Endoluminal Reconstruction for Nonsaccular Aneurysms of the Proximal Posterior Cerebral Artery with the Pipeline Embolization Device


ABSTRACT

BACKGROUND AND PURPOSE: Treatment options for nonsaccular posterior cerebral artery aneurysms include a range of surgical and endovascular reconstructive and deconstructive methods. However, no truly satisfactory treatment option is available to date for lesions arising from the P1 and P2 segments. The purpose of the present case series is to investigate both the efficacy and safety of the Pipeline Embolization Device in treating these challenging aneurysms.

MATERIALS AND METHODS: We present a series of 6 consecutive patients who underwent endoluminal reconstruction with the Pipeline Embolization Device for nonsaccular P1 or P2 segment aneurysms between January 2009 and June 2013.

RESULTS: Aneurysm location included the P1 segment in 2 patients and the P2 segment in 4 patients. Mean aneurysm diameter was 23 mm (range, 5–44 mm). Mean length of the arterial segment involved was 10 mm (range, 6–19 mm). Clinical presentation included mass effect in 4 patients and perforator stroke and subacute aneurysmal subarachnoid hemorrhage in 1 patient each. Endovascular reconstruction was performed by using 1 Pipeline Embolization Device in 5 patients and 2 overlapping Pipeline Embolization Devices in the remaining patient. Angiographic aneurysm occlusion was immediate in 1 patient, within 6 months in 4 patients, and within 1 year in the remaining patient. Index symptoms resolved in 4 patients and stabilized in the remaining 2. No new permanent neurologic sequelae and no aneurysm recurrence were recorded during the mean follow-up period of 613 days (range, 540–725 days).

CONCLUSIONS: Endovascular reconstruction with the Pipeline Embolization Device for nonsaccular aneurysms arising from the P1 and P2 segments compares favorably with historical treatment options in terms of occlusion rate, margin of safety, and neurologic outcome.
underwent endovascular reconstruction with the PED by our team between January 2009 and June 2013. Basilar apex aneurysms involving the P1 segment were excluded from the present series because in our opinion, they represent a different disease with a very different set of challenges. Patient characteristics are provided in On-line Table 2. The average aneurysm diameter was 23 mm (range, 5–44 mm). The mean length of the arterial segment involved was 10 mm (range, 6–19 mm). Five aneurysms were unruptured, and 1 came to our attention several months following low-grade aneurysmal subarachnoid hemorrhage (aSAH) related to the index P1 aneurysm—initially managed with observation at an outside institution. Index symptoms of the 5 patients with unruptured aneurysms included mass effect–related compression symptoms in 4 patients and hemiparesis following a thalamic perforator stroke in the remaining patient. Mass effect–related compression symptoms included cranial nerve (CN) III palsy in 2 patients, sensorimotor hemisyndrome combined with CN III palsy in 1 patient, and dizziness in 1 patient. Four of the 6 aneurysms included in the present series showed sizable (subtotal) thrombotic subcompartment, 1 showed minimal thrombosis, and the remaining one showed no evidence of thrombosis.

All patients were pretreated with acetylsalicylic acid, 325 mg daily, and clopidogrel, 75 mg daily, for at least 5 days. A P2Y12 assay (VerifyNow; Accumetrics, San Diego, California) was obtained at the beginning of the procedure and thereafter daily until discharge to evaluate and confirm the level of platelet inhibition obtained by the dual antiplatelet regimen. Endoluminal reconstruction was performed in all except 1 case by using a single PED. In patient 4, we elected to overlap 2 devices to maintain single coverage of the normal vascular segments proximal and distal to the aneurysm, with double-coverage of the aneurysm neck. The specific dimensions of the PED were chosen after determination of the length of the aneurysmal arterial segment and parent vessel diameter at the landing zones, proximal and distal to the aneurysm.
The advent of minimally porous endoluminal devices has produced a paradigm shift in the treatment of both anterior and posterior circulation aneurysms and, in particular, has generated enthusiasm for their use in challenging posterior circulation lesions. Although the early experience with flow diverters in the posterior circulation has been mixed, the variability in outcomes likely reflects, in part, the heterogeneity of lesions involving the posterior circulation group rather than an inherent limitation of the treatment technique per se. The current small series illustrates this point, demonstrating both the efficacy and reasonable safety of the PED in treating proximal PCA aneurysms. This is further underscored by the large size and complex geometry of lesions in this series and by the single technical complication related to device deployment in a case of particularly challenging geometry.

For the most part, treatment with the PED was limited to a single device due to concern for coverage of eloquent regional perforators. This was circumvented in patient 4, in whom it was elected to overlap two shorter devices across the aneurysm neck in a manner that maintained single coverage of the normal vascular segments proximal and distal to the aneurysm, illustrating one technical refinement to enable increased selective coverage of the aneurysm, while concomitantly minimizing the associated coverage risk to adjacent perforators. Given reports of occasional late in-stent thrombosis, particularly in the posterior circulation, it may be prudent to prolong dual antiplatelet therapy (12 months or longer) and to consider indefinite single agent maintenance.

In our opinion, these results are largely in line with those that would be expected after classic deconstructive treatment such as proximal parent artery clip or coil occlusion. In the present series, transaxial follow-up imaging was performed in all cases, demonstrating, in line with previous reports, an acute stage of thrombosis consistently followed by aneurysm involution during several months. Two of three patients who had CN III palsy recovered rapidly, with the third patient (patient 5) with a giant 44-mm aneurysm displacing CN III and the adjacent brain stem. Patient 3, who also presented with long-standing brain stem symptoms related to a particularly large aneurysm, showed stabilization, but not complete resolution of index symptoms as well. Based on our results we advocate that clinical recovery parallels to a large degree the degree and duration of neural compression, and the specific sensitivity of the involved neural structures to compression. In conclusion, therapeutic parent artery sacrifice may allow more immediate mass effect reduction, but the benefit of more rapid decompression remains, to our knowledge, unproven. Also, deconstructive methods fundamentally rely on the competence of the collateral arterial supply and ischemic complications following therapeutic parent vessel sacrifice include hemianopia orthalamic perforator stroke and certainly do occur as illustrated in On-line Table 1. Based on our experience, we hence propose that endoluminal reconstruction with the PED likely falls within the range of deconstructive methods in terms of relieving mass effect but offers the benefits of preserved anterograde flow in the parent PCA.

Nonaneurysmal proximal PCA aneurysms are formidable lesions that remain challenging to treat with any existing method. Despite the encouraging results reported in the present series, there remain limits with the currently available generation of PED. The potentially fatal incident that occurred in patient 3 illustrates how PED deployment becomes progressively more challenging in the more tortuous distal territories, in part due to the relative stiffness of the currently available PED delivery platform. This point is underscored by the extremely complex vascular geometry, the large size of the aneurysm (31 mm), and the fact that a single 35-mm PED was used in patient 3. Although in our case, full deployment of the PED covered the site of arterial injury and hence was an immediate bailout, future device development will need to address the limitations of the current generation of PED. Depending on the local vascular geometry, we also advocate, in selected cases, overlapping two shorter, hence more flex-
ible devices, which are less prone to torsion during deployment devices, in a manner maintaining single coverage of the normal arterial segments proximal and distal to the aneurysm while maximizing selective coverage across the aneurysm neck (eg, illustrative case, patient 4).

CONCLUSIONS
PED embolization of nonsaccular aneurysms arising from the proximal PCA compares favorably with historical treatment options in terms of occlusion rate, margin of safety, and neurologic outcome. The present series lends support to the use of the PED, in a manner maintaining single coverage of the normal arterial segments proximal and distal to the aneurysm while maximizing selective coverage across the aneurysm neck (eg, illustrative case, patient 4).

Disclosures: Daniel W. Zumofen—UNRELATED: Employment: New York University School of Medicine, Department of Radiology, Comments: fellow salary for my fellow/clinical instructor position in the Department of Radiology, New York University School of Medicine, New York, New York; Grants/Grants Pending: personal scholarship from the Fund Helmut Hartweg and the Swiss Academy of Medical Science, Comments: 1-year personal scholarship from the Fund Helmut Hartweg and the Swiss Academy of Medical Science to cofinance my fellowship at the New York University School of Medicine. Maksim Shapiro—UNRELATED: Consultancy: Covidien, Comments: I am a Pipeline device proctor and consultant with Covidien; Payment for Development of Educational Presentations: Covidien, Comments: I am a Pipeline device proctor and consultant with Covidien. Tibor Becske—UNRELATED: Consultancy: Covidien/ev3 (consultant); Payment for Lectures (including service on Speakers Bureaus): Covidien/ev3, Comments: I have given lectures for honoraria in the past; Payment for Development of Educational Presentations: Covidien/ev3, Comments: I participated in developing training programs for US physicians in the use of the Pipeline device. Peter K. Nelson—RELATED: Consulting Fee or Honorarium: Covidien; UNRELATED: Consultancy: Covidien.

REFERENCES