Doubled Stenting for Effective Occlusion of a Dissecting Carotid Artery Aneurysm

G. BENNDORF, E. WELLNHOFER*, G.H. SCHNEIDER**

Department of Radiology, * Cardiology and * Neurosurgery, Charité; Humboldt University Berlin

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Summary

Endovascular stent placement for treatment of symptomatic pseudoaneurysms in extracranial carotid arteries proved safe and effective. We aimed at increasing the efficacy of stenting for treatment of an internal carotid artery (ICA) dissecting aneurysm by reducing the stent porosity through placement of oversized overlapping stents.

A 55-year-old woman presented with right sided hemiplegia and aphasia. CT revealed an infarction in the left hemisphere, and cerebral angiography showed an extracranial dissection of the left ICA with a 1.0 x 2.0 cm pseudoaneurysm at the C1-level. Two oversized self-expandable stents (8/30, 8/40 Wallstent) were placed, bridging the dissected segment and overlapping at the level of the aneurysmal neck. Immediate control angiography showed remarkably reduced filling of the pseudoaneurysm. Intravascular flow assessment depicted a significant reduction of intraaneurysmal flow (31/0 cm/s). Follow-up arteriograms performed after six days and nine months confirmed complete disappearance of the pseudoaneurysm and a patent vessel lumen.

Reduced stent porosity causes significant haemodynamic changes inside the aneurysmal sac and accelerates intraaneurysmal thrombosis. Deployment of oversized and overlapping stents may be helpful in achieving rapid complete occlusion and avoiding additional coil packing.

Introduction

Wide-necked arterial aneurysms of the carotid artery are especially difficult to treat for vascular surgeons, if located extracranially but close to the skull base. Endosaccular treatment by coil packing might not succeed either, and in large aneurysms, compaction or recurrence may develop.

The application of metallic stents has shown increasing promise for endovascular treatment of dissecting aneurysms in the extracranial and recently also intracranial territories¹⁻¹⁴. Depending on local haemodynamics, complete aneurysmal occlusion by stent placement is usually achieved within a few months^{5,6} requiring repeated control angiographies and extended anticoagulation. We present a patient with a dissecting carotid aneurysm which was successfully occluded within a few days by placement of two overlapping self-expandable metallic stents.

Case Report

A 55-year-old woman presented at our hospital with right-sided hemiplegia and aphasia. Computed tomography (CT) revealed an infarction in the left temporal lobe. Digital subtraction angiography (DSA) showed dissection of the left extracranial ICA with a 10 x 20 mm pseudoaneurysm at the C1-level (figure 1A). To protect the patient from further throm-

boembolic events, endovascular treatment was performed. A 9F guiding catheter was placed into the right common carotid artery and two overlapping self-expandable stents (8/30, 8/40, Wallstent; Boston Scientific, Boston, USA) were deployed. The first stent bridged the entire dissected segment, while the second and shorter stent was placed across the aneurysmal orifice. The arteriogram at the end of the procedure showed a patent parent artery with the dissected vessel wall having been remodeled. (figures 1B, 1C). The pseudoaneurysm showed a reduced but clearly visible filling in the arterial phase after placement of the first stent. The final angiogram at the end of the procedure revealed an only minimal opacification of the aneurysm in the late venous phase (figure 1D). Assessment of flow changes was achieved by using an intravascular Doppler guidewire before and after stenting and revealed a significant reduction of the intraaneurysmal flow (figure 2).

Anticoagulant treatment was started four days prior to stenting including Plavix 150 mg per day, aspirin 325 mg twice daily, and heparin 5000 U as an intra-arterial bolus during the procedure. Plavix medication was continued for three weeks, and aspirin for ever post stenting. The control arteriogram after six days showed complete disappearance of the aneurysm and preservation of the carotid artery (figure 3A). The follow-up arteriogram after nine months demonstrated a well patent carotid lumen without significant intimal fibrosis (figure 3B). The patient recovered partially from her stroke and did not experience further ischemic attacks.

Discussion

Pseudoaneurysms following spontaneous dissection or trauma typically follow a benign course¹⁵. However, it is rare that they regress radiographically with anticoagulant therapy^{15,16}. As shown in a recent study by Guillon¹⁵, 65% of dissecting carotid aneurysms remained unchanged, 30% decreased in size, but only 5% resolved completely. Less frequently, they can cause significant clinical complications¹⁷ such as thromboembolic events, thus requiring more aggressive treatment.

Because these lesions are often located close to the skull base, surgical access may be complicated or impossible. Thus, various endovas-

cular means are nowadays increasingly recommended for management of cervical carotid aneurysms^{1,2,5,6,18}. Similarly to the intracranial circulation, electrolytically detachable coils may be used for selective extracranial aneurysm occlusion as reported by Lempert¹⁹ in a study with 11 successfully treated patients. However, endosaccular coil packing of pseudoaneurysms lacking a true arterial wall always carries the risk of rupturing the false sac and is therefore not recommended in our institution.

Alternatively, metallic endoprostheses, particularly stents, have aroused major interest as they have proved safe and effective for exclusion of these lesions while preserving the parent vessel^{1,5,7,9,18}. A disadvantage compared to coils is that a complete occlusion of the aneurysm after stenting is rarely achieved initially, and may take three to six months^{1,2,5,10} or in some cases even longer^{2,5,14}. Liu⁴ reported recently on long-term outcome after stent placement in seven patients including four with dissection induced pseudoaneurysms. Only two of their patients showed complete occlusion of the aneurysm at the time of the procedure, one underwent additional coil packing and another showed healing after 18 months.

To enhance the speed of occlusion, additional deployment of coils before or after stenting has been advocated^{6,14}. Furthermore, covered stents have also been applied for immediate exclusion of these lesions by several investigators^{8,13,20}. Covered stents would be theoretically ideal endoprostheses, but they are still in technical development and associated with several risks and certain disadvantages²¹.

The placement of overlapping stents (doubled stenting) across the aneurysm orifice is a relatively simple technique to increase their effect on the reduction of intraaneurysmal flow and subsequent aneurysm thrombosis (JJ Vitek, personal communication). This effect is caused by a reduction of the overall area viable to flow into the aneurysm, as well as loss of flow energy by increased turbulence in the area of the meshes. Aenis²² demonstrated in a side wall aneurysm model, that the flow is significantly diminished inside the stented aneurysm and less undulated inside the parent vessel. Pressure zones at the distal neck and the dome decreased post stenting and shear stress rates at the distal neck were elevated but more con-

Figure 1 Initial arteriogram and stenting. A) Left internal carotid arteriogram a.p. view. Irregular narrowing of the vessel lumen involving about 5 cm of the cervical portion. Demonstration of a 20 mm wide necked pseudo-aneurysm. B, C, D) Common carotid arteriogram a.p. views, early and late phase. Normalization of the diameter of the carotid lumen after placement of two Wallstents (8/30, 8/40), overlapping meshes at the level of the orifice result in only faint filling of the aneurysm (arrow), revealing the significant reduction of the intraaneurysmal flow caused by covering the neck with the low porosity of doubled stents (arrows).

finer and unidirectional compared to the non-stented model. The influence of stent porosity on changing the local haemodynamics between the aneurysm and the parent vessel was shown in experimental studies by Lieber²³ and Wak-

looh²⁴. In a recent experimental study, Yu²⁵ was able to demonstrate that the dampening of the intraaneurysmal flow by stents is effective, if the ratio of the effective mesh area and the total surface of the stent is sufficiently small, re-

Figure 2 Flow assessment. Intra-aneurysmal flow velocity demonstrated sharp negative peak immediately following maximal acceleration which is to be regarded as a sign of flow reflection from the dome of the aneurysmal sac. Intra-aneurysmal antegrade flow velocity spectra are of rather low intensity compared to intracarotid flow. Following stenting, intra-aneurysmal velocity (31 cm/s prior to stenting) was nearly abolished.

Figure 3 Follow-up arteriogram 6 days and 9 months after stenting. Left internal carotid arteriogram ap (6 days) and lateral (9 mos) view. Complete disappearance of the aneurysm and reestablishment of normal vessel caliber. The ECA continues to fill through the stent struts. Only minimal "thickening" caused by neo-intima.

ardless of the size of the aneurysm. The flow movement inside the aneurysmal pouch can be suppressed to less than 5% of the bulk mean flow velocity, inducing intraaneurysmal thrombus formation.

The case reported here supports these experimental results, showing that lowered porosity of overlapping stents may significantly impede the intra-aneurysmal blood flow accelerating intra-saccular thrombus formation. A comparison between flow data with one stent and with overlapped stents was unfortunately not done during the procedure, and therefore the contribution of the lowered porosity to reduction of intra-aneurysmal flow could not be demonstrated. Nevertheless, the final flow data show that intra-aneurysmal flow was virtually abolished. The blood stasis achieved within the aneurysm was likely to speed up the thrombotic occlusion of the pouch. Assessment of intra-aneurysmal flow by Doppler guidewires was found to be feasible in large nonruptured intracranial aneurysms earlier by our group²⁶. Providing real-time flow velocities may also be helpful in proving the effectiveness of stenting

pseudoaneurysms within the extracranial cerebral circulation.

Double stenting undoubtedly increases the foreign body material in the arterial wall. Yet, overlapping restenting and double stents are common practice in cardiology and seem to be rather safe. Furthermore, the follow-up arteriogram in our patient (nine months post-stenting) did not show more "thickening" compared to what is commonly observed after carotid stenting due to neo-intima. Adequate stents with low porosity are not available at the moment. Other adjunctive methods of single stenting suggested for the occlusion of carotid aneurysms have some limitations, too. Additional injection of glue into the aneurysm may be unsafe and risky and coil packing of the aneurysmal pouches is rather expensive^{12,14}. Double stenting may be a simple and effective alternative treatment for symptomatic dissecting aneurysms. It should be evaluated and compared to other invasive treatments currently explored in interventional neuroradiology. Flow-velocity measurements may be a helpful investigative tool for guiding therapy.

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Goetz Benndorf, M.D.
Neuroangiography/Neurointervention
Dept. Radiology, Charite, HU Berlin
Augustenburger Pl.1
13353 Berlin
e-mail: g.benndorf@charite.de