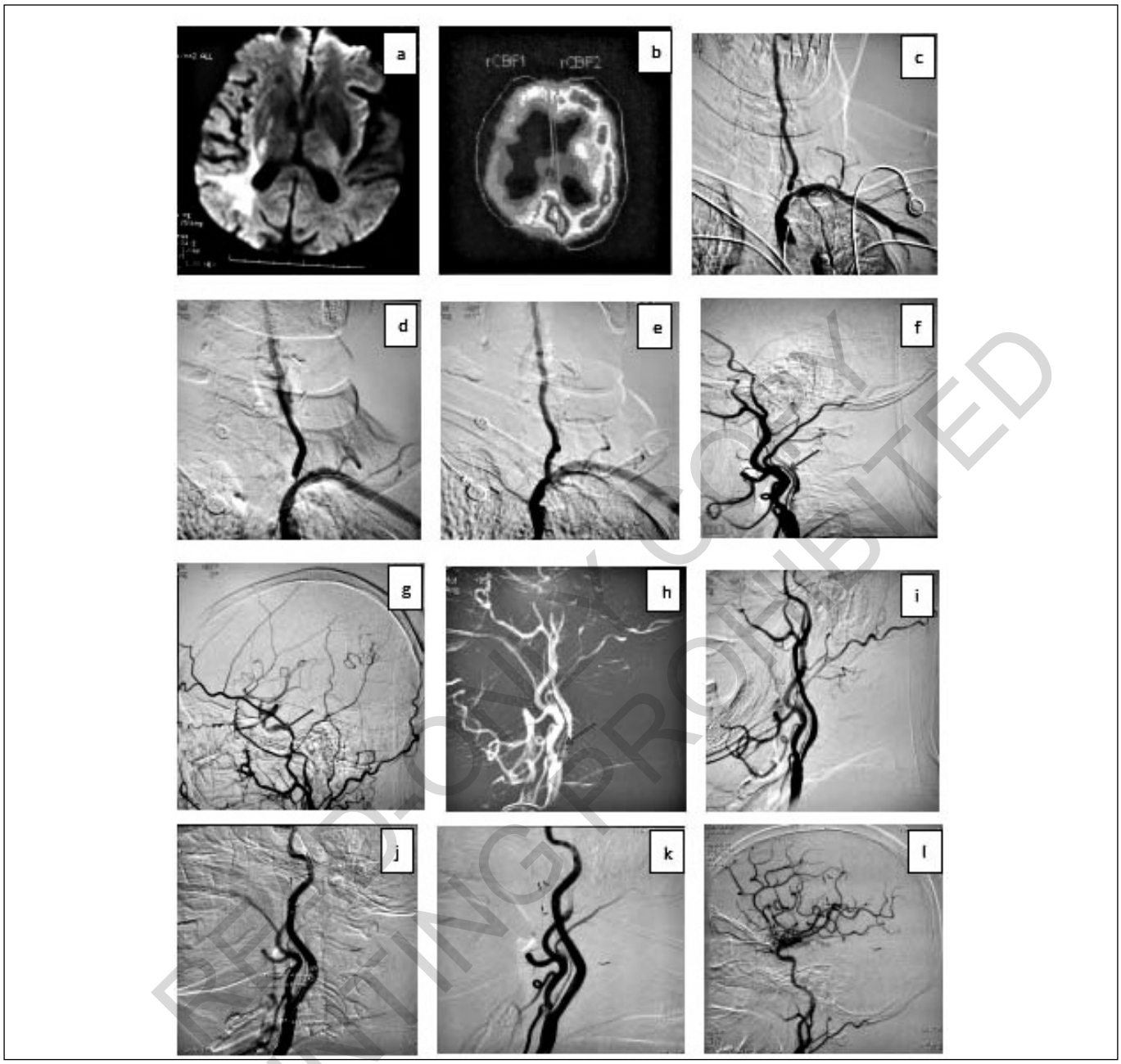

Fig. 2: Imaging data of patients with right internal carotid occlusion (accompanied with left subclavian artery stenosis and severe stenosis at the left vertebral artery opening). (A) Head MRI revealed that the right cerebral hemisphere had a lacunar infarct lesion. (B) ECT cerebral blood flow tomography revealed that the perfusion of the right cerebral blood flow decreased. (C) DSA posteroanterior radiograph revealed left subclavian artery stenosis and severe stenosis at the left vertebral artery opening. (D) A 7.0 × 30 mm balloon was dilated via the PT guide wire at the stenosis segment of the left subclavian artery with a pressure pump. (E) Pressure pump dilation for balloon-expanding stent (5.0 × 12.0 mm) at the stenosis segment of the left vertebral artery opening was performed, and the stent was formed well. (F) Preoperative right common carotid artery DSA early artery phase revealed occlusion at the original segment of the internal carotid (as indicated by the arrow). (G) The DSA later artery phase revealed an antidromic and filled internal carotid (as indicated by the arrow). (H) Under the support of an 8F guiding catheter and 5F multifunctional catheter, a pilot guide wire was selected and entered through the occlusion, and place it in the ophthalmic artery segment of right internal carotid. A 3.0 × 20.0 mm balloon (as indicated by the arrow) was used to dilate the occlusion segment many times. (I) In terms of the reexamination of angiography, based on NASCET standards, the stenosis of right internal carotid was approximately 70%, in this regard, the patient has persistent hypotension and sinus bradycardia, and the phase II stent implantation was proposed. (J) The patient's blood pressure and heart rate became stable 10 days later. Under the premise of protective umbrella placement, a 6.0 × 20 mm balloon was used to dilate at the stenosis segment again, the inner diameter of carotid artery was measured, and a self-expanding stent (9.0 × 40.0 mm) was used. (K) The self-expanding stent was released at the original occlusion segment of the right internal carotid. The stent was formed well and the carotid blood flow was smooth. (L) DSA lateral radiograph of the right internal carotid revealed the intracranial segment of the carotid artery, which was well filled, with good blood flow.

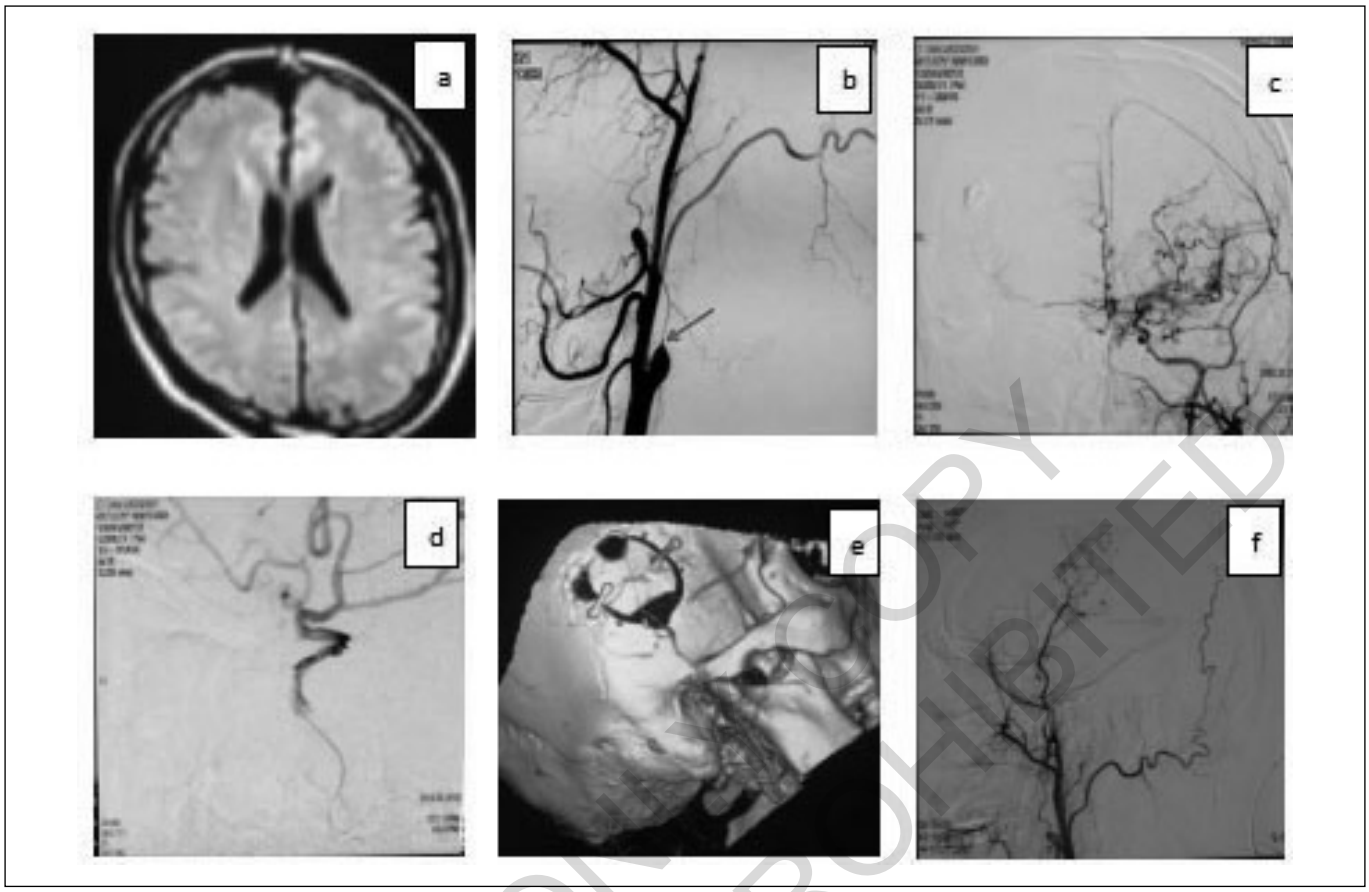

Fig. 3: The preoperative and postoperative imaging data (A) of one patient had an occlusion at the original segment of the right internal carotid (combined by the smoke phenomenon of the left middle cerebral artery), which failed to obtain a successful endovascular treatment of the right internal carotid. STA-MCA anastomosis was subsequently performed. It was revealed that the bilateral cerebral hemispheres had multiple lacunar infarct lesions in the Head MRI. (B) Right common carotid artery angiography revealed an occlusion at the original segment of the right internal carotid (as indicated by the arrow). (C) Left common carotid artery angiography revealed a smoke phenomenon of the left middle cerebral artery. (D) Microcatheter angiography showed that the head end of the microcatheter was located in the normal lumen. After dilation with a proper balloon, the carotid artery angiography revealed that the intracranial vessels featured a poor development. (E) The endovascular treatment of right internal carotid was not successful, STA-MCA anastomosis was subsequently performed, and this was reexamined through head CTA. (F) During the reexamination of the common carotid artery by angiography after STA-MCA anastomosis, blood flow in the SVBG (a superficial temporal artery) was unobstructed.

the left side + stent implantation through the vertebral artery original stenosis operation in the left side + endovascular treatment to the internal carotid artery occlusion in the left side. Patients who have persistent hypotension, sinus bradycardia symptom recovered well after dilatation and boost treatment (Fig. 2).

Follow-Up Results

The NHSS score of 14 cases of endovascular treatment that opened at six months after the operation was 2.0 ± 1.36, which improved (P<0.05) compared to that of pre-operation. Mid leg somasthenia and dizziness improved or the occurrence of transient amaurosis in patients did not significantly increase during the follow-up. Seven patients underwent DSA six months after the operation, suggesting a fluent blood flow of the carotid artery and a good stent condition. Three patients underwent CTA examination eight months after the operation, suggesting a fluent blood flow of carotid artery and no significant restenosis was within the stent. One of the four patients followed up through telephone had apoplexy, and B ultrasound revealed stent thrombosis in the neck. Patients who failed endovascular treatment and underwent superficial temporal artery-MCA bypass operation underwent CTA and DSA after four months, and they had good blood flow (Fig. 3).

Discussions

The main treatments for patients with chronic carotid artery occlusion are CEA, intracranial and extracranial

vascular bypass surgery and endovascular treatment. CEA can effectively realize the recanalization of the carotid artery for patients of carotid artery proximal segment occlusion. However, as a whole, CEA has a relatively low success rate and a relatively high death rate, especially in high-risk patients of chronic carotid artery occlusion. At the presence of various high-risk factors, the difficulty of exclusively using CEA surgery to treat chronic occlusive artery is relatively significant [1]. Therefore, it is necessary to further explore the curative effect and safety of endovascular treatment for high-risk patients of chronic carotid artery occlusion.

Since the first report of atherosclerotic internal carotid occlusion by Fisher in 1951, the research reports of this disease have been increasing both at home and abroad [7]. When the carotid artery transformed from stricture to occlusion gradually, part of these patients gradually open his or her collateral compensation; and if collateral compensation was sufficient, the patient might not display the apparent ischemia. If collateral circulation was not sufficient, there might be frequent cerebral ischemia attacks, and even apoplexy, in patients. The atherosclerotic internal carotid artery was once the contraindication of carotid endarterectomy and carotid artery stenting. Recently, with the emergence of various intervening appliances, especially the development of embolic protection devices and self-expandable stents [8], endovascular therapy of chronic carotid artery occlusion, which has hurtles pain, low surgery complications, and high safety and rate of success [9], has drawn the attention of doctors of neurological intervention.

The clinical relevant symptoms of ischemia and radiographic hypoperfusion have become an important standard of endovascular treatment indication. The distal end of the occluded blood vessel not exceeding ophthalmic artery segments and proximal-end occluded segment existing in the opening of the vascular stump ensured the viability of the intervention treatment [10]. Under the circumstance of thrombosis being in the distal end of occlusion, the time span of thrombosis is one of the important factors for surgery success. If DSA displayed limited occlusion in the proximal end of the carotid artery, the carotid artery Doppler ultrasonography would show the formation of fresh thrombus from the bulb to the dismal end of the carotid artery; and the success rate of the carotid artery recanalization would be high [1]. For occlusive lesion patients with long occlusive duration, long expected occlusive vascular segment, or clear calcification, the difficulty of his or her endovascular therapy would become more and more obvious [11]. For the time being, the success rate of endovascular therapy varies according to different treatment centers. Kao et al. [12] was the first to report the success rate of endovascular therapy to be approximately 73%, while the success rate reached 93.3%, reported by Terada et al. [13]. In general, the rate of complications during surgery was at approximately 3.3%. 16 cases of carotid artery chronic occlusive patients in this group were undergone endovascular therapy, 14 cases were successfully opened; and the success rate was at 87.5%, higher than the rate reported by Kao et al. After occlusive vascular therapy, there may be the recurrence of occlusion or in-stent restenosis [14]. The early discovery can reduce the relevant rate of clinical incidence when intracranial hemodynamics was influenced again. Standard clinical and image follow up are one of the important contents after recanalization therapy of chronic carotid artery occlusion. In this research, the NIHSS scores of 14 patients who had a successful opening in the endovascular treatment surgery after six months were reduced compared with that before surgery; and the difference was statistically significant. In the process of patient following ups, one case revealed apoplexy again, and underwent neck B-ultrasonography for stent thrombosis in a local hospital. In addition, temporary ischemic attack and death was not found in other patients. This research is incorporated in the 16 cases of high-risk patients with indication of endovascular therapy, and DSA, they all showed the regurgitant flow in distal end of carotid artery occlusion, which indicated that carotid artery occlusion was segmental occlusion instead of being a whole course occlusion. By first estimation, the length of the atherosclerosis obliterans plaque was within the range of recanalization. Among 16 patients, only 12 patients had bifurcation occlusions; while there were four cases of internal carotid longer segment occlusion (two cases of opening failure). During the treatment, local embolus fallings should be avoided, thereby forming new distal cerebral infarction during treatment under the premise that the microcatheter reaches to the distal normal blood vessel and the distal normal blood vessel is longer. Furthermore, the use of a remote protection device can also achieve a very good effect on cerebral protection. In this research, 12 patients (accounting for 86%) with occlusion at the local bifurcation used an embolic protection device. Since these patients had occlusion at the longer segment, the internal carotid had an insufficient space for the whole vessel to release the embolic protection device. Hence, single balloon dilatation was used without an embolic protection device during the operation.

For some patients at high risk of chronic carotid artery occlusion, especially patients in the absence of clinical efficacy after regular medication for a time and failed to or refused to undergo CEA, we need to comprehensively analyze these patients, confirm their indications of endovascular treatment, establish a detailed operation plan, and fully inform these patients and their families about the possible benefits and potential risks of the operation, providing the endovascular treatment [15]. Therefore, as for patients at high risk of chronic carotid artery occlusion, focus should be given in screening, especially in confirming patients who have indications of endovascular treatment before the operation, which is

very important and helpful to improve the safety and success rate of the endovascular treatment.
In general, it is technically feasible for the endovascular treatment of patients at high risk of chronic carotid artery occlusion, the incidence of its complications is low, and it is safe and efficient [16]. Furthermore, it has been proven to have a good application prospect on the improvement of neurocognitive function and reduction of potential stroke risk [17]. The endovascular treatment has a unique advantage when compared with other surgical treatment options. Fully evaluating and strictly mastering the operation indications of patients before the operation are the keys to a successful endovascular treatment for chronic internal carotid occlusion. Since the incidence of the chronic carotid artery occlusion is low and the patients can achieve better compensation through different compensatory approaches (including Willis ring, compensation of reverse reflux through the external carotid artery to the internal carotid), this can result in a free of the specific clinical symptom in some patients and limited sample size (especially in some patients who had indications of endovascular treatment) [18]. The safety and long-term efficacy of endovascular treatment still needs further observations [19]. More and more patients would benefit from the consummation of endovascular treatment in the future.

Riassunto

Questo studio è finalizzato a discutere della sicurezza e dell'efficacia a breve termine del trattamento endovascolare in pazienti ad alto rischio con occlusione cronica dell'arteria carotide. Per questo è stata eseguita un'analisi retrospettiva sui dati clinici di 16 pazienti ad alto rischio con occlusione cronica dell'arteria carotide che sono stati sottoposti a trattamento endovascolare presso il Dipartimento di Neurochirurgia del Primo Ospedale affiliato dell'Università medica di Xinjiang da novembre 2013 a luglio 2016.
È stata rilevata l'incidenza di evoluzioni negative a 1 settimana, a 30 giorni e a sei mesi dopo l'intervento ed è stato adottato il NIHSS (National Instituite of Health Stroke Scale) per valutare la funzione neurologica dei pazienti sei mesi prima e dopo l'operazione. Il tempo di follow-up è stato di 6-26 mesi, con una media di 18,4 mesi.
RISULTATI: il grado di stenosi dell'arteria carotidea di questi 16 pazienti è stato del 100%. Il relativo grado dopo l'operazione era del 24,9 ± 17,0%; e la differenza era statisticamente significativa (P <0,05). La dissezione iatrogena dell'arteria carotidea si è verificata in un caso e l'ipotensione persistente e la bradicardia sinusale si sono verificate in un caso. Inoltre, un caso di trattamento endovascolare non è stato accettato per passare a riparazione chirurgica. Successivamente, è stato eseguito il bypass dell'arteria temporale-STA-MCA; riguardo al CTA (Computer Tomography Angiography) e DSA (Digital substraction Angiography) postoperatori, il risultato ha mostrato che la perfusione era buona. Un caso ha rifiutato di sottoporsi a trattamento chirurgico. Il punteggio NIHSS di 14 casi di trattamento endovascolare che sono stati aperti con successo sei mesi dopo l'operazione è stato di 2,0 ± 1,36, che è migliorato (P <0,05) rispetto a quello pre-operatorio.
CONCLUSIONE: il trattamento endovascolare su pazienti ad alto rischio con occlusione cronica dell'arteria carotide è sicuro ed efficace. E ha un evidente effetto curativo a breve termine.

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