CASE REPORT

Focal, transient mechanical narrowing of a pipeline embolization device following treatment of an internal carotid artery aneurysm

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SUMMARY

Flow diversion is a promising technique for cerebral aneurysm treatment but presents new and sometimes unique challenges. Transient reversible narrowing due to device reconfiguration of the pipeline embolization device (PED) has not been previously described. Here we describe a patient with dolichoectasia of the distal right internal carotid artery with an associated saccular sidewall aneurysm who developed asymptomatic circumferential narrowing of the proximal aspect of the PED in the first month following deployment. The patient was followed conservatively and demonstrated partial resolution of device narrowing on 6 month follow-up imaging.

BACKGROUND

Treatment of complex intracranial aneurysms by flow diversion is becoming an increasingly utilized endovascular technique.^{1–8} Potential complications of flow diversion include parent vessel occlusion, aneurysm rupture, thromboembolism, and intraparenchymal hemorrhage.² Less commonly, flow diverter migration has been described in several reports following the use of the pipeline embolization device (PED) (ev3, Irvine, California, USA) and Silk flow diverter (Balt Extrusion, Montmorency, France).^{9–10} Another unique phenomenon of delayed change in flow diverter configuration has been previously described in a single case involving Silk.¹¹

Here we report the case of a young woman who underwent treatment of a complex internal carotid artery (ICA) aneurysm by PED who subsequently developed an asymptomatic circumferential focal narrowing of the flow diverter construct that partially resolved with conservative management.

CASE PRESENTATION

A 43-year-old woman presented to our clinic for management of a complex, fusiform, and saccular right ICA aneurysm found during a workup for worsening headaches. The patient had undergone microsurgical repair of a ruptured right ICA terminus aneurysm at an outside hospital 8 years previously. Catheter angiography demonstrated dolichoectasia of the supraclinoid right ICA, beginning just proximal to the posterior communicating artery origin and extending to the terminus (figure 1). There was an associated posteriorly oriented saccular sidewall aneurysm measuring 6×5 mm with a wide 4 mm neck (arrows, figure 1A, B). The posterior communicating artery arose from the saccular component

(block arrow, figure 1B). Given the complexity of the lesion and its morphology, treatment with flow diversion was recommended.

Following the initiation of dual antiplatelet therapy, flow diverter placement was performed under general anesthesia. A 6 F shuttle sheath was navigated into the distal right common carotid artery and 10 mg of verapamil were administered intra-arterially in the right ICA for prophylaxis for vasospasm. A Navien 058 guide catheter (ev3) was advanced into the petrous ICA, followed by navigation of a Marksman (ev3) microcatheter into the ipsilateral middle cerebral artery. A 4.75×16 mm PED was then deployed in the distal right ICA across the aneurysm with its distal end in the proximal M1 segment.

The proximal aspect of the PED initially failed to expand to nominal size. The microcatheter was used to ‘bump’ the proximal end of the device, resulting in its full expansion. However, during this maneuver, the distal end of the flow diverter foreshortened and moved proximally to the carotid terminus. Post deployment angiography demonstrated gross patency of the PED, with good apposition of the device to the vessel wall. The device extended from the normal caliber ophthalmic ICA segment to the carotid terminus (figure 2A, B).

The patient tolerated the procedure well and was discharged home 2 days later. A 1 month follow-up angiogram (figure 2C, D) was performed to ensure stability of stent position and to exclude ongoing proximal migration. This demonstrated an interval change in mechanical configuration of the construct, with the proximal portion of the device having circumferentially narrowed and elongated, decreasing in diameter from 3.5 to 2.0 mm (white arrows, figure 2B, D). There was no evidence of device migration or intimal hyperplasia. As the patient remained asymptomatic, she was conservatively managed with close imaging follow-up.

Catheter angiography performed at 3 (figure 2E, F) and 6 months (figure 2G, H) post PED deployment demonstrated moderate improvement in the proximal device narrowing (white arrows, figure 2F, H). In addition, a progressive focal stenosis at the ipsilateral ophthalmic artery origin was noted (block arrow, figure 2G), although flow in the vessel was maintained. The saccular sidewall aneurysm thrombosed by 3 months.

DISCUSSION

In cases of delayed flow diverter migration, the device typically foreshortens as it increases in

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Figure 1 Anteroposterior (A) and lateral (B) views of a right internal carotid artery three-dimensional rotational angiogram demonstrates dolichoectasia of the supraclinoid right internal carotid artery extending to the terminus, with an associated posteriorly oriented saccular sidewall aneurysm (white arrows in (A) and (B)). A small right posterior communicating artery (white block arrow in (B)) is noted to arise from the saccular component. Surgical clips from a prior aneurysm microsurgical repair are noted.

diameter and achieves better vessel wall apposition. This may result in either proximal or distal migration of the flow diverter, sometimes with disastrous consequences.^{9–11} Apart from this foreshortening associated with device migration, delayed changes in flow diverter configuration have only been previously reported in a single case by Cohen *et al*, which involved the Silk flow diverter. In this instance, the patient had undergone flow diversion of an ICA aneurysm and developed significant tapering of the distal aspect of the Silk device on follow-up. The mid portion of the device was also narrowed due to intimal hyperplasia. The patient was treated with balloon angioplasty, which was complicated by intracerebral hemorrhage requiring surgical evacuation.

As opposed to reports of PED foreshortening and migration, the proximal aspect of the device in our patient circumferentially narrowed and elongated. There was no evidence of migration of the PED, nor narrowing due to intimal hyperplasia. Interestingly, the change in flow diverter configuration was partly reversible, as evidence by follow-up catheter angiography.

The etiology of this delayed mechanical change in PED configuration remains uncertain. One possibility is that an inflammatory reaction associated with evolving thrombosis of the saccular aneurysm could have resulted in parent vessel narrowing. We believe that the focal narrowing noted at the ophthalmic artery origin supports this hypothesis. Alternatively, placement of the flow diverter may have resulted in significant vasospasm of the parent vessel, which was initially masked during the procedure by the pre-administration of intra-arterial verapamil. Vasospasm in turn could have induced the change in device configuration. In either scenario, eventual resolution of inflammation or vasospasm, along with the intrinsic radial force of the PED, could explain the partial reversibility of device narrowing. Finally, it is unclear whether the necessary oversizing of the device proximal to the dolichoectatic segment and/or the braided stent design, could have contributed to the change in PED configuration.

Follow-up imaging after PED deployment is usually not performed before 3–6 months as flow diversion can take a year or

Figure 2 Subtracted (A) and native (B) lateral views of a right internal carotid artery angiogram obtained immediately following pipeline deployment demonstrates gross patency of the device (white arrows in (B)), with good apposition to the vessel wall. Subtracted (C) and native (D) lateral views of a right internal carotid artery angiogram performed 1 month later demonstrates an interval change in flow diverter configuration, with the proximal portion of the device having circumferentially narrowed (white arrows in (D)). Subtracted and native lateral views of angiograms performed 3 (E, F) and 6 (G, H) months following device deployment demonstrate progressive moderate improvement in proximal device narrowing (white arrows in (F) and (H)), as well as the development of a focal stenosis at the origin of the covered right ophthalmic artery (block white arrow in (G)). The saccular sidewall aneurysm is noted to have thrombosed by the 3 month follow-up.

more to achieve aneurysm closure. In the case of our patient, we elected to perform catheter angiography at 1 month due to concern for proximal device migration. Otherwise, the patient would have been followed at 6 months with catheter angiography, at which time the more subtle residual change in device configuration may not have been appreciated. It is possible that early transient changes in flow diverter configuration may occur more frequently, but are not appreciated as they are asymptomatic and resolve by the time of first imaging follow-up.

The benign clinical course demonstrated by our patient, as well as the spontaneous partial reversal of device narrowing, both suggest that conservative management is reasonable in patients who experience similar early changes in flow diverter configuration. Although the risks of conservative management in these instances remain unknown, intervention with balloon angioplasty clearly entails a small but significant risk of serious complications, as seen in the only other previously reported case with a Silk flow diverter.

In conclusion, serial catheter angiography to monitor for progression of device narrowing is a reasonable course of action when encountering early changes in flow diverter configuration.

Learning points

- ▶ The pipeline embolization device can demonstrate changes in device configuration following deployment, which may be partially reversible.
- ▶ Changes in device configuration need to be differentiated from the development of in-stent stenosis due to intimal hyperplasia as the mechanical nature and configuration of the construct should be stable in patients with intimal hyperplasia.
- ▶ Conservative management with short term follow-up may be a reasonable course of action for patients who develop early changes in flow diverter configuration.

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Competing interests None.

Patient consent Obtained.

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