Recanalization with subsequent near-total occlusion of an internal carotid artery aneurysm after immediate thrombotic occlusion using a flow-diverting stent

Case report

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A flow-diverting stent is placed in the parent artery to reduce blood flow in the aneurysm sac to facilitate progressive thrombosis and neointimal remodeling while maintaining outflow in the side branches and perforators. All international multicenter registries have reported on the progressive occlusion of aneurysms with time and have implied that an occluded aneurysm would not recanalize given the protective effect of the altered hemodynamics. Recanalization of an occluded aneurysm after placement of a flow-diverting stent has not been reported in the literature. The authors here describe a case of aneurysm recanalization after immediate thrombotic occlusion of the aneurysm with a flow-diverting stent. A 46-year-old male chronic smoker with chronic hypertension and hypercholesterolemia had a recurrent internal carotid artery aneurysm 1 year after embolization. Immediate thrombotic occlusion of the aneurysm and cessation of blood flow to the posterior communicating artery (PCoA) occurred immediately after activating a flow-diverting stent, with corresponding ischemic complications. However, 3 months after insertion of the stent, follow-up MR angiography showed recanalization of the aneurysm as well as of the PCoA. Additional angiography studies at 6 months showed near-total occlusion of the aneurysm with the restoration of blood flow to the PCoA.


KEY WORDS • cerebral aneurysm • flow-diverting stent • embolization • vascular disorders

Abbreviations used in this paper: ICA = internal carotid artery; PCA = posterior cerebral artery; PCoA = posterior communicating artery; PED = pipeline embolization device.

With the introduction of Guglielmi detachable coils 20 years ago, endovascular coil embolization has become an established treatment for intracranial aneurysms.9 However, coil embolization has limitations in terms of recurrence and the need for mechanical constraints to prevent coil herniation into parent vessels.3,5,8,9 These limitations have inspired pioneers and scientists to work on alternative endovascular tools through computational fluid dynamics and animal models, with the subsequent successful development of dedicated flow-diverting stents with relatively low porosity, high pore density, and good trackability.2,7 Subsequent clinical studies have confirmed high 6-month complete occlusion rates (without significant parent vessel stenosis or occlusion) between 75% and 93% and short-term morbidity and mortality rates between 5% and 12%.1,4,6 All studies reported progressive occlusion of aneurysms with time and implied that an occluded aneurysm would not recur given the protective effect of the altered hemodynamics.1,2,4,6 The recurrence of a previously occluded aneurysm after the insertion of a flow-diverting stent has not been reported in the literature. We here describe a case of aneurysm recanalization in a patient following placement of a flow-diverting stent for an ICA aneurysm.

Case Report

History and Examination. This 46-year-old man initially presented with the acute onset of severe headache and dizziness, without a history of recent head injury. He was a chronic smoker and had hypertension and hyper-
cholesterolemia on medications. He was conscious with no neurological focal motor or speech deficit. Computed tomography studies of the brain showed diffuse subarachnoid hemorrhage in the basal cisterns. Digital subtraction angiography demonstrated a saccular ICA aneurysm (3.8 mm high, 5 mm wide, and 2-mm neck) at the origin of a fetal configuration PCoA.

First Treatment. Total occlusion was achieved with coil embolization using Matrix2 UltraSoft coils (Boston Scientific) of 5×10 cm and 3×8 cm. There was no procedural or subarachnoid hemorrhage–related complication.

First Posttreatment Course. The patient returned for a follow-up digital subtraction angiography study 1 year after the embolization, and a major aneurysm recurrence was noted (2.8×2.9×3.5 mm; Fig. 1A). The natural history of the disease and various treatment options were discussed in detail with the patient. He eventually decided to undergo flow-diverting stent treatment.

Second Treatment. The patient was prescribed and took double antiplatelet treatment (aspirin 160 mg daily and clopidogrel 75 mg daily) for a week before admission for stent insertion. After inducing general anesthesia, we performed a right femoral artery single wall puncture and a 6 Fr sheath was inserted. The left ICA was selected and exchanged for a 6 Fr Neuron guiding catheter (Penumbra). A 3 Fr Marksman microcatheter (ev3 Neurovascular, Covidien) was first placed distally to the straight segment of the proximal middle cerebral artery via microguide-wire guidance. A flow-diverting stent PED (3.5×16 mm, ev3 Neurovascular, Covidien) mounted on a delivery wire and constrained within a sheath was inserted into the rotating hemostatic valve and introduced into the hub of the microcatheter. The technique of activation has been previously described.10 Under heparinization (heparin bolus of 3500 IU when placing the guiding catheter), by pushing the delivery wire, the PED was advanced through the whole length of the microcatheter until the PED was at the distal end of the catheter. The PED delivery wire was then held in place while the microcatheter was retracted, supplemented by delivery wire rotation, to initiate activation distally at the ICA junction with the bifurcation. Mainly through forward pressure on the delivery wire, the device was further activated to create a tight mesh. Finally, the microcatheter was advanced to compress the proximal end of the PED, and the delivery wire was retracted. Check ICA angiography showed unexpected immediate occlusion of the aneurysm as well as of the PCoA (Fig. 1B). Vertebral artery angiography showed a narrow first segment of the PCA supplying the distal PCA without retrograde filling of the PCoA (Fig. 1C).

Second Posttreatment Course. The patient woke up with new right partial homonymous hemianopia and was started on hypertensive therapy for a week. Heparinization was continued for 2 more days. Computed tomography studies of the brain showed a small left occipital watershed infarct with hemorrhagic transformation (Fig. 1D). Double antiplatelet treatment was continued. The right partial homonymous hemianopia gradually resolved, and the small left occipital hematoma resolved on follow-up CT of the brain.

At 1 month after treatment with the flow-diverting stent, the patient presented with new right partial homonymous hemianopia and was started on hypertensive therapy for a week. Heparinization was continued for 2 more days. Computed tomography studies of the brain showed a small left occipital watershed infarct with hemorrhagic transformation (Fig. 1D). Double antiplatelet treatment was continued. The right partial homonymous hemianopia gradually resolved, and the small left occipital hematoma resolved on follow-up CT of the brain.

Fig. 1. A: Left ICA angiogram, lateral view, obtained at the 1-year follow-up, showing the recurrent aneurysm. B: Left ICA angiogram, lateral view, obtained immediately after PED activation, showing aneurysm occlusion together with fetal configuration PCoA occlusion. C: Left vertebral artery angiogram, anteroposterior view, showing the narrow first segment of the left PCA supplying the distal PCA with no retrograde filling of the PCoA. D: Postprocedural brain CT obtained on hospital Day 3, showing a small left occipital watershed infarct with hemorrhagic transformation (white arrow). E: Brain CT obtained at 1 month after stent treatment, showing a new infarct in the tail of the caudate nucleus and internal capsule extending to the corona radiata, compatible with an anterior choroidal artery territory infarct (white arrow).
stent, a right hemiparesis suddenly developed after inadvertently stopping the double antiplatelet treatment after discharge. Computed tomography scanning showed a new infarct in the tail of the caudate nucleus and internal capsule extending to the corona radiata, compatible with an anterior choroidal artery territory infarct (Fig. 1E). Double antiplatelet treatment was reinitiated, and the risks of cessation were emphasized. The patient was then transferred to a rehabilitation hospital and mostly recovered with only subtle right upper limb clumsiness 2 months later. At 3 months after treatment with the flow-diverting stent, the patient refused to undergo catheter angiography, and MR angiography showed recanalization of the aneurysm as well as of the fetal configuration PCoA (Fig. 2A). Clopidogrel was then stopped, and he was maintained with 160 mg of aspirin daily. At 6 months after stent treatment, the patient agreed to undergo follow-up catheter angiography. Planar angiography showed thrombotic occlusion of the aneurysm with recanalization of the PCoA and preservation of the anterior choroidal artery (Fig. 2B). Rotational angiography showed a tiny residual neck separated from the PCoA (Fig. 2C).

**Discussion**

We describe here the first case of a recurrence after aneurysm occlusion through the placement of a flow-diverting stent. The hemodynamic exclusion and immediate thrombosis resulting from the insertion of such a stent may be reversed, and thus follow-up imaging should be considered even after documented occlusion.

Our case illustrated 2 other aspects of flow-diverting stent treatment. The cessation of double antiplatelet treatment after placement of a flow-diverting stent can be associated with thromboembolic complications, which agrees with the fact that overall metallic coverage of the parent vessel is at least 3 times higher than other intracranial stents, especially with the presence of other vascular risk factors such as hypertension and smoking. Branch occlusion can occur even with activation of a single flow-diverting stent. Possible contributing factors may include inadequate anticoagulation (activated clotting time was not checked) and clopidogrel nonresponder (clopidogrel-related platelet inhibition was not checked). Some experts now avoid the flow-diverting stent treatment of aneurysms with an essential branch coming out from the neck, because the continuous outflow may keep the aneurysm “alive.” Our case report supports these experts’ opinion about the other risk of inadvertent branch occlusion together with aneurysm occlusion. Our case also demonstrated other risk factors for aneurysm recurrence after coil embolization. Whether these risk factors (hypertension and chronic smoker) played a role in the recanalization in our patient remain to be determined. Recanalization possibly occurred shortly after the procedure with the appearance of a hemorrhagic infarct. One point of note is that the flow-diverting stent is usually associated with delayed thrombotic occlusion of an aneurysm, as illustrated in our case.

**Disclosure**

The authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper.

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