Treatment of symptomatic vertebrobasilar artery stenosis with stent-assistant angioplasty in the elderly

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Summary

Objective: To study the efficacy, safety, and feasibility of stent-assistant angioplasty (SAA) in the treatment of symptomatic vertebrobasilar artery stenosis in the elderly. **Methods:** SAA was performed in 26 elderly patients with symptomatic vertebrobasilar artery stenosis. The success rate, perioperative complications, and long-term effectiveness were evaluated. **Results:** A total of 29 balloon expandable stents were implanted in these patients. The success ratio was 100%. The degree of stenosis decreased from 81.3 ± 8.8% to 3.7 ± 3.6% ($p < 0.01$). Complications were absent during the perioperative period. Follow-up was performed for seven to 36 months (median: 21.9 months). Two patients developed the recurrent symptoms of vertebrobasilar artery stenosis, and no cerebral ischemic events were noted in the remaining patients, suggesting a favorable outcome. **Conclusion:** SAA is a safe and effective strategy for the treatment of symptomatic vertebrobasilar artery stenosis in the elderly.

Keywords: Stent-assistant angioplasty; vertebrobasilar artery stenosis; complication; therapy.

Study conducted at the Department of Neurology, Hangzhou Third People's Hospital, Zhejiang, China

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Introduction

Symptomatic vertebrobasilar artery stenosis (SVAS) is an important cause of posterior circulation ischemia. Traditional treatments for SVAS are usually unlikely to achieve long-lasting effectiveness and the prognosis of SVAS is often poor[1,2]. The selection of a proper therapeutic strategy for SVAS has been challenging clinicians. In recent years, stent-assistant angioplasty (SAA) has been introduced for the treatment of cerebrovascular diseases. SAA can recanalize the blood vessels, increase the cerebral blood flow (CBF), and reduce the incidence of stroke[3,4]. The present study retrospectively reviewed the clinical records of 26 elderly patients with SVAS who did not responded to pharmacotherapy and received SAA in this hospital.

Patients and methods

General information

A total of 26 elderly SVAS inpatients aged 72.1 ± 3.9 years were recruited from the Department of Neurology from May 2008 to October 2010. Before admission, the risk factors of stroke were controlled in these patients with anti-platelet aggregation therapy and plaque stabilization therapy (statins). The group comprised 11 males and 15 females with a mean age of 72.1 ± 3.9 years (range: 65-78 years). 12 patients were characterized by transient ischemic attack (TIA) of vertebrobasilar system and 14 by posterior circulation infarct (POCI). Digital subtraction angiography (DSA) revealed stenosis in the first part of the vertebral artery (n = 16), V4 segment of the vertebral artery (n = 3), and basilar artery (n = 7). This study was approved by the ethics committee of Hangzhou Third People's Hospital. All patients met the indications for SAA and an informed consent was obtained before surgery.

The indications for SAA included: 1) patients were aged ≥ 60 years; 2) patients had symptomatic SVAS (TIA of vertebrobasilar system or non-disabling ischemic stroke), the degree of stenosis in DSA was > 50%, and patients had concomitant contralateral occlusion; 3) the degree of stenosis in the dominant side was > 50%; 4) the vertebral artery stenosis was also found in the non-dominant side and this vertebral artery was connected to the posterior inferior cerebellar artery – the symptoms were related to the insufficient blood supply of the ipsilateral posterior inferior cerebellar artery; (5) the degree of stenosis of the basilar artery was > 50%; 6) patients and/or relatives accepted the SAA and patients were compliant to the treatment. Contra-indications included: 1) patients with residual severe neurological dysfunction after stroke; 2) patients with concomitant severe liver, heart, kidney or lung diseases/failure; 3) patients with complete vascular occlusion; 4) patients who developed intracranial hemorrhage or internal bleeding within 3 months prior to surgery, or had hemorrhagic tendency; 5) patients with intracranial aneurysm or arteriovenous malformation which could not be managed before or during the SAA; 6) patients with intracranial tumors.

Treatment

Three days before surgery, oral aspirin (100 mg/d), clopidogrel (75 mg/d), and atorvastatin (20 mg/d) were administered, and patients fasted for 6 h before surgery. Extra-cranial angioplasty was performed under local anesthesia and intra-cranial angioplasty under general anesthesia. Patients were routinely monitored with an electrocardiogram monitor. Right femoral artery puncture was performed with modified Seldinger technique; subsequently, a 6F arterial sheath was inserted. Systemic heparinization was performed with 5000 U of intravenous heparin. A 6F guiding tube was inserted along the arterial sheath. Under the direction of a guiding wire, the top of a guiding tube was inserted into the 1~2 cm proximal to the affected vessels. When the lesions were located at the beginning part of the vertebral artery, the top of guiding tube was inserted into the subclavian artery; when the lesions were located at the intracranial segment of the vertebral artery and basilar artery, the guiding tube was inserted into the affected vertebral artery. Then, the balloon expandable stent was guided into the lesioned artery, and released once the location was confirmed. Subsequently, angiography was carried out to detect the location of the stent, its relation with the blood vessel wall, forward blood flow, and the improvement of stenosis. When the expansion of the stent was not acceptable, an intra-stent expansion was performed. The arterial sheath was remained and the heparin was naturally neutralized. Four hours later, the arterial sheath was removed. Post-operatively, the vital signs were monitored and the symptoms and signs of the nervous system were observed. Oral aspirin (100 mg/d) and clopidogrel (75 mg/d) were administered for three consecutive months. Thereafter, the aspirin was discontinued and clopidogrel (75 mg/d) was given for maintenance. All patients were treated with atorvastatin 20 mg/d continuously.

Evaluation of therapeutic efficacy

Measurement of stenosis degree

The evaluation of stenosis was performed according to the North American Sypmptomatic Carotid Endarterectomy Trial (NASCET) criteria[5]. The luminal diameter at the point of greatest stenosis (D_{sten}) and at the normal part of the artery (D_{dist}) was measured, and the degree of stenosis was calculated as follows: $S = [1- (D_{sten}/D_{dist})] \times 100\%$. DSA was performed before surgery and immediately after surgery for the evaluation. In addition, DSA or CTA was performed for re-examination six to 24 months after surgery.

Measurement of blood flow velocity at the stenotic lesions

Transcranial Doppler (TCD) was employed to measure the blood flow velocity. The media velocity (Vm) at the point of greatest stenosis was measured before surgery and one week as well as three, six, 12, and 24 months after surgery.

Evaluation of clinical efficacy

The success rate and the incidence of perioperative complications were determined. For the 12 TIA patients, TIA was monitored post-operatively. For 14 patients with cerebral infarction, the National Institutes of Health Stroke Scale (NIHSS)[6] was employed to assess the neurological function at admission, discharge, and one day after surgery.

Follow-up

For the 26 patients receiving SAA, the score system of Malek et al.[7] was used to evaluate the clinical efficacy. Malek's assessment is divided into five scores - 1 (the best): no neurological deficit and no vertebrobasilar ischemic symptoms during the follow-up period; 2 (good): no neurological deficit, and vertebrobasilar TIA does not exceed one in three months; 3 (better): a slight neurological deficit, vertebrobasilar TIA does not exceed one per month; 4 (poor): no improvement in neurological deficit or vertebrobasilar ischemic symptoms are not relieved; 5: any cause of death. During the follow-up period, TIA, stroke, and death were recorded. Evaluation was performed at three, six, 12, and 24 months after surgery. Follow-up was performed through hospital visit with the same clinician.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) 10.0 was used for statistical analysis. Data were expressed as mean ± standard deviation. Variance analysis (one-way ANOVA) was used in group while the Q test (post-hoc multiple comparisons between groups were made with LSD) was used between groups. A p-value < 0.05 was considered statistically significant.

Results

Clinical efficacy and peri-operative complications

In the present study, a total of 29 stents were inserted: ten Genesis stents, two Cypher stents, seven Intec stents, and ten Apollo stents. As shown in Figures 1A, 1B, 1C, and 1D, the success rate was 100%. Before surgery, the mean degree of stenosis was 81.3 ± 8.8% (range: 65%~95%). After surgery, the mean degree of stenosis decreased to 3.7 ± 3.6% (range: 0%~10%). The degree of stenosis was significantly improved ($p < 0.01$). For 14 patients with cerebral infarction, the neurological function was markedly improved, and the NIHSS score[6] decreased remarkably ($p < 0.01$). On discharge, the neurological function of these patients was further improved but similar to that of one day after surgery. Before discharge, ischemia-related symptoms were not found, and the deterioration of original symptoms was also absent. TIA was not noted among these patients after surgery. During the perioperative period, no severe complications were found.

Blood flow velocity at the point of greatest stenosis

The blood flow signals in TCD were satisfactory in all patients. The blood velocity (Vm) before surgery and one week, and three, six, 12, and 24 months after surgery is presented in Table 1. Results showed the Vm of stenotic arteries was extremely high before surgery, but dramatically reduced after surgery and remained in normal range. Significant difference was found in the Vm between before and after surgery ($p < 0.01$). However, the Vm was similar at one week, and three, six, 12, and 24 months after surgery ($p > 0.05$).

Follow-up

The median follow-up period was 21.9 months (range: 7~36 months). The results showed that there were 23 patients with Malek score[7] of 1, two with Malek score of 2, and one with Malek score of 3. For one patient with vertebral artery stenosis and TIA, the degree of residual

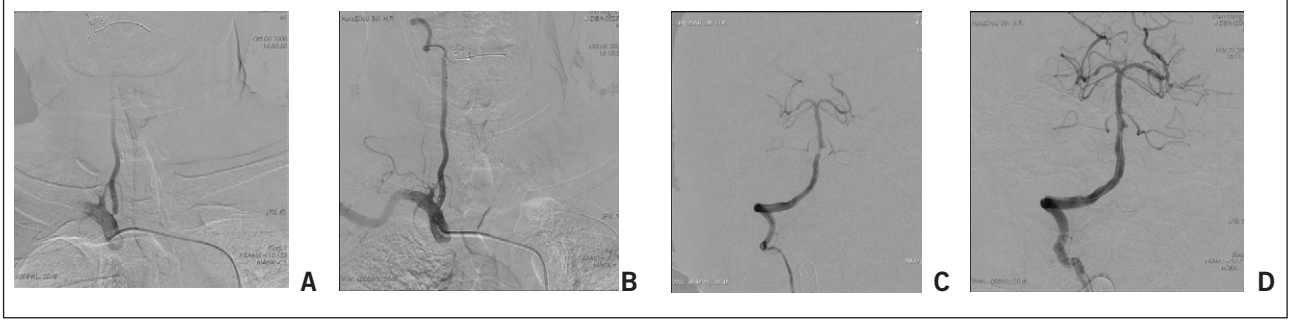

Figure 1 – The stenosis of the vertebral artery and the clinical efficacy. Before surgery, ostial stenosis degree of the vertebral artery was 85% (**A**); after surgery, it was 0% (**B**). Before surgery, V4 stenosis degree of the vertebral artery was 90% (**C**); after surgery, it was 10% (**D**).

Table 1 – The blood velocity (Vm) of basilar and vertebral arteries before surgery and one week and three, six, 12, and 24 months after surgery (cm/sec)

	Before surgery	1 week	3 months	6 months	12 months	24 months
Basilar	111.58 ± 8.48*	67.57 ± 7.00	68.57 ± 4.54	62.43 ± 7.09	66.17 ± 9.20	59.00 ± 7.81
Vertebral	100.42 ± 9.50*	51.42 ± 5.44	55.68 ± 5.88	47.79 ± 5.46	50.40 ± 4.81	54.75 ± 5.24

*Compared with other periods, $p < 0.01$.

stenosis was 10%, TIA occurred once at seven months after surgery, and the symptoms of TIA were similar to those before surgery. Re-examination with DSA showed that the degree of stenosis was still 10%, and anti-platelet/coagulation therapy was then performed without occurrence of TIA afterwards. For one patient with cerebral infarction, the pre-operative stenosis degree was 92% and the NIHSS score was 9. Immediately after surgery, the degree of stenosis was 10% and the NIHSS score was 4. On discharge, the NIHSS was 1. However, 16 months after surgery, the initial symptoms deteriorated and the NIHSS score was 6 on re-examination. DSA showed that the degree of stenosis was similar to that immediately after surgery. Intensive therapy was carried out and the patient achieved remission. Of the remaining patients, new ischemia-related symptoms and deterioration of initial symptoms were absent, and TIA and death were not observed.

Of note, five patients received re-examination with DSA, of whom two were found to have developed stenosis (28.6%) at the first part of arteries. The remaining 19 patients were examined with CTA. Stent migration and fracture, and re-stenosis were not found. The forward blood flow was acceptable.

Discussion

The traditional treatments for SVAS include pharmacotherapy and surgical intervention. However, the risk for stroke is still relatively high in vertebrobasilar artery stenosis patients receiving routine pharmacotherapy, and the prognosis of these patients is still poor. The warfarin-aspirin symptomatic intracranial disease (WASID) study demonstrated that the incidence of stroke events in the region supplied by the stenotic arteries was still high even though the patients were treated with warfarin or aspirin[8]. The annual incidence of stoke due to stenosis of basilar artery, vertebral artery, posterior cerebral artery, and posterior inferior cerebellar artery was 10%, 7%, 7.8%, and 6%, respectively. Rasmussen et al.[9] reported that approximately 25% to 30% of patients with vertebrobasilar TIA had increased incidence of fatal events and elevated mortality and disability. In the present study, 26 patients received pharmacotherapy with statins and/or antiplatelet drugs to control the risk factors of stroke before admission, but the response was poor. These results demonstrate that pharmacotherapy cannot improve the stenosis fundamentally. In addition, the surgical intervention for stenosis has complicated procedures and potential complications, which significantly limits the wide application of surgical intervention. In recent years, with the development of neurological intervention techniques and interventional materials, SAA has been an effective strategy for the treatment of vertebrobasilar artery stenosis due to the minimal invasion and high effectiveness[10,11]. In the present study, a total of 29 lesions in 26 patients were treated with SAA, achieving a success rate of 100%. The clinical symptoms and signs were significantly improved, showing favorable short-term therapeutic effectiveness. Moreover, these patients were followed-up for seven to 36 months (median: 21.9 months). Results showed that there were 23 patients with Malek score of 1, two with Malek score of 2, and one with Malek score of 3, which indicates that the intermediate and long-term effectiveness are also high.

The SAA for the stenotic arteries can re-canalize the arteries, improve the blood supply, elevate the perfusion of the brain tissues, and alleviate the symptoms. In addition, the stent can prevent the atherosclerotic plaque from breaking and reduce the risk for stroke due to falling of the atherosclerotic plaque. In the present study, the degree of stenosis in these patients was 81.3 ± 8.8% before surgery and 3.7 ± 3.6% after surgery. Hemodynamics testing showed a marked improvement following SAA, and normal hemodynamics were maintained for at least 24 months, which was consistent with previously reported results[12]. The 12 patients with TIA were followed-up for seven to 36 months post-operatively, and the results showed significant improvement. Except for one patient who developed TIA seven months after surgery, similar symptoms and cerebrovascular events were not observed in the remaining patients. In the 14 patients with cerebral infarction, neurological function was dramatically improved post-operatively. Only one patient developed deterioration of original symptoms at 16 months after surgery, and re-examination with DSA showed the degree of stenosis was similar to that immediately after surgery. This may be related to the falling of emboli in other sites. Improvement was achieved following intensive therapy.

SAA is an effective method for the treatment of SVAS, but still presents a risk for rupture, artery dissection, perforating artery occlusion, thrombosis, cerebral hyperpefusion, and re-stenosis[13-15], which may be associated with the

sample selection, therapeutic regimen, and experience of clinicians. In the present study, peri-operative complications did not occur, which may be attributed to the simple lesions in these patients, good preparation before surgery, and small sample size.

It has been reported that the incidence of re-stenosis was as high as 32.4% within six months after surgery[13], and some patients with re-stenosis were even asymptomatic. In the present study, two patients were found to have developed stenosis among seven patients receiving DSA, but both were asymptomatic, which may be related to the mild degree of stenosis (20% and 35%, respectively). In one patient, the stenosis may be attributed to the large diameter of the stent, which results in the over-expansion of the affected artery and subsequent hyperplasia of intima. Although SAA has some complications, the incidence of these complications is relatively low, and some complications can be avoided with the accumulation of experience.

Currently, large randomized controlled studies on endovascular stenting for symptomatic basilar artery stenosis are still lacking[16,17]. The Carotid and Vertebral Artery Transluminal Angioplasty Study (CAVATAS), the only randomized study to date to compare outcomes after endovascular and medical treatment for patients with vertebral artery stenosis, included only 16 such patients[17,18], and there was no difference in outcomes among those treated by stenting or drug therapy. Presently, there are mostly retrospective studies on the vertebrobasilar artery stenosis treated with SAA. Although the evidence of these findings cannot be compared to that of evidence-based randomized controlled studies, SAA for vertebrobasilar artery stenosis has some advantages such as a high success rate, fewer complications, prevention of recurrent stroke, and better short-term clinical improvement[16,19]. Overall, SAA is safe and effective. Following SAA, the degree of stenosis is significantly improved and the hemodynamics returns to normal. Follow-up also confirms the favorable long-term effectiveness.

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