Transcirculation Pipeline embolization device deployment: a rescue technique

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The Pipeline embolization device (PED) has become a very important tool in the treatment of nonruptured cerebral aneurysms. However, a patient's difficult anatomy or vascular stenosis may affect the device delivery. The purpose of this article was to describe an alternate technique for PED deployment when ipsilateral anatomy is not amenable for catheter navigation.

A 44-year-old woman with a symptomatic 6-mm right superior hypophyseal artery aneurysm and a known history of right internal carotid artery dissection presented for PED treatment of her aneurysm. An angiogram showed persistence of the arterial dissection with luminal stenosis after 6 months of dual antiplatelet treatment. The contralateral internal carotid artery was catheterized and the PED was deployed via a transcirculation approach, using the anterior communicating artery. Transcirculation deployment of a PED is a viable option when ipsilateral anatomy is difficult or contraindicated for this treatment.

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KEY WORDS transcirculation; contralateral internal carotid artery; Pipeline embolization device; rescue technique

THE Pipeline embolization device (PED) has changed the paradigm of aneurysm treatment since it was approved in 2011.^{5,13,18} The popularity of the PED is based on its efficacy in treating aneurysms when compared with conventional coiling (> 80% vs 66% aneurysm obliteration rate, respectively, with minimal—if any—aneurysm recurrence).^{2,3,5,6,10,13,15}

Usually the PED deployment is antegrade, with the delivery microcatheter entering the inflow of the aneurysm. Sometimes the deployment can be difficult, mainly because of tortuous anatomy, predisposing patients to complications like device migration and malpositioning, aneurysm rupture, delayed thrombosis, and stroke.^{4,9}

We present a case of transcirculation PED deployment in a patient with right internal carotid artery (ICA) dissection. This technique can be extrapolated to patients with

difficult ipsilateral ICA anatomy, diseased ipsilateral ICA (dissections, fibromuscular dysplasia), or any other cause that contraindicates ipsilateral circulation deployment.

Case Report

History and Examination

We present the case of a 44-year-old woman who, upon workup for worsening headaches, was found to have a right superior hypophyseal artery aneurysm and a family history of ruptured brain aneurysms. The patient underwent digital subtraction angiography that was complicated with ipsilateral right ICA dissection just above the bifurcation. On further evaluation, the dissection flap was non-flow limiting, and the patient had a complete circle of Willis. The patient was treated conservatively with immediate

ABBREVIATIONS ACA = anterior cerebral artery; ACoA = anterior communicating artery; CCA = common carotid artery; ICA = internal carotid artery; PED = Pipeline embolization device.

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FIG. 1. Angiogram showing a lateral view of the right ICA dissection (**A**); notice the tapering of the ICA above the bifurcation (*thick arrow*). An anteroposterior view (**B**) and a lateral view (**C**) of the 6-month follow-up digital subtraction angiography. Severe ICA stenosis is noted where the previous dissection happened (*thin arrows*). The superior hypophyseal aneurysm is shown in panels **B** and **C** (*arrowheads*).

heparinization and 75 mg/day of clopidogrel plus 81 mg/day of aspirin for 6 months. The patient was followed up 6 months later with CT angiography that showed improvement of the dissection. At this point, she was scheduled for elective PED treatment of the aneurysm.

Technical Procedure

On treatment day, the P2Y12 assay was checked to confirm correct platelet inhibition (P2Y12 reaction unit [PRU] 142, baseline 280, 49% inhibited). The right common carotid artery (CCA) injection showed persistent residual stenosis (Fig. 1), making the ipsilateral PED deployment challenging. The left ICA injection showed a functional

anterior communicating artery (ACoA) complex and generous cross-filling into the right ICA circulation (Fig. 2).

At this point, a second groin sheath was placed and the patient underwent heparinization with the usual protocol for Pipeline deployment (5000 IU of heparin to achieve the activated clotting time goal of 2–3 times the baseline). A 6-Fr envoy catheter was positioned at the right CCA. A Penumbra Neuron Max was brought up to the left CCA bifurcation, and then the Navien 0.058-inch catheter (Medtronic, Inc.) was brought up to the left petrous ICA. A roadmap angiographic run was obtained (Fig. 2) and a 0.027-inch Marksman catheter (Medtronic, Inc.) along with the Synchro2 guidewire (Stryker Neurovascular) was navigated to the left anterior cerebral artery (ACA), ACoA, contralateral right ACA, and right ICA, and was placed at the distal petrous segment of the right (contralateral) ICA. At this point, the left ICA Navien catheter was advanced to the distal ICA segment to provide better catheter support. A classic PED model was brought up to the tip of the Marksman catheter (Fig. 3). The PED was deployed at that position.¹⁴ An angiographic run showed good wall apposition, the distal PED coil and pusher wire were retrieved without problems, and the entire delivery system was removed (Fig. 4).

Posttreatment Outcome

There were no complications during the procedure, and the patient was discharged home on postoperative Day 1 in stable condition.

FIG. 2. **A:** Left ICA injection angiogram showing cross-flow to the right ICA circulations and a functional ACoA complex. **B:** Roadmap angiogram of both circulations was used to navigate the Marksman catheter past the right superior hypophyseal aneurysm.

FIG. 3. Anteroposterior (A) and lateral (B) roadmap angiograms of the right ICA circulation. The Navien 0.58-inch catheter had initially been placed on the cavernous left ICA (*double arrows*). The 0.27-inch Marksman catheter was navigated to the right proximal ICA cavernous segment, past the aneurysm (*single arrows*). The PED is being navigated through the Marksman catheter into the right A_1 artery. The Navien catheter positioned on the left distal petrous ICA segment (*double arrows*) will be advanced to the distal left ICA segment prior to PED deployment to provide better catheter support and to avoid PED malpositioning during deployment.

FIG. 4. A and B: Anteroposterior and lateral views of the PED braid deployed (*straight lines* in panels A and B), with the distal tip of the Marksman at the left A_1 segment, proximal to the braid (*double arrows* in panel B) and the distal PED pusher wire and coil distal to the aneurysm and the braid, in the left cavernous ICA segment (*single arrow* in panel B). C and D: Late arterial phase with the staggering of contrast in the right superior hypophyseal segment aneurysm (*arrowhead* in panel C, *double arrows* in panel D).

Discussion

Pipeline embolization device deployment can sometimes be difficult, especially when encountering tortuous anatomy. We describe a case in which ipsilateral deployment was not possible due to arterial dissection and stenosis. After evaluating the patency of the circle of Willis, we decided to approach the contralateral side (left ICA circulation) to achieve transcirculation PED deployment (on the right ICA). This is the first known description of this approach as a rescue technique for deployment of PED.

Transcirculation techniques are reserved for the treatment of complex cerebral aneurysms, and they should be reserved for patients in whom the risks of leaving their aneurysms untreated are high and who have a strong family history of ruptured aneurysms.¹ These techniques can be achieved via a communicating vessel, and they are especially efficacious when the angulation of the parent or branching vessel would be difficult or impossible to catheterize from an antegrade approach.^{1,8,11,12,16,17,19,20}

Transcirculation techniques for treatment of intracranial aneurysms have been extensively described for intrasaccular coiling, but not for extrasaccular flow diversion treatment.^{1,7,8,11,12,16,17,19,20} They are associated with increased risk of thromboembolic complications due to navigation of smaller communicating cerebral arteries with the microcatheters,¹ and these procedures should only be attempted after careful evaluation of the anatomy, when the ipsilateral parent vessel approach is difficult or contraindicated.

There are several factors to be considered before attempting transcirculation techniques, and they are as follows.

- 1) Bilateral femoral access is necessary for correct navigation of the catheters. A dual road map should be obtained for proper catheter navigation (Fig. 2). Sometimes, when it is difficult to visualize the ACoA complex, counter-compression of the ICA may be necessary for proper visualization.
- 2) The caliber of the communicating artery should allow the passage of the delivery catheter. A diameter of 1 mm is usually enough to pass the delivery catheter (0.93 mm). When the surgeon is having problems passing the catheter through the ACoA complex, a quick intraarterial infusion of nicardipine could be used to relax and dilate the complex.^{11,16}
- 3) The size of the ICA of interest should be carefully measured to calculate the size and length of the PED. Deploying a longer-than-needed PED from a transcirculation approach would translate into braid coverage of distal circulation and small perforator arteries, increasing the risk of ischemic strokes. Deploying a shorter PED translates into insufficient distal coverage with possible distal braid retraction and herniation into the aneurysm sac, creating flow diversion into the aneurysm dome (increased risk of aneurysm rupture). We recommend measuring in 3D views as well as conventional high-magnification views to average the measurements and choose the braid.
- 4) Catheter support is essential every time a transcirculation approach is planned. A shuttle catheter should be brought to the ICA bifurcation. The distal access

catheter (Navien 0.058-inch catheter; Medtronic, Inc.) should be carried as distal as possible to avoid problems with trackability of the PED. The entire system should be unloaded (pulling the catheters to straighten them up) prior to the initial PED deployment to avoid malpositioning of the braid.

- 5) Placement of a single PED should be the goal to prevent thromboembolic complications from longer procedure times. In theory, the newer Pipeline Flex could offer an advantage over the classic model due to its improved flexibility with catheter navigation and its ability to resheath when deployment is not optimal. This last statement would depend on the operator. We decided to use the classic model because we are more comfortable with it.

Conclusions

Transcirculation PED deployment is a good option when encountering difficult or contraindicated catheter navigation in the ipsilateral circulation. Although this technique may potentially increase the incidence of thromboembolic complications, it is safe and efficacious when compared with the natural history of untreated aneurysms, especially in younger individuals with a strong family history of ruptured brain aneurysms. We recommend optimal P2Y12 inhibition and heparinization for the patient at the beginning of the procedure, with activated clotting time follow-up.

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Disclosures

Drs. Jabbour and Tjoumakaris are consultants for Medtronic, Inc.

Author Contributions

Conception and design: Jabbour, Tjoumakaris. Acquisition of data: Valle-Giler, Atallah. Analysis and interpretation of data: Jabbour, Valle-Giler, Atallah, Tjoumakaris. Drafting the article: Valle-Giler, Atallah. Critically revising the article: all authors. Reviewed submitted version of manuscript: Tjoumakaris. Approved the final version of the manuscript on behalf of all authors: Jabbour. Study supervision: Jabbour, Rosenwasser.

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