Adjunct Use of a Self-expanding Stent for Treatment of Intracranial Stenosis

A Case Report

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Summary

We present a case of a patient who received adjunct treatment with a self-expanding stent after balloon dilatation of a symptomatic stenosis of the carotid siphon.

After predilatation, complementary angioplasty with a balloon-expandable stent was abolished due to lack of compliance of the delivery system. Since the vascular anatomy allows for the passage of balloon systems only, the stenosis was further dilated and a self-expanding stent was delivered to avoid the risk of complications related to dissection and vessel recoil. However, problem of in-stent stenosis remains at the long-term follow-up period.

Introduction

Endovascular percutaneous transluminal angioplasty (PTA) for intracranial stenosis is aimed at improving the blood flow and decreasing thromboembolic events related to atheromatous lesions. Currently, the use of stents is advocated in case of dilatation of intracranial stenosis in order to diminish the risk of potential complications that are related to dissection and vessel recoil¹⁻⁴.

The successful use of balloon-expandable coronary stents in intracranial vessel stenosis has been reported⁵⁻⁹. A limitation with currently used

stents is the difficulty encountered in delivering these through a tortuous vascular path. Neuroform2™ (Target/BSC/Smart Therapeutics, Fremont, CA), a self-expanding stent designed for the treatment of wide-neck intracerebral aneurysms, can be delivered even through tortuous carotid siphons^{10,11}. Since self-expanding stents exhibit radial forces that are insufficient to open a stenosis, one can opt to use them in conjunction with balloon dilatation.

We present the usefulness of a technique that employs a Neuroform stent after balloon dilatation of an intradural internal carotid artery (ICA) stenosis.

Case Presentation

A 76-year-old female presented with mild left hemiparesis and hemineglect. Physical examination revealed arterial hypertension with retinopathy and hypercholesterolemia. MR imaging and MR angiography suggested haemodynamic cerebral injury due to a severe stenosis of the right ICA (figure 1). Cerebral angiography showed severe atherosclerotic stenosis (82%) in the right C2 portion (figure 2,3). In addition, a parenchymogram corroborated haemodynamic insufficiency of the right hemisphere (figure 4).

The patient was started on 100 mg of aspirin and 75 mg of clopidogrel per day. The hemi-

Figure 1 Coronal MR imaging (FLAIR) suggests a watershed infarction in the right parietal region.

Figure 2 An angiogram of the right ICA in oblique view shows a severe stenosis in the C2 portion.

paresis improved within a couple of weeks; however, the hemineglect persisted.

Three weeks after the event, a stent-assisted angioplasty with a balloon-expandable stent was planned.

Figure 3 Three-dimensional (3D) angiogram of the right ICA shows severe stenosis in the C2 portion.

Endovascular Procedure

Under general anesthesia, a 6F guiding catheter (Envoy, Cordis Endovascular, Miami Lakes, FL) was placed via the right femoral artery in the cervical left ICA in a double coaxial fashion along with an 8F catheter (Vista Britetip, Cordis Endovascular). This system provides a good stability of the guiding catheter against the tortuosity of the vessels. A bolus injection of 6000 U of heparin was administered intravenously, followed by infusion of 1000 U of heparin per hour. A microguidewire (Transend 14, Target/BSC) was advanced into the ICA beyond the stenosis and was followed by a microcatheter (Excel 14, Target/BSC). Subsequently, the microguidewire was replaced by a 300-cm-long microguidewire (X-celerator-14 Exchange, Micro Therapeutics, Irvine, CA). Measurements performed using a 3D DSA assessment (DSA, BV 3000; 3D postprocessing workstation, INTEGRIS 3D-RA release 2.2, Philips Medical Systems (PMS), The Netherlands) revealed that the minimum diameter of the stenosis was 0.8 mm. We performed predilatation using a 2.5 - 12 mm balloon (Marverick, Scimed/BSC, Maple Grove, MN) at 6 atm (figure 5). We then tried to advance two kinds of balloon-expandable stents (Driver, 4-9 mm, Medtronic, Minneapolis, MN; Lekton Motion, 4 - 10 mm, Biotronik, Berlin, Germany). However,

we could not deliver these beyond the C3 portion of the carotid siphon even while providing strong support with the double coaxial guide catheter system advancing the tip of the guiding catheter near the petrous portion of the carotid artery. Therefore, we decided to perform a second predilatation using a 3.5 - 12 mm balloon (Sprinter, Medtronic) at 14 atm (figure 6); reaching almost the adjacent ICA lumen size (proximal to stenosis: 4 - 4.5 mm, distal to stenosis: 4.1 - 5.7 mm). This dilatation was followed by successful deployment of a 4 - 15 mm Neuroform2 stent (figure 7) to avoid the risk of complications related to possible dissection or vessel stenosis recoil. Compared with pretreatment angiography and transcranial Doppler (TCD), the postoperative angiogram showed mild residual stenosis with improved flow (figure 8).

The postoperative course was uneventful and antiplatelet therapy was continued for three

Figure 4 An initial parenchymogram shows delayed flow in the territory of the right middle cerebral artery.

Figure 5 DSA shows a pre- (A) and post- (B) first predilatation with a 2.5 mm balloon. A control angiogram (B) of post first dilatation shows improvement in severe stenosis.

Figure 6 A) X-Ray shows a second predilatation with a 3.5 mm balloon after failure to deliver two kinds of balloon-expandable stents. The position of the guiding catheter should be close to the petrosal portion of the ICA. B) Post second predilatation angiogram shows further improvement from the first post predilatation image.

months. Follow-up cerebral angiography (CAG) was performed eleven months after the intervention; it demonstrated asymptomatic moderate in-stent stenosis (figure 9). In addition, the parenchymogram did not reveal any haemodynamic insufficiency (figure 10). Long-term follow-up and continuous antiplatelet therapy is necessary.

Discussion

1) Stent Assisted Angioplasty for Intracranial Atherosclerosis

Several studies on the natural history of patients with symptomatic intracranial atherosclerosis have reported that the annual risk of stroke or death, which ranges from 7.8%-45% remains high, both with and without medica-

tion¹²⁻¹⁴. Recently, the SSYLVIA study¹⁵, a non-randomized prospective trial of intracranial symptomatic atherosclerotic lesions using balloon-expandable intracranial stents in 61 patients, reported a significant improvement in the incidence of stroke/death (13.2%) compared with the WASID (22.5%)¹³ and Stanford studies (27.5%)¹⁴.

The SSYLVIA study reported a 6.6% morbidity within 30 days of the procedure; this study included 43 intracranial lesions, of which six were related to the supraclinoid ICA segment. Retrospective series from 2000^{5,7,9} have also shown good results with a low risk of procedure-related neurologic morbidity (0%-8.3%) and mortality (0%-2.9%), provided there is a reliable antithrombotic medication in-take¹⁶. Although, intracranial stenting is still contro-

Figure 7 A,B) DSA shows successful deployment of the 4 mm - 15 mm Neuroform stent. The guiding catheter was pulled back to the cervical ICA.

versial, these studies suggest that this procedure shows good safety and efficacy for elective cases.

2) Difficulty in Delivering the Devices

In recent years, mostly low-profile balloon-expandable stents were applied in intracranial cerebrovascular disease.

Delivery of balloon-expandable stents to intracranial lesion may be challenging due to limited flexibility of the delivery system when vessels with a tortuous anatomy are encountered; such vessels may be present in a variety of locations. A better tracking performance is obtained with low-profile dilatation balloons without mounted stents; therefore, treatment with balloon dilatation alone may be more appealing.

However, balloon dilatation has been reported to exhibit risks of dissection and restenosis. One advantage of stent-assisted angioplasty is the exclusion of the plaque and regions of dissection from the vessel lumen, as well as prevention of vessel recoil and rupture¹⁻⁴. In our case, we tried to optimize the available techniques by dilating with low-profile balloons and using a very flexible delivery system of a currently available commercial self-expanding stent (Neuroform 2). In our case, we considered performing stent assisted angiography using a Neuroform 2 stent, in order to prevent thrombosis and dissection. We decided to perform sufficient predilatation and avoid postdilatation because we were being apprehensive about displacement or stent damage. We did not experience any difficulty in advancement or deploy-

Figure 9 A,B) Follow-up DSA and 3D angiogram showing in-stent stenosis (approximately 40%).

ment while the device was passed through the carotid siphon.

3) *Durability of Intracranial Stenting*

The durability of intracranial stenting for atherosclerotic stenosis remains uncertain; ho-

wever, it is likely to have a high rate of recurrent stenosis, similar to coronary stenting. In the SSYL VIA study, recurrent stenosis was observed in 32% of patients during the 6-month-follow-up period¹⁵. Moreover, even in a few reports on the use of a Neuroform stent for an

Figure 8 A final control angiogram shows improvement in stenosis.

Figure 10 Follow-up parenchymogram showing no haemodynamic insufficiency in the territory of the right ICA.

aneurysmal neck-plasty without balloon angioplasty, in-stent stenosis was observed one to three months after the procedure^{17,18}.

The eleven month follow-up angiography also revealed in-stent stenosis. These results suggest the limitation in the durability of a "bare stent." Recent clinical studies have proven that drug-eluting stents (DES) such as Sirolimus and Paclitaxel that are used for delivering antiproliferative agents to the coronary vessel wall dramatically reduce the rate of restenosis. In the future, DES for neurovascular applications will probably be developed.

Conclusions

1) Self-expanding stent assisted angioplasty is also a useful option if deployment of a balloon-expandable stent for intracranial stenosis.

2) We expect that new flexible self-expanding stents for intracranial vessel stenosis may be developed further.

3) The durability of intracranial stenting remains unknown, particularly, in-stent stenosis that develops during long time follow-up period is a problem. Further clinical studies are needed in this area.

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