Treatment of Vertebro-Basilar Dissecting Aneurysms Using Intravascular Stents

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Key words: dissecting aneurysm, stent, coil, vertebral artery, basilar artery

Summary

Endovascular surgery is an established primary therapeutic modality for dissecting aneurysms at vertebro-basilar arteries. Intravascular stents can be used to treat the dissecting aneurysms for which simple obliteration procedures cannot be used. In such cases, stent implantation alone or a combination of stents and coils need to be selected properly by taking into consideration the site and shape of dissections.

In this report, three patterns of stent application are described and their method of selection is discussed.

Introduction

The treatment of aneurysms in vertebro-basilar (VB) arteries has shifted over the past 10 years from open surgery to endovascular procedures. This new treatment for dissecting aneurysms (DAs) now appears to be well established^{2,9,13,14}. The recent application of intravascular stents has made it possible to treat DAs of the VB system without obliteration of the parent artery^{4,5,7,10,12}. The "stent and coil" technique in which coils are delivered through stent struts has been widely used with improved results, however some DAs cannot be resolved with this approach. In the present report, various types of stent application for DAs are described and discussed.

Material and Methods

During the past four years, nine cases with DAs at vertebral and / or basilar arteries were treated with endovascular procedures at our institute. These nine cases include six that presented with subarachnoid haemorrhage (SAH) and three presenting with ischemic symptoms. Although DA patients with ischemic symptoms are usually treated medically, we intervened surgically because of repeat transient ischemic attacks or because of the growth of aneurismal enlargement during the observation period. In our nine DA cases, five damaged vertebral arteries were obliterated with coils, while intravascular stents were applied to the remaining four cases.

Intravascular stents were used only when obliteration of the suffered vertebral artery (VA) could not be achieved for various reasons or when a DA was located at the basilar artery. All stenting procedures were performed under an adequate heparinization followed by antiplatelet therapy. Representative cases are described below.

Case 1 (figure 1)

A 55-year-old male had a history of SAH from a DA at the right VA. This was treated by obliteration of the right VA proximal to a posterior inferior cerebellar artery (PICA) using an aneurismal clip. Eleven years later, he pre-

Figure 1 Case 1: Left VAG before treatment (A,B), after the second stent placement (C,D), and 3.5 months after the initial treatment (E,F). The dissecting aneurysm involved branching of the left PICA. Stagnation of the blood flow is shown soon after the second stent implantation (D). Complete obliteration of the aneurysm while preserving the left VA and PICA was obtained 2.5 months after placement of the second stent.

sented with SAH from a DA at the left VA involving the origin of a PICA. On Day one, an S670 stent (3 mm x 18 mm; AVE, Medtronic, Minneapolis, MN) was implanted covering the aneurismal dilatation and an origin of the PICA, in order to preserve the left VA and PICA. Arteriography immediately after stent implantation showed correction of the irregularly shaped VA and stagnation of the blood flow at the aneurismal dilatation.

Although no recurrent haemorrhage was experienced, persistent aneurysm was demonstrated by arteriography four weeks after SAH. A second stent (S670, 3 mm x 18 mm) was implanted and overlapped the first stent. Stagnation of the aneurysm was enhanced by this sec-

ond procedure and the patient returned to work six weeks after SAH. Follow-up arteriography at six months showed no aneurysm and preservation of the PICA.

Case 2 (figure 2)

A 49-year-old male with a medical history of hypertension presented with vomiting and a sudden-onset headache.

After diagnosis of SAH with CT images, he experienced a repeat haemorrhage and fell into a comatose state. Arteriography showed a DA at the basilar trunk and an S670 stent (3 mm x 12 mm) was implanted. Coil implantation was not planned because of the small aneurismal dilatation. As arteriography four weeks after

Figure 2 Case 2: Left VAG before treatment (A,B), after stent implantation (C), and four weeks after stent implantation (D) and a plain roentgen graph after addition of coils (E). The aneurysm was obliterated six months after the initial treatment (F).

onset showed enlargement of the aneurismal dilatation, GDCs were delivered into the aneurysm by a micro-catheter passed between the stent struts.

The patient returned to work and an arteriograph taken 3.5 months after SAH onset showed no aneurysm.

Case 3 (figure 3)

A 52-year-old male presented with repeat vertigo attack. MRI showed an aneurysm at the prepontine cistern and arteriography showed a DA with a large aneurismal dilatation at the left VA. It was decided to obliterate the aneurysm in view of the large aneurismal size and the possibility of being the embolic source.

After an adequate period of anti-platelet therapy, an S670 stent was implanted in the left VA covering the sub-occlusive portion and the aneurismal dilatation. Following the stent implantation, GDCs were delivered by micro-catheter passed between the stent struts. Because of the large orifice, small “dog-ear” shaped neck remnants were shown by arteriography soon after procedure. Although follow-up arteriography at six months showed the same appearance, the neck remnants had disappeared after one year.

Case 4 (figure 4)

A 52-year-old woman with a medical history of hypertension and diabetes presented with

Figure 3 Case 3: A large dissecting aneurysm at the left VA was treated with a stent and coils (A,B). A small remnant neck was shown after coil embolization (C), and persisted for more than six months. Follow-up examination at 12 months showed complete obliteration (D).

disturbed consciousness following sudden-onset headache and vomiting. She fell into a comatose state after CT examination, but recovered to her previous level of consciousness within an hour. Subsequent left vertebral arteriography (VAG) showed an irregular-shaped DA at or near the VB junction (VBJ). The right VAG showed a sub-occlusive segment immediately proximal to the aneurismal lesion revealed by the left VAG.

The aneurismal lesion was appeared thicker in the left VAG and we interpreted this as dissection of a VA with an aneurismal dilation at the left VA near the VBJ. We planned implantation of a stent from the right VA to basilar artery (BA) followed by coil embolization of the aneurismal dilation and left VA. While ad-

vancing a 0.014-inch guide-wire, it entered the aneurismal dilation directly and the orifice of the aneurismal dilation was proven to exist at the VBJ.

After implantation of an S670 stent (3.0 mm x 18 mm) from just proximal of the anterior inferior cerebellar arteries to the right VA, the aneurismal dilatation and the left VA was occluded distal to the branching of a PICA. Soon after intervention the right VAG showed smooth vessel walls without evidence of aneurysm.

The patient was discharged without neurological symptoms 5 weeks after onset. An arteriography performed before discharge showed preservation of the right VA and BA and no evidence of dissection or aneurysm.

Figure 4 Case 4: Right (A,B) and left (C) VAG before treatment. Right VAG (D,E) immediately after the implantation of a stent from the BA to right VA and coil embolization of the aneurysm and left VA (F).

Results

The methods for stent implantation employed in our series can be classified into three or four patterns (figure 5). Pattern A comprises of single or double stent use without coils. This method was initially applied to Cases 1 and 2, and although a single stent did not obliterate the aneurismal dilatation, no recurrent haemorrhage was experienced. A second stent was added in Case 1 and coil embolization was added in Case 2. Patterns B and C are combinations of a stent and coils. In Pattern B, coils are delivered from a micro-catheter passed between struts. Case 2 was finally treated with this method and Case 3 was treated with this method from the onset. These cases required

several months to achieve complete obliteration of the aneurysm. The method employed in Case 4 was Pattern C and involved delivery of a stent and coils from a different axis. Complete obliteration of the aneurysm and correction of the sub-occlusive portion were achieved immediately following the procedure in Case 4.

Discussion

The application of intravascular stents to DAs of the vertebro-basilar system has become an alternative therapeutic modality because it allows the treatment of aneurysms that cannot be treated with simple obliteration procedures^{4,5,7,10}. However, intravascular stents are as-

sociated with considerable risks of ischemic complications during acute and chronic periods^{4,6,11}. Therefore the indication of stent implantation for DA should be carefully considered and candidates should be patients with DAs at BA, DAs at or near the VB junction, DAs involving a PICA, or DAs of VAs which must be preserved for various reasons. Our Cases 1, 2, and 4 met these criteria, but Case 3 did not.

We decided on stent use in Case 3 in view of the ischemic risks associated with obliteration of a VA near the VBJ and the risks associated with stent implantation.

Several possible mechanisms can be proposed to explain the success of intravascular stents in the treatment of DAs. Firstly, they could work as an artificial neck in preserving the blood flow from a parent artery when placing coils. This remodeling mechanism is widely utilized as a "stent and coil" technique not only for treating DAs, but also for the treatment of wide-neck aneurysms using specially designed stents¹. Other possible mechanisms include mechanical obstruction of the pseudo-lumen and hemodynamic alternation⁸.

Haemodynamic alternation includes factors such as the correction of turbulent flow in the true lumen, isolation of aneurismal dilatation from the blood flow and the reduction of hemodynamic stress to the aneurismal wall. Furthermore, the implantation of stents could promote reconstitution of the intimal lining, although intimal hyperplasia may cause chronic occlusion of the parent artery⁶. Stagnation of the blood flow observed after stent placement in our Case 1 may have been due to incomplete isolation of the aneurysm from the blood flow. The fact that recurrent haemorrhage was pre-

vented in Cases 1 and 2 despite the aneurismal depiction might be an effect of haemodynamic alternation. Aneurismal obliteration in our Cases 1 - 3 was obtained within several months after intervention, and this might be the time required for neointimal reconstruction and / or completion of thrombosis.

We used three methods to take advantage of the efficacy of intravascular stents in the treatment of DAs (figure 5). Each method should be chosen according to the anatomical site or the form of the DA. Stent implantation without coils should be employed for DAs with smaller aneurismal dilatation or DAs involving the branching of a PICA or AICA. In such cases, thrombosis of the aneurismal dilatation is likely to depend on the density of the strut. The use of double stents³ or dense-strut stents might promote the thrombosis. Although previous work applied the double stents in one step, we used this method in two stages. Staged double-stent implantation may reduce the risk of ischemic complications.

The "stent and coil" method described here as Pattern B might be useful in cases of DAs with relatively large aneurismal dilatation. Pattern C, which has not previously been reported, might be utilized for the DAs at or near the VBJ.

Conclusions

The optimal treatment of DAs with intravascular stents requires selection of the most appropriate method of stent implantation with or without coils. If the stent is chosen according to its flexibility or strut density, then stent implantation could become the primary therapeutic strategy in the treatment of DAs.

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