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The Neck-Crossing Technique Using the Low-Profile Distal Access Catheter in Flow Diverter Placement for Dissecting Posterior Cerebral Artery Aneurysm: A Case Report

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Abstract

We report a case in which a novel distal access catheter proved successful in the placement of a flow diverter for a challenging distal cerebral artery lesion. We discuss the advantages and pitfalls of this technique and considerations for its use. A 74-year-old female presented with intermittent headaches, and was diagnosed with a dissecting aneurysm at the proximal right posterior cerebral artery with a sharp bleb, measuring 9.8 mm in diameter. Given the complex vascular anatomy, stent-assisted coil embolization was initially considered but deemed high risk for dual catheter for jailing technique with 6-Fr size guiding catheter due to the tortuosity and stenosis of the parent vessel. Therefore, we opted for flow diverter treatment, which presented its challenges during delivery. By employing a low-profile distal access catheter, Phenom Plus (outer diameter: 4.2-Fr. inner diameter: 1.13 mm; Medtronic, Minneapolis, Minnesota, United States), with a minimal ledge between it and the delivery catheter, Phenom 27 (outer diameter: 2.8-Fr, 0.91 mm; Medtronic), we successfully crossed the neck of the aneurysm with Phenom Plus and placed the flow diverter. While acknowledging potential risks, this case demonstrates the value of the neck-crossing technique using a low-profile distal access catheter as an alternative option for treating challenging peripheral artery aneurysms with flow diverters. This technique offers promise in specific situations where conventional methods pose challenges.

Keywords

- dissectiong posterior cerebral artery aneurysm
- flow diverter treatment
- neck-crossing technique
- low-profile distal access catheter
- pipeline flex embolization device with shield technology

Introduction

In recent years, the adoption of flow diverters (FDs) for the treatment of cerebral aneurysms has been remarkable.[1,2] Low-profile devices that can be navigated with a 17-catheter (microcatheter with 0.017" tip inner diameter) have become common, and good treatment results with small distal arteries are well-known.[3,4] Meanwhile, only the Pipeline Flex Embolization Device with Shield Technology (PED-S; Medtronic, Minneapolis, Minnesota, United States) and

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Flow Re-direction Endoluminal Device (FRED; Terumo MicroVention, Aliso Viejo, California, United States), which are compatible with 27-catheters (microcatheters with 0.027" tip inner diameter), are available in our country. The indications for FDs have expanded to include the internal carotid artery (ICA) and vertebral arteries (VAs) for the former, and, in addition, the proximal parts of the anterior cerebral artery, middle cerebral artery, and basilar artery (BA) for the latter. In this report, we present a case in which the neck-crossing technique, using a novel distal access catheter (DAC),[5,6] proved successful in the placement of an FD for a challenging dissecting aneurysm at the proximal segment of the right posterior cerebral artery. We discuss the advantages and pitfalls, along with considerations, including a literature review.

Case Presentation

A 74-year-old female with a history of intermittent headaches for several years underwent a head magnetic resonance imaging (MRI) examination, which revealed multiple unruptured cerebral aneurysms. Her medical history included a hysterectomy for uterine disease and antihypertensive medication due to hypertension. There were no notable findings in her family history. She was referred to us to assess the indication for treating the cerebral aneurysms and to address the necessary one.

Upon admission, the neurological examination revealed no focal neurological signs. Neuroradiological imaging showed unruptured cerebral aneurysms in three locations on magnetic resonance angiography, including the proximal right posterior cerebral artery (PCA), the supraclinoid segment of the left ICA, and the distal right intracranial VA distal to the posterior inferior cerebellar artery. MRI showed that a dome of the proximal right PCA aneurysm compressed the right cerebral peduncle from the antero-medial side (►**Fig. 1A**). Digital subtraction angiography (DSA) indicated that the last two aneurysms were small or had a fusiform-shaped smooth configuration. As for the first one, just after branching from the BA, the aneurysm was directed posteriorly and had a sharp bleb at its tip (►**Fig. 1B, D**). The long diameter measured 9.8 mm, and the neck diameter was 8.7 mm, with the PCA main trunk being involved in the aneurysm, suggesting a dissecting aneurysm (►**Fig. 2A, B**). The perforator of the P1 segment of the PCA was dominant on the left side, with no apparent ones on the right side on DSA. No observable branches were originating from the aneurysm wall. Based on these findings, endovascular treatment for the right PCA aneurysm was deemed necessary, taking into

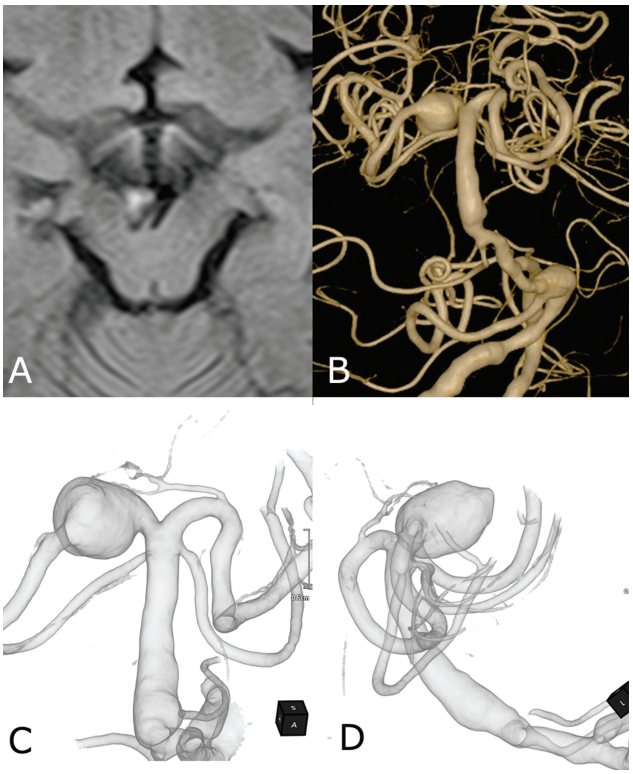

Fig. 1 (**A**) Fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) showing a dome of the proximal right posterior cerebral artery aneurysm compressing the right cerebral peduncle from the anteromedial side. (**B**) Anteroposterior (AP) view of a three-dimensional digital subtraction angiography (3D DSA) of the left vertebral angiography (VAG) showing the right posterior cerebral artery aneurysm. (**C**) Translucent image of the AP view of the 3D DSA from the left VAG delineating the dissecting nature of the aneurysm. (**D**) Translucent image of the lateral view of the 3D DSA from the left VAG showing a bleb at the upper posterior portion of the aneurysm.

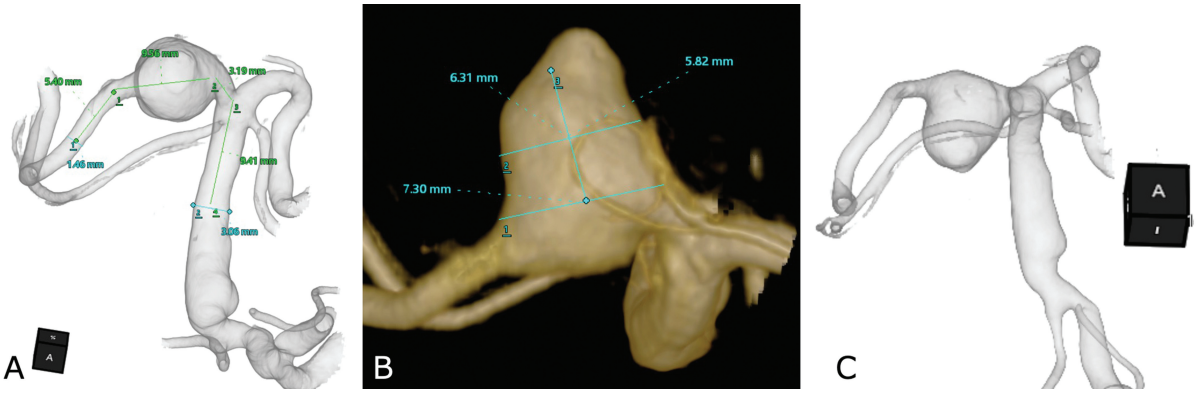

Fig. 2 (**A**) Measurement of the diameter and length of the left posterior cerebral artery (PCA) and basilar artery (BA). (**B**) Measurement of the aneurysm's width, height, and neck. (**C**) Working angle view showing the expected course of the flow diverter from the BA to the left PCA.

account its shape and size. Initially, stent-assisted coil embolization was considered. However, given the presence of a fusiform aneurysm in the right VA and the strong tortuosity and stenosis of the left VA to the BA, the introduction of multiple microcatheters for the jailing technique was considered high-risk. Given the simplicity and curative potential of the treatment, it was decided to proceed with FD treatment, utilizing catheter access through the left VA. In our country, FD is not reimbursed by insurance for PCA aneurysms, so the patient provided informed consent, including acknowledgment of the off-label use of FD, and an understanding of the associated treatment risks at this specific location.

Endovascular Treatment

Dual antiplatelet treatment (aspirin 100 mg/day and prasugrel 3.75 mg/day) was initiated 14 days before the treatment. Platelet function evaluation by VerifyNow (Accumetrics, San Diego, California, United States) performed 2 days before treatment showed ARU 394 and PRU 189, both of which were within optimal ranges. Under general anesthesia, a 4Fr 10cm short sheath introducer was placed in the right superficial femoral artery, and after confirming adequate puncture status by contrast, it was exchanged for a 7Fr 30cm long sheath introducer. Heparin (5,000 units) was systemically injected, and 5 minutes later, an activated clotting time (ACT) of 367 seconds was confirmed. Thereafter, heparin was additionally administered to maintain the ACT around 300 after hourly ACT measurements. A 7Fr 90cm guiding catheter (Roadmaster; Nipro, Osaka, Japan) was advanced to the level of the fourth cervical vertebra of the left VA. 3D-DSA was performed, setting multiple working angles to access P1 (►**Fig. 2C**), the neck and the aneurysm body, and the distal PCA. Phenom Plus (outer diameter: 4.2-Fr. inner diameter: 1.13 mm; Medtronic) was selected as the DAC. After advancing Phenom 27 (outer diameter: 2.8-Fr, 0.91 mm; Medtronic) using Synchro SELECT Standard (Stryker, Kalamazoo, Minnesota, United States) inside Phenom Plus into BA via the intracranial VA, when attempting to advance Phenom 27 to cross the lesion, difficulties arose due to the sharp bending of the PCA just after the neck, as well as the branching angle from the BA. Even after substituting the guidewire from Synchro SELECT Standard to Traxess (Terumo MicroVention) and GT 0.012" double angle guidewire (Terumo MicroVention), it remained unreachable. Therefore, the microcatheter was replaced with an Excelsior SL-10 (Stryker), and the guidewire was switched to a Synchro SELECT Soft (Stryker) with its tip manually shaped to a moderate degree. This allowed for successful distal access, and the Excelsior SL-10 reached beyond the neck of the aneurysm to the P3 segment of the PCA. After changing the guidewire to a Chikai-14 300cm (Asahi Intecc, Aichi, Japan), Phenom 27 was successfully crossed with a catheter exchange. A PED-S 3.25mm × 20mm (Medtronic) was selected as the FD and guided into the Phenom 27 (►**Fig. 3A**). However, at the angle just before reaching the neck from the P1 origin of BA, the PED-S tip could not pass beyond it, even though the leading wire had passed through (►**Fig. 3B**). Attempts to force it caused a portion of Phenom 27, just proximal to its tip, where the PED-S was advanced, to deflect into the dome. At this juncture, to secure additional backup support, Phenom Plus was advanced cautiously, enabling it to follow Phenom 27 smoothly without encountering any resistance (►**Fig. 3C, D**). Furthermore, as Phenom Plus was carefully advanced, it traversed from the BA to the PCA, crossed the neck of the aneurysm, and reached the distal bend of the PCA, beyond the aneurysmal neck (►**Fig. 3E**). Subsequently, PED-S was advanced and positioned inside Phenom 27, extending it further beyond the intended landing zone (►**Fig. 3F**). While Phenom Plus was gradually retracted from the neck region toward the BA, PED-S was opened and deployed, ensuring a secure landing (►**Fig. 4**).

After deployment, there was significant flow stagnation within the aneurysm. High-resolution cone-beam computed tomography confirmed the adequate adaptation of PED-S to the vessel wall (►**Fig. 5A**), and angioplasty was not deemed necessary. Heparin reversal was not performed, and the sheath introducer was removed using Perclose ProGlide (Abbott Vascular, Santa Clara, California, United States). Postoperatively, there were no neurological abnormalities. An MRI examination conducted on day 1 following the procedure showed no abnormalities, including ischemic lesions (►**Fig. 5B**). The patient was discharged on day 4 postoperatively while maintaining dual antiplatelet therapy. Currently, the patient is in the latency period for a follow-up DSA. A video of the procedure is available (►**Video 1**).

Video 1

Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0044-1791711.

Discussion

Dissecting aneurysms of the PCA is rare,[7] and there are no clear guidelines for treatment indications. In this case, although it was unruptured and asymptomatic, the size and shape of the aneurysm led us to consider treatment indications. The primary choice for curative treatment in this case was endovascular therapy, given the location of the lesion.[8] Stent-assisted coil embolization is the first consideration in terms of endovascular techniques. In this case, the aneurysm tip was directed posteriorly and indented partly to the right cerebral peduncle, but not significantly, so stent-assisted embolization may be an option. FD placement was also considered as an alternative.[9] Evidence supporting the use of FDs in peripheral artery aneurysms has been steadily growing.[3,10] There is an increasing expectation for the use of low-profile FDs with smaller deployment diameters in the treatment of peripheral artery aneurysms.[3,10]

Initially, stent-assisted coil embolization was considered in this case. However, the presence of significant arterial sclerosis along the route from the left VA to the BA made it

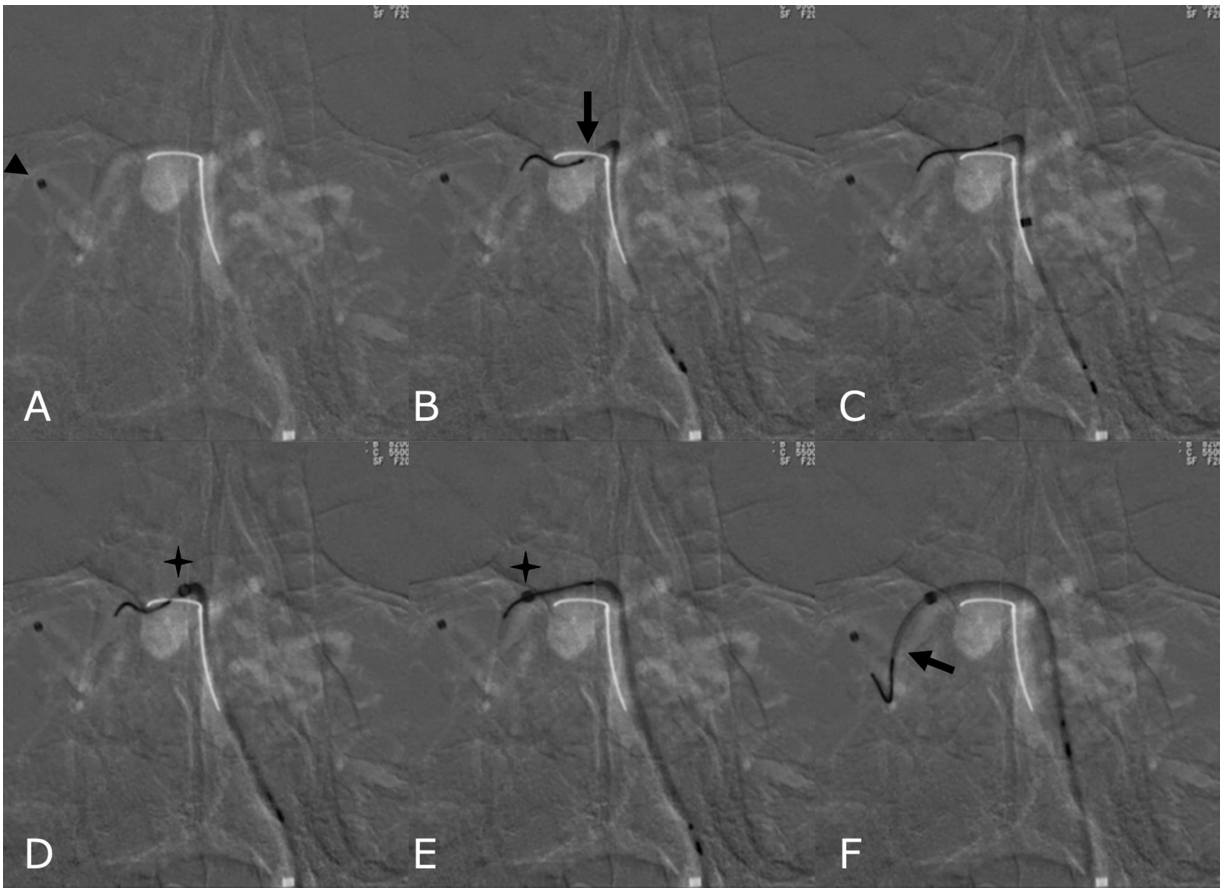

Fig. 3 X-ray fluoroscopic images during the treatment: (**A**) Phenom 27 has reached the distal portion of the left posterior cerebral artery (PCA). (**B**) A Pipeline Embolic Device with Shield technology (PED-S) became stuck and could not be advanced. (**C**) The tip of the Phenom Plus (PP) is approaching the mid-basilar artery. (**D**) The tip of the PP has reached the proximal neck of the aneurysm. (**E**) The tip of the PP has passed beyond the distal neck of the aneurysm. (**F**) The PED-S was advanced inside the Phenom 27 to the PCA, distal to the aneurysm. Arrowhead: tip of the Phenom 27. Arrow: tip of the Pipeline Embolic Device with Shield technology. Cross: tip of the Phenom Plus.

challenging to achieve sufficient aneurysm occlusion using the jailing technique with two microcatheters. It is important to note that in our country, low-profile FDs for peripheral artery aneurysms have not yet been introduced, and reimbursement for FDs in this location has not been established. While both PED-S and FRED were considered options, we opted for the former due to factors such as the presence of a coating[4,11–13] and its suitability for curved areas.[14] Therefore, Phenom 27 induction was necessary in this case. However, the placement site had a bend in the right PCA beginning from the cerebral base artery, in addition to the aneurysm's distal side, making it challenging to guide the microcatheter for the FD.

As a result, we introduced a 17-catheter, instead of Phenom 27, and then induced the latter by catheter exchange. At this point, the Phenom Plus, a low-profile DAC with an outer diameter of 4.2 Fr (1.40 mm), provided sufficient backup support. Furthermore, during the introduction of PED-S through Phenom 27, difficulties were encountered as mentioned above. To overcome this, we carefully guided Phenom Plus along Phenom 27, successfully reaching the distal PCA by crossing the neck with Phenom Plus. With only a 0.22 mm difference in diameter between the inner diameter of Phenom Plus (1.13 mm) and the outer diameter of Phenom 27 (2.8 Fr, 0.91 mm), the ledge effect was minimal (►**Fig. 5C**). Therefore, this combination of a DAC and neck crossing was considered highly useful. In recent years, the use of this DAC has increased in neuroendovascular treatment, particularly through transradial access, owing to its low-profile design. Another distinctive feature is the minimal ledge between this catheter and Phenom 27. Therefore, the approach of using Phenom Plus as a low-profile DAC is considered to be more beneficial in the treatment of peripheral artery aneurysms compared with conventional standard DACs such as Sofia Select (Terumo MicroVention) and Navien (Medtronic). Specifically, this technique may be applicable to aneurysms that are suitable for flow diversion in arteries beyond the Circle of Willis, such as the anterior communicating artery, middle cerebral artery, PCA, or even further distal arteries that are larger in diameter than the outer diameter of the Phenom Plus, which is 4.2 Fr (1.40 mm).

To the best of our knowledge, this report represents the first documentation of a FD treatment utilizing the neck-crossing technique for the distal cerebral aneurysm using Phenom Plus, leveraging this specific characteristic.

As a limitation, it is important to note that this report represents a single case, and this technique may not apply to all peripheral artery aneurysms. Caution is required due to

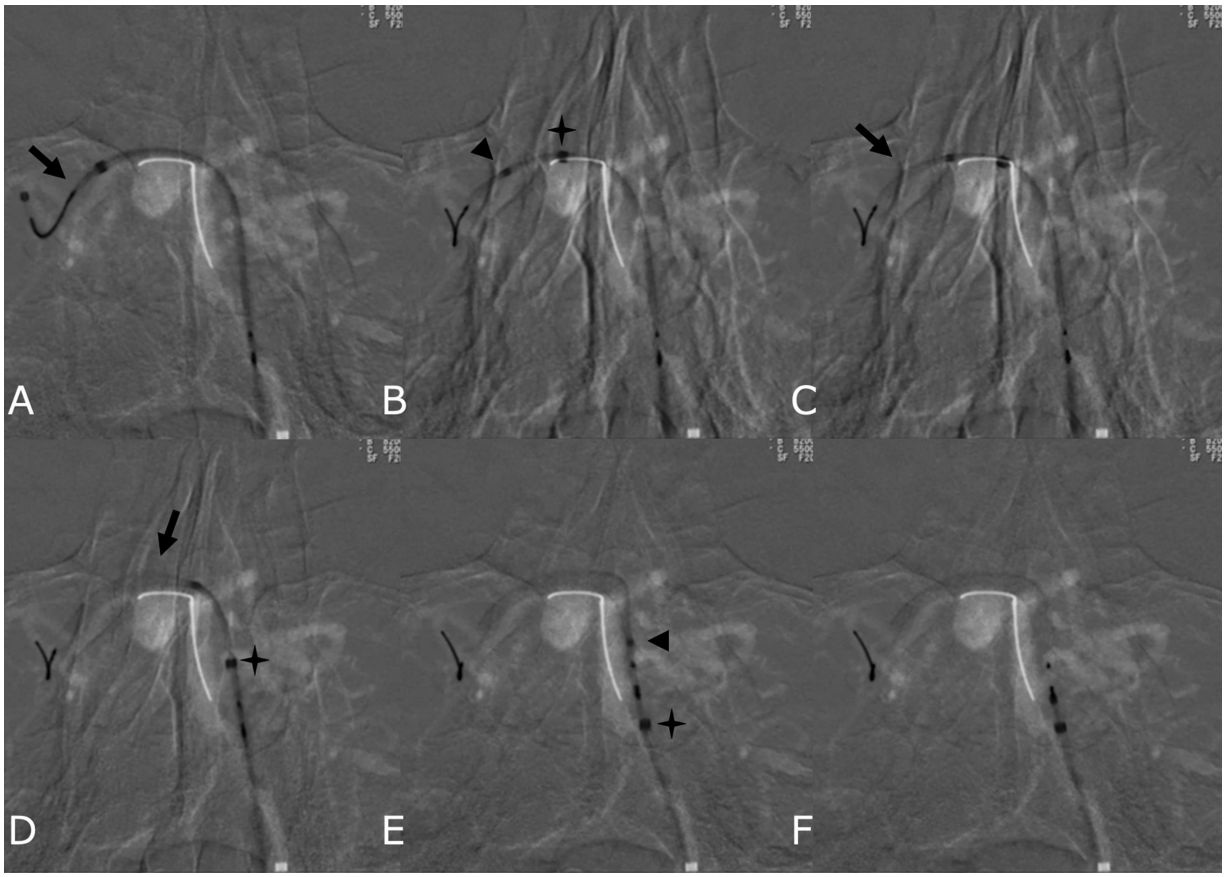

Fig. 4 X-ray fluoroscopic images during the treatment (continuation of ►**Fig. 3**): (**A**) A Pipeline Embolic Device with Shield technology (PED-S) is positioned correctly inside Phenom 27. (**B**) The Phenom 27 is unsheathed, and the distal part of the PED-S is coming out of the Phenom 27 while the tip of the Phenom Plus is moving proximally. (**C**) The PED-S is gradually opening within the posterior cerebral artery (PCA), distal to the aneurysm. (**D**) The PED-S is successfully opened at the neck of the aneurysm. (**E**) The proximal part of the PED-S is about to be deployed in the basilar artery. (**F**) The PED-S has been fully deployed at the appropriate position. Arrowhead: tip of the Phenom 27. Arrow: tip of the Pipeline Embolic Device with Shield technology. Cross: tip of the Phenom Plus.

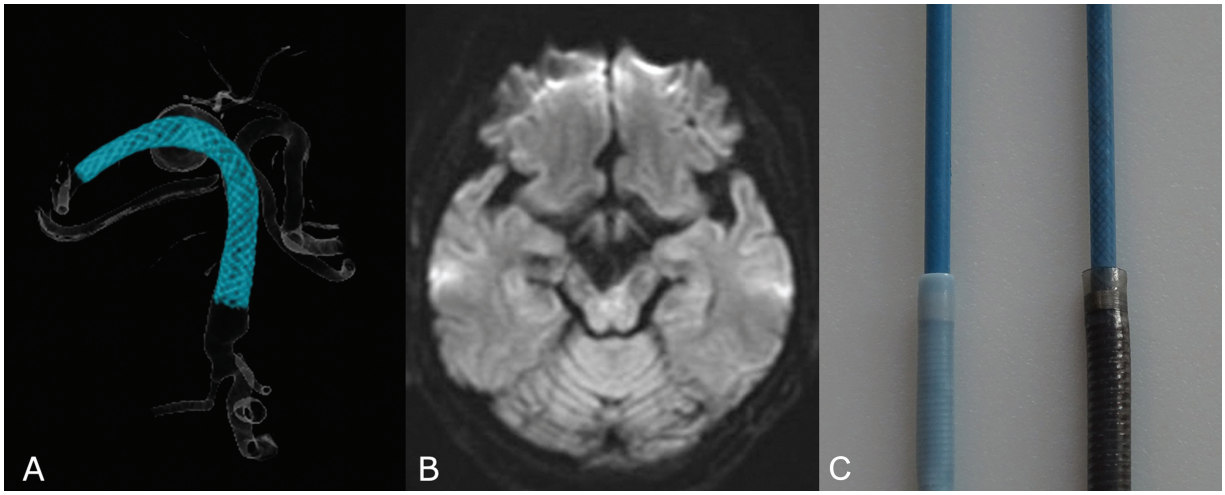

Fig. 5 High-resolution cone-beam computed tomography (CT) image showing the location of the Pipeline Embolic Device with Shield technology. (**B**) A fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) image on day 1 showing no ischemic lesions. (**C**) On the left, the Phenom 27 is inserted into the Phenom Plus, showing almost no ledge. On the right, the Phenom Plus is inserted into a standard 5-French distal access catheter, showing a significant ledge.

potential vascular risks, including vascular dissection caused by the DAC itself, ischemia due to wedging into the parent vessel, and the possibility of pull-out perforating arteries due to vascular stretching. Of course, long-term follow-up, including DSA, is necessary to monitor the future course of this case.

Conclusion

We reported a case involving the placement of a FD for a dissecting aneurysm in the right PCA. In this case, the neck-crossing technique with a low-profile DAC proved to be valuable. This technique can serve as an alternative option for the treatment of peripheral artery aneurysms with FDs, especially when achieving the introduction of the FD or its delivery catheter proves to be challenging.

Note

Written informed consent was obtained for the treatment, including the off-label use of Pipeline Shield and the publication of this case report. This study was performed by the ethics committee guidelines and principles of the Declaration of Helsinki.

Authors' Contributions

A.H. and I.N. helped in patient care and data collection, contributed substantially to the conception or design of the work, the acquisition, analysis, or interpretation of data for the work, drafted the work or revised it critically for important intellectual content, provided final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. K.S., S.M., J.M., T.H., J.T., S.W., T.S., and J.K. helped in patient care and data collection. revised the work critically for important intellectual content, provided final approval of the version to be published, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Conflict of Interest

None declared.

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