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Technical note

Acute branch occlusion after Pipeline embolization of intracranial aneurysms

Rishi R. Lall [a], Emanuela Crobeddu [b], Giuseppe Lanzino [a,*], Harry J. Cloft [b], David F. Kallmes [b]

[a] Department of Neurologic Surgery, Mayo Clinic, 200 First Street S.W., Rochester, MN 55905, USA
[b] Department of Radiology, Mayo Clinic, Rochester, MN, USA

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ABSTRACT

Flow-diverters are used in the treatment of large and complex intracranial aneurysms. One major concern with this concept is the potential for compromise of side branches and perforators covered by the device. We describe three patients treated with the Pipeline embolization device (PED; ev3 Endovascular, Plymouth, MN, USA) who developed immediate compromise of flow into an eloquent side branch covered by the device. Three patients, two with giant posterior circulation aneurysms and one with recurrence of a previously clipped and subsequently coiled middle cerebral artery aneurysm, were each treated by placement of a single PED. Shortly after placement of the devices, despite adequate antiplatelet and anticoagulation regimens, partial or complete occlusion of a major side branch occurred. In all three patients, the occlusion was promptly reversed with intra-arterial administration of abciximab with no clinical sequelae. These cases are concerning because branch occlusion occurred even in the setting of patients appropriately premedicated with dual antiplatelet therapy and in whom genetic testing suggested clopidogrel responsiveness. Close monitoring of patients treated with these devices is critical to establish the frequency of this and other unanticipated complications.

1. Introduction

Flow diversion is a novel concept which is applied in the treatment of large and complex intracranial aneurysms [1–4]. One of the main concerns with flow-diverters is potential compromise of parenchymal branches, including perforating vessels that are covered by the device [3,5]. Although experimental studies have shown that small side branches stay open after placement of multiple telescoping devices, the fate of perforators and side branches in humans after aneurysm treatment is largely unknown [5–9]. We describe three patients treated with the Pipeline embolization device (PED; ev3 Endovascular, Plymouth, MN, USA) for aneurysms in locations other than the paraclinoid internal carotid artery (ICA) who developed immediate compromise of flow into a side branch covered by the device.

2. Case reports

2.1. Patient 1

This 64-year-old woman presented with a World Federation of Neurosurgical Societies grade I subarachnoid hemorrhage from a giant basilar bifurcation aneurysm incorporating the proximal left posterior cerebral artery (PCA) (Fig. 1A). The patient's only focal neurologic deficit was a partial third nerve palsy. She did not have angiographically visible posterior communicating arteries. It was decided to treat the aneurysm with a staged endovascular approach with the first session consisting of coil obliteration of the portion of the aneurysm sac considered responsible for the rupture (Fig. 1B). Three weeks following coil embolization she returned for flow diversion therapy. She was pretreated with three doses of aspirin 325 mg and a 300 mg loading dose of clopidogrel. The procedure was done under full heparinization with an activated clotting time (ACT) of greater than 250 seconds. A Neuron 070 guide catheter (Penumbra, Alameda, CA, USA) was placed into the basilar artery. Attempts to selectively catheterize the left PCA were unsuccessful and therefore a Marksman (ev3 Endovascular) microcatheter was placed over a 0.14 inch micro-guide wire into the distal right PCA. A 3.5 × 16 mm PED was placed from the mid P1 into the basilar artery (Fig. 1C). Several minutes following PED placement the left P1 occluded, along with the residual aneurysm sac, and substantial thrombus was evident within the PED in the right P1 segment (Fig. 1D). The patient was given a bolus of intra-arterial abciximab (0.25 mg/kg), which resulted in immediate dissolution of the acute thrombus, as well as reappearance of the residual aneurysm (Fig. 1E). She recovered without any new neurological

* Corresponding author. Tel.: +1 507 284 2511; fax: +1 507 284 0161.
E-mail address: lanzino.giuseppe@mayo.edu (G. Lanzino).

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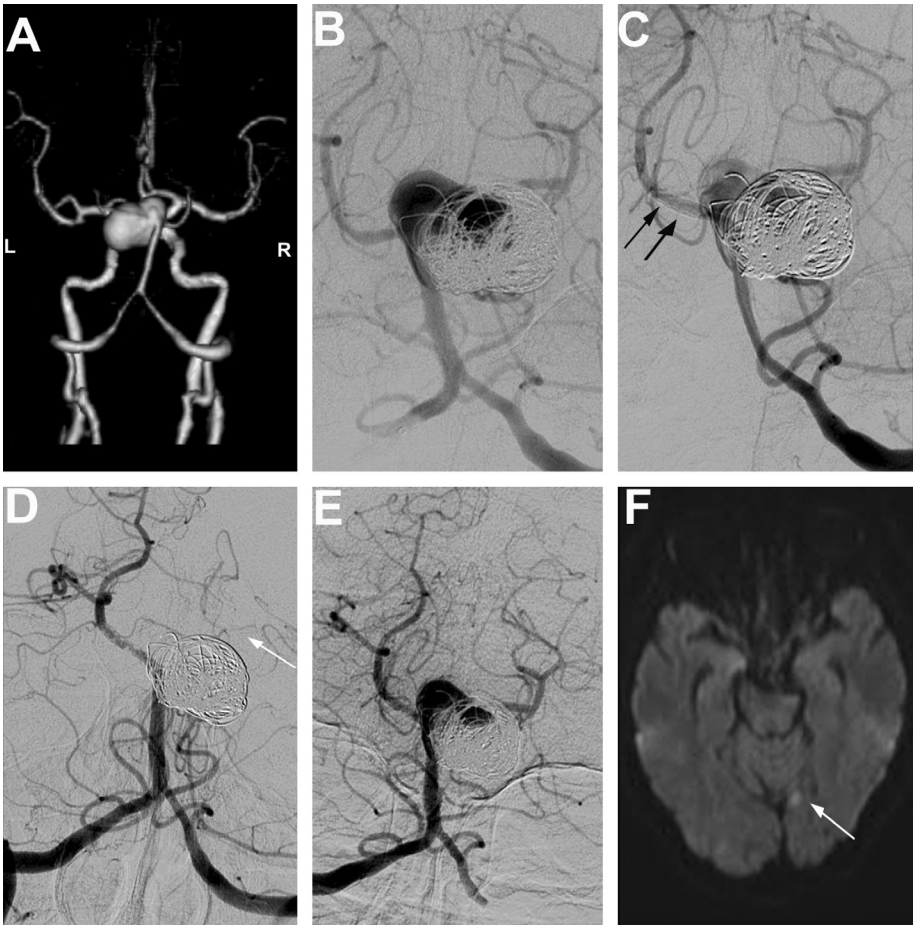

Fig. 1. (A) Shaded surface image from CT angiogram in the anteroposterior (AP) projection demonstrates giant, distal basilar aneurysm incorporating the left P1 segment. (B) AP digital subtraction angiogram (DSA) of the left vertebral artery demonstrates partial coil occlusion of the dome of the basilar aneurysm shown in A. (C) AP DSA of the left vertebral artery immediately following placement of a single Pipeline embolization device (ev3 Endovascular, Plymouth, MN, USA) from the mid-basilar to the right posterior cerebral artery (PCA) (arrows) showing slight diminution in intra-aneurysmal flow, as evidenced by diminished density of contrast within the aneurysm cavity. (D) AP DSA several minutes following PED placement showing occlusion in the aneurysm cavity and the left PCA (arrow), along with thrombus formation within the PED in the right PCA. (E) Complete restoration of flow is demonstrated in both PCA and the aneurysm cavity following abciximab infusion. (F) Axial brain MRI with diffusion/perfusion showing small bilateral punctate diffusion-restricted lesions in the occipital lobes (arrow).

deficits. Post-procedure MRI with diffusion/perfusion showed small bilateral punctate diffusion-restricted lesions in the occipital lobes (Fig. 1F). There were no lesions involving either the thalamus or the brainstem. She was discharged on post-procedure day 6 after a brief period of intravenous heparin while being transitioned to Coumadin (Bristol-Myers Squibb, New York, NY, USA). Cyp2C19 genotyping was performed to determine clopidogrel sensitivity and she was found to have increased expression of the enzyme responsible for activation of clopidogrel, which suggests normal to moderately increased antiplatelet response to clopidogrel [10]. One month later, Coumadin was discontinued while aspirin and clopidogrel were continued. MRI/magnetic resonance angiography (MRA) was performed 6 weeks after flow-diversion therapy and showed persistent residual aneurysm filling and no new ischemic insults. Clinically, she returned to work and complained of occasional headaches.

2.2. Patient 2

This 67-year-old man was admitted for subacute neurologic deterioration consisting of progressive gait ataxia, dementia, and urinary incontinence. Head CT scan and subsequent MRI/MRA demonstrated marked ventriculomegaly with transependymal absorption (Fig. 2A) secondary to a partially thrombosed giant vertebrobasilar aneurysm with marked surrounding edema and brainstem compression (Fig. 2B). The patient underwent ventriculoperitoneal shunt placement which resulted in improvement of his gait, return of his cognitive function to his baseline and resolution of incontinence. Three months later, he underwent catheter angiography which re-demonstrated the partially thrombosed vertebrobasilar junction aneurysm located along the proximal arm of a fenestration (Fig. 2C). Given the degree of surrounding edema and the presence of brainstem compression, it was decided to treat the patient with a PED. Under general anesthesia and full heparinization, the left vertebral artery (VA) was catheterized with a 070 6 French Neuron catheter. A Marksman catheter was advanced across the guide-wire. A 4.75 × 20 mm PED was deployed across the aneurysm neck. The patient was extubated, however on awakening from general anesthesia he was found to have dysarthric speech and lower cranial neuropathy as well as difficulty following commands. He was promptly re-intubated and a control angiogram was done. Selective VA injections showed patency of the basilar artery but occlusion of flow into the left posterior inferior cerebellar artery (PICA) (Fig. 2D). The patient was treated with a bolus of intra-arterial abciximab (0.25 mg/kg) and follow-up injections demonstrated clot resolution with revascularization of the left PICA (Fig. 2E). Once in the neuroscience intensive care unit, he was extubated and found to have no new focal neurologic deficits while promptly following commands. Post-procedure MRI with diffusion/perfusion showed no ischemic insult. The patient