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Transradial access for anterior circulation deployment of pipeline embolization device: A case report, literature review, and technical note

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Abstract:

Common femoral artery (CFA) transfemoral access (TFA) has been the traditional route for neuroendovascular intervention with flow diversion including the pipeline embolization device (PED) for the treatment of wide-necked aneurysms. Successful deployment requires significant catheter support, thus making alternative access challenging. A 56-year-old-female presented with subarachnoid hemorrhage secondary to a large ruptured posterior communicating artery (PCOM) aneurysm as well as found to have an unruptured left superior cerebellar artery (SCA) aneurysm. Endovascular embolization of PCOM aneurysm via TFA was complicated by a right CFA pseudoaneurysm. The SCA aneurysm was treated 8 weeks later via left TFA with consequent development of a left CFA pseudoaneurysm. Contrasted magnetic resonance angiography revealed recurrence at the neck of the PCOM aneurysm at 4-month follow-up, treated via transradial access (TRA) PED flow diversion to avoid additional groin complications. Anatomic, procedural, and clinical considerations for TRA anterior circulation flow diversion using the PED are reviewed.

Keywords:

Anterior circulation, common femoral artery, device, neuroendovascular, pipeline embolization, transradial

Introduction

Transfemoral access (TFA) is historically standard interventional neuroangiography.[1] The pipeline embolization device (PED) (Medtronic PLC, Fridley, MN) is a braided flow diverting (FD) stent approved by the Federal Drug Administration for the treatment of large or giant wide-neck internal carotid artery (ICA) intracranial aneurysms (IA).[1,2] PED placement can be challenging in patients with complicated vascular anatomy.[3] We present a female with multiple anterior and posterior circulation IA who underwent right transradial access (TRA) for PED FD. We discuss the clinical and procedural considerations for TRA in FD and discuss relevant literature.

Case Report

A 56-year-old female presented to our center with a Hunt Hess grade (HH) 2 and Fisher grade (F) 3 aneurysmal subarachnoid hemorrhage. Uncomplicated right TFA was performed with a Micropuncture kit (Cook Medical, Bloomington, IN) and passage of a 6F Flexor Shuttle Guiding Sheath (Cook Medical, Bloomington, IN). Digital subtraction angiography (DSA) revealed a large ruptured partially thrombosed IA originating from a right fetal

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posterior communicating artery (PCOM) [Figure 1a] and an incidental unruptured left superior cerebellar artery (SCA) IA. Uncomplicated embolization of the PCOM IA was achieved using balloon-assisted coil embolization [Figure 1b] and the SCA aneurysm was left untreated. Postprocedural common femoral artery (CFA) injection demonstrated a small-caliber vessel with no evidence of injury [Figure 1c]. On postbleed day-8, the patient developed a pseudoaneurysm of the right CFA that was successfully treated with ultrasound guided thrombin injection. The remainder of the hospitalization was uneventful and the patient was discharged neurologically intact on postbleed day-19.

The patient was started on aspirin and clopidogrel dual antiplatelet therapy (DAPT) in anticipation of elective stent-assisted coil embolization (SAC) of the SCA IA [Figure 2a], which was achieved without complication via left TFA 8 weeks post initial presentation [Figure 2b].

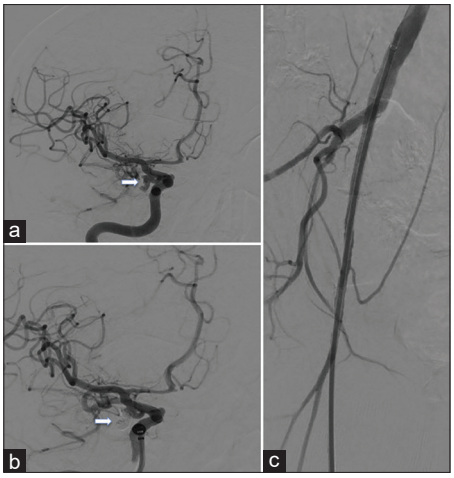

Figure 1: Right anterior oblique right internal carotid artery injection demonstrating large partially thrombosed ruptured posterior communicating artery aneurysm (Arrow) before (a) and after (b) successful balloon assisted coil embolization. Right common femoral artery injection (c) showing small caliber patent vessels without evidence of injury

Concurrent DSA confirmed persistent obliteration of the previously treated PCOM IA. Postprocedural left CFA injection demonstrated small-caliber vasculature without evidence of injury [Figure 2c], and arterotomy closure was completed via an extraluminal closure device. Immediately postoperatively, the patient developed clinical signs suspicious of hemorrhagic shock. Computed tomography angiography (CTA) of the abdomen and pelvis demonstrated a large retroperitoneal hematoma and extravasation from the left femoral system and emergent peripheral DSA identified a left CFA pseudoaneurysm [Figure 3] requiring open patch angioplasty. The patient made a complete recovery and was discharged home.

Four-month contrasted magnetic resonance angiography demonstrated occlusion of the left SCA IA and a small recurrence at the neck of the right PCOM IA. Eight months posthemorrhage, the patient underwent elective PED FD of the recurrence via right TRA [Figure 4]. The approach was selected in consideration of the clinical history of bilateral access-site CFA pseudoaneurysms and continued administration of DAPT. The patient made a complete recovery and is living independently with 6-month DSA pending.

Transradial pipeline embolization device technique

The patient was placed under general anesthesia and positioned supine with the right wrist placed on an arm board. Using a 5F Micropuncture set (Cook Medical, Bloomington, IN), TRA was gained and a 10cm 6F slim sheath (Terumo, Tokyo, Japan) was placed over a glidewire (Terumo, Tokyo, Japan) guidewire connected to continuous heparinized saline. A 5F-100 Simmons-2 diagnostic catheter (Cordis, Fremont, CA) was advanced over a guidewire and formed within the aortic arch to select the right common carotid artery (CCA) and exchanged for a 6Fr Benchmark guide

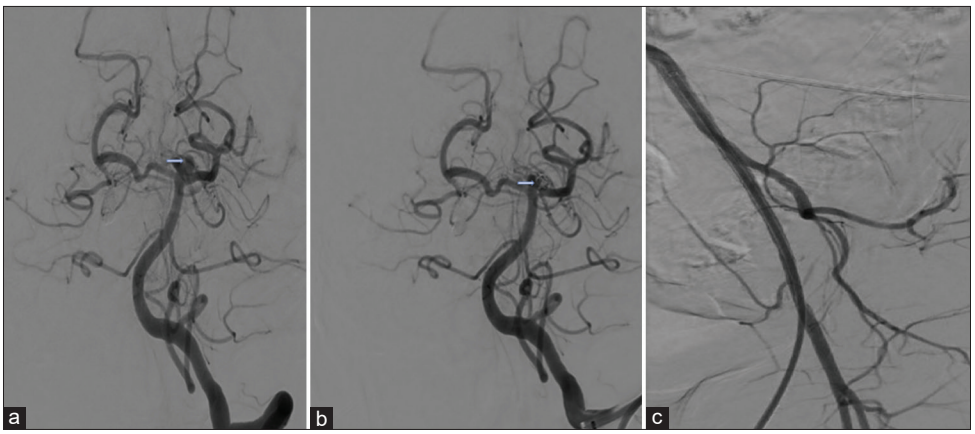

Figure 2: Anteroposterior left vertebral artery injection demonstrating unruptured left superior cerebellar artery origin aneurysm (Arrow) before (a) and after (b) successful stent assisted coil embolization. Left common femoral artery injection (c) showing small caliber vessels without evidence of injury

catheter (Penumbra Inc, Alameda, CA). The right ICA injection confirmed a broad-based recurrence at the neck of the previously treated right PCOM IA [Figure 4a].

Importantly, two sharp turns in the distal cervical segment of the right ICA were encountered [Figure 5]. To traverse this anatomy, the more navigable 4Fr Phenom Plus distal access catheter (Medtronic, Minneapolis, MN) was utilized in place of the standard 0.058 Navien support catheter (Medtronic, Minneapolis, MN) to select the petrous ICA. Superselective catheterization of the right middle cerebral artery (MCA) was performed with a Synchro II microwire and a Phenom microcatheter (Medtronic, Minneapolis, MN) was advanced into the distal MCA M1 segment. A 5 mm × 12 mm PED was partially unsheathed within the M1 and then pulled into the ICA and deployed across the aneurysm neck [Figure 4]. A control run was performed that demonstrated a widely patent stent, apposition of the stent against the vessel walls, and complete coverage of the aneurysm neck [Figure 4].

Follow-up DSA confirmed continued obliteration of the left SCA IA [Figure 4]. The right vertebral artery (VA) was congenitally hypoplastic and terminated in the right posterior inferior cerebellar artery and therefore was not adequate for visualization of the lesion. Additional runs revealed an incidental extracranial dissection and pseudoaneurysm of the ICA at the junction of the cervical and petrous segments [Figure 6], believed to be of spontaneous etiology given a lack of previous catheterizations of the vessel.

The sheath was removed with a Prelude SYNC radial compression device (Merit, South Jordan, Utah)

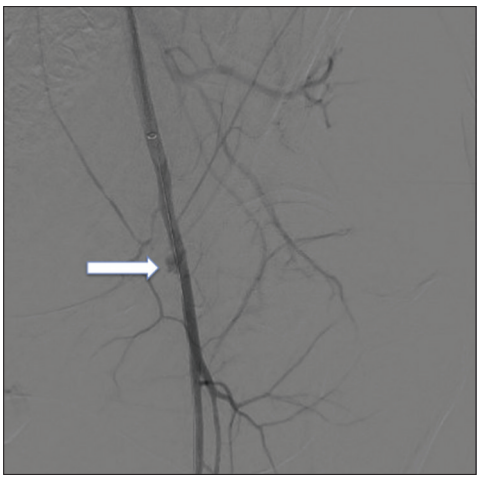

Figure 3: Anteroposterior left common femoral artery injection showing pseudoaneurysm (arrow) at the time of open repair by vascular surgery

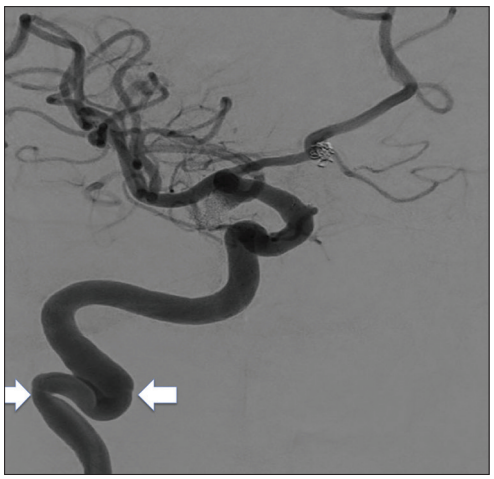

Figure 5: Anteroposterior right internal carotid artery injection showing an acute 180° turn in the distal cervical segment (arrows)

Figure 4: Right anterior oblique right internal carotid artery injection demonstrating recurrent posterior communicating artery aneurysm (Arrow) and (b) left vertebral artery injection showing persistent obliteration of superior cerebellar artery aneurysm. (c) RAO non-subtracted fluoroscopy showing pipeline stent placement and (d) internal carotid artery injection showing patent stent and vasculature following deployment

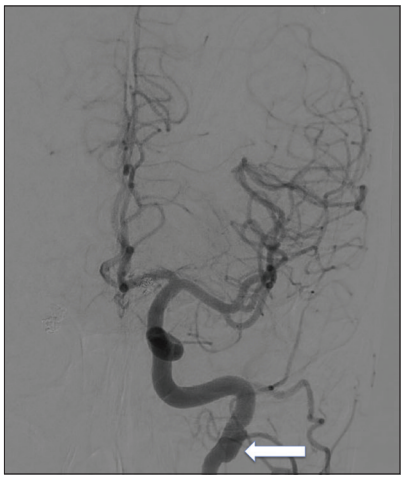

Figure 6: Anteroposterior left internal carotid artery injection showing an asymptomatic likely spontaneous dissection and pseudoaneurysm at the cervical-petrous junction (arrow)

applied for arteriotomy closure without postoperative complication. All aneurysms remained completely occluded on 6-month follow-up angiography.

Discussion

We performed a comprehensive search of PUBMED for all published cases of PED placement via a TRA [Table 1].[3-7] Two patients had IAs in the anterior circulation (ICA)[3,4] and six patients within in the posterior circulation (vertebrobasilar, VA, and SCA).[5-7] TFA was unfavorable for three patients due to a type III aortic arch configuration and tortuous brachiocephalic anatomy.[3,4,6] None of the patients experienced perioperative or postoperative complications.

The TFA has been the favored arterial access due to the large caliber, accessibility, and compressibility of the CFA.[1,2] The approach allows access of the major cerebral vessels with simple curved catheters from the aortic arch,[1,2] however, is potentially limited by iliofemoral and/or aortic atherosclerosis, tortuosity, and angulation.[8-17] TFA-associated complications include pseudoaneurysm formation, infrainguinal hematoma, and potentially fatal retroperitoneal hematoma.[8-17] Pseudoaneurysm formation is typically secondary to iatrogenic injury to the vessel wall, which may occur more frequently in patients with vasculopathy.[18] Commonly used strategies to avoid femoral artery pseudoaneurysm include locating the neck of the femur to avoid profunda femoris puncture, the Seldinger puncturing technique, and adequate compression after sheath removal, such measures mitigate but do not obviate risk.[18]

In our case, the patient underwent two procedures via TFA, one through each CFA with uncomplicated access. Femoral angiography revealed small-caliber vessels without abnormality. Despite this, both procedures were complicated by CFA pseudoaneurym. Our suspicion is that the patient likely suffers from an as of yet undetermined vasculopathy due to young age, incidence of multiple complex IA, presence of a spontaneous left ICA cervicopetrous dissection, marked ICA tortuosity, and bilateral CFA pseudoaneurysm formation. As such, TRA was selected for FD to avoid future complications.

The radial artery has long been utilized during interventional cardiology due to the superficial and distal location and compressibility of the vessel.[3] Recently, TRA has also gained considerable favor among neurointerventionalists for both diagnostic and interventional angiography. As an extension of the subclavian artery, the radial artery often provides excellent access to the ipsilateral VA, thereby facilitating posterior circulation intervention.[5,7-10] Access to the anterior vasculature is more challenging and often requires catheters with a secondary curve.[4-6] In the case described, we were able to successfully select all cerebral vessels through the right TRA. The Simmons-2 catheter was easily formed in the aortic arch and engaged the right and left CCA and VA without complication.

The use of PED FD provides the benefits of obviating the need for IA selection, favorable long-term obliteration rates, low recurrence rates, and lower procedural costs.[13,14] The device requires significant support for deployment and is, therefore, most commonly delivered through a triaxial system consisting of a shuttle sheath, an intermediate catheter, and a microsystem.[15-17] This catheter configuration is historically introduced using TFA due to the large caliber of the iliofemoral vasculature.[2,3,5,15-17] The ultimate success of the intervention was predicated, in part, by careful preoperative planning. First, as mentioned, the anterior circulation requires a secondary curved catheter for selection via the TRA. This maneuver also required an exchange following CCA selection due to the limited length of the Simmons-2 catheter used (100 cm). To avoid this, future interventions will be performed using a 120 cm Simmons-2 that will extend beyond the guide catheter tip, thereby eliminating the need for an exchange. Second, the 6Fr shuttle sheath commonly used for PED deployment is large and difficult to navigate through a radial approach. As a diameter greater than 2.5 mm allows for the use of long sheath catheters commonly used via TFA, measuring of the baseline diameter of the radial artery by ultrasound is also recommended prior to attempted TRA.[19] In addition, ultrasound allows for determination of the existence and patency of the ulnar artery, obviating the need for physical exam maneuvers to assess collateral blood flow such as the Allen and Barbeau test.[19]

The Benchmark catheter proved to be an ideal alternative in that it was compatible with the 6F slim radial access sheath, provided ample support for PED deployment, and was easily navigated into the proximal right ICA following selection. Third, the tortuosity of the distal right ICA precluded the use of the standard 058-Navien intermediate catheter. Although it does sacrifice some support, the Phenom Plus distal access catheter effectively navigated this tortuosity and allowed for safe deployment of the PED.

Our case supports the feasibility of anterior circulation PED deployment through a triaxial system via TRA. Careful planning and selection of the appropriate catheters is paramount in achieving successful deployment. As with TFA, radial artery access is not without potential complications, including arterial dissection or traumatic arteriotomy, pseudoaneurysm formation, compartment syndrome, and occlusive and/or embolic limb ischemia.[4-6]

Table 1: Published cases of pipeline embolization device placement for cerebral aneurysm treatment via a transradial approach

Years	Author	Age/gender	Location (circulation) and size, mm	Circulation approached through	Rationale for TRA	Mode of TRA	PED characteristics	6 month Follow-up
2013	Dietrich *et al.*[4]	76 female	Right ICA (anterior), 20	Anterior	Type III aortic arch	3.9 Fr 125 cm distal-access catheter exchanged for Marksman	Two (4.5 mm×20 mm, EV 3), sequential	Near-complete occlusion, residual at neck
2016	Daou *et al.*[5]	81 female	VB (posterior), 15	N/A	N/A	N/A	N/A	90% occlusion
2017	Peitz *et al.*[3]	84 female	Right ICA (anterior), 40	Anterior	Type III aortic arch	Penumbra neuron MAX 6Fr 088 sheath navigated over penumbra 5Fr select SIM-1 catheter	Two (5 mm×30 mm, medtronic), telescoping	N/A
2017	Zhang *et al.*[6]	62 female	Right VA (posterior), 12.3	Posterior	Brachiocephalic artery tortuosity	6Fr sheath exchanged for 6Fr MPD guide	Single, 3.25 mm×30 mm, covidien	N/A
2019	Raz *et al.*[7]	N/A	Left VA (posterior), 9.2	Posterior	Experimental	Phenom plus 0445 navigated over shapeable 035 Terumo Glidewire	Single, medtronic	Complete occlusion
		N/A	Right VA (posterior), 13.7	Posterior	Experimental	Phenom plus 0445 navigated over shapeable 035 Terumo Glidewire	Two, medtronic, telescoping	Complete occlusion
		72 female	Right VA (posterior), 13	Posterior	Experimental	5Fr navien navigated over 038 Terumo Glidewire	Two, medtronic, sequential	Complete occlusion
		N/A	Left SCA (posterior), 12	Posterior	Experimental	4Fr exchanged for 5Fr 115 cm Navien	Single, medtronic	Complete occlusion at 6 months
2019	Our case	56 female	Right PCOM (anterior), 12	Anterior	Bilateral femoral artery pseudoaneurysms	100 cm 5Fr simmons-2 exchanged for 6Fr Benchmark Guide	Single, 5 mm×12 mm	Follow up angiogram pending

VB: Vertebrobasilar artery, VA: Vertebral artery, ICA: Internal carotid artery, SCA: Superior cerebellar artery, PCOM: Posterior communicating artery, N/A: Not available, TRA: Transradial approach, PED: Pipeline embolization device

Additional cases and acquired experience are necessary to improve the efficiency of the procedure and to demonstrate its widespread applicability.

Conclusion

TRA has recently gained favor for cerebral diagnostic and interventional angiography. TRA for anterior circulation FD via PED deployment presents a unique set of challenges. We present successful treatment of a recurrent right PCOM IA with a PED placed via the right transradial approach in a patient that had suffered multiple previous bilateral CFA access complications. The TRA appears to be a viable alternative for PED placement in the anterior circulation but requires careful planning and appropriate catheter selection.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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