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Utility of Pipeline embolization device for emergency recanalization of a dissecting carotid tonsillar loop: illustrative cases

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BACKGROUND Cervical arterial tortuosity is not uncommon in patients with spontaneous carotid artery dissections (CADs), but the tortuosity often precludes endovascular stent reconstruction. The authors report 2 cases of emergency recanalization of a carotid tonsillar loop dissection using a Pipeline embolization device (PED).

OBSERVATIONS Two patients presented with symptomatic CAD involving tonsillar looping of the cervical internal carotid artery (ICA). Although the tonsillar loop prevented navigation of the carotid and peripheral stent delivery system, a PED was easily navigated and successfully deployed, resulting in successful recanalization of a looped ICA.

LESSONS Emergency recanalization of a cervical CAD using a PED is a feasible alternative for treating a cervical CAD associated with tonsillar loops.

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KEYWORDS tonsillar loop; cervical carotid artery; dissection; stent reconstruction; Pipeline embolization device

Cervical carotid artery dissection (CAD) is an important cause of acute ischemic stroke and can lead to significant stroke.[1] Arterial tortuosity is known to be a surrogate marker for a subclinical connective tissue disorder, and severe tortuosity of the cervical carotid artery is often encountered in the patients with cervical CAD.[2,3]

Although endovascular treatment of cervical CAD is usually performed with carotid stents or peripheral stents,[4] navigation of those stent delivery systems into tortuous arteries is challenging because of the inflexibility of these large-profile stents. The Pipeline embolization device (PED) (eV3/Covidien) is a flow-diverter stent with a high radial force and high pore density, and it can be mounted in and deployed through a flexible delivery system.[5] These features may be useful for the endovascular reconstruction of stenocclusive lesions located in a highly tortuous carotid artery. We report two cases of emergency recanalization using a PED for a dissecting cervical internal carotid artery (ICA) associated with a tonsillar loop.

Illustrative Cases

Case 1

A 55-year-old man with a history of hypertension presented with acute-onset dysarthria, right hemiparesis, and an initial National Institutes of Health Stroke Scale (NIHSS) score of 10. He was transferred to our hospital about 5 hours after the onset of symptoms. Upon transfer to our hospital, he had declined to an NIHSS score of 17 with total aphasia. Computed tomography (CT) angiography showed left ICA occlusion. Because he was symptomatic, urgent angiography was performed. The left common carotid artery (CCA) injection demonstrated tapered occlusion of the cervical ICA (Fig. 1A). A 6-Fr long sheath was advanced into the left CCA, and a triaxial system, including a microwire, microcatheter, and intermediate catheter, was navigated through the stenotic segment. A diagnostic angiogram obtained immediately after this procedure demonstrated improved antegrade flow in the ICA, suggesting arterial dissection in a tortuous segment (Fig. 1B). Intravenous heparin was given to achieve an activating clot time of 250 seconds, and the patient was loaded with 15 mg of integrilin

ABBREVIATIONS CAD = carotid artery dissection; CCA = common carotid artery; CT = computed tomography; ICA = internal carotid artery; NIHSS = National Institutes of Health Stroke Scale; PED = Pipeline embolization device.

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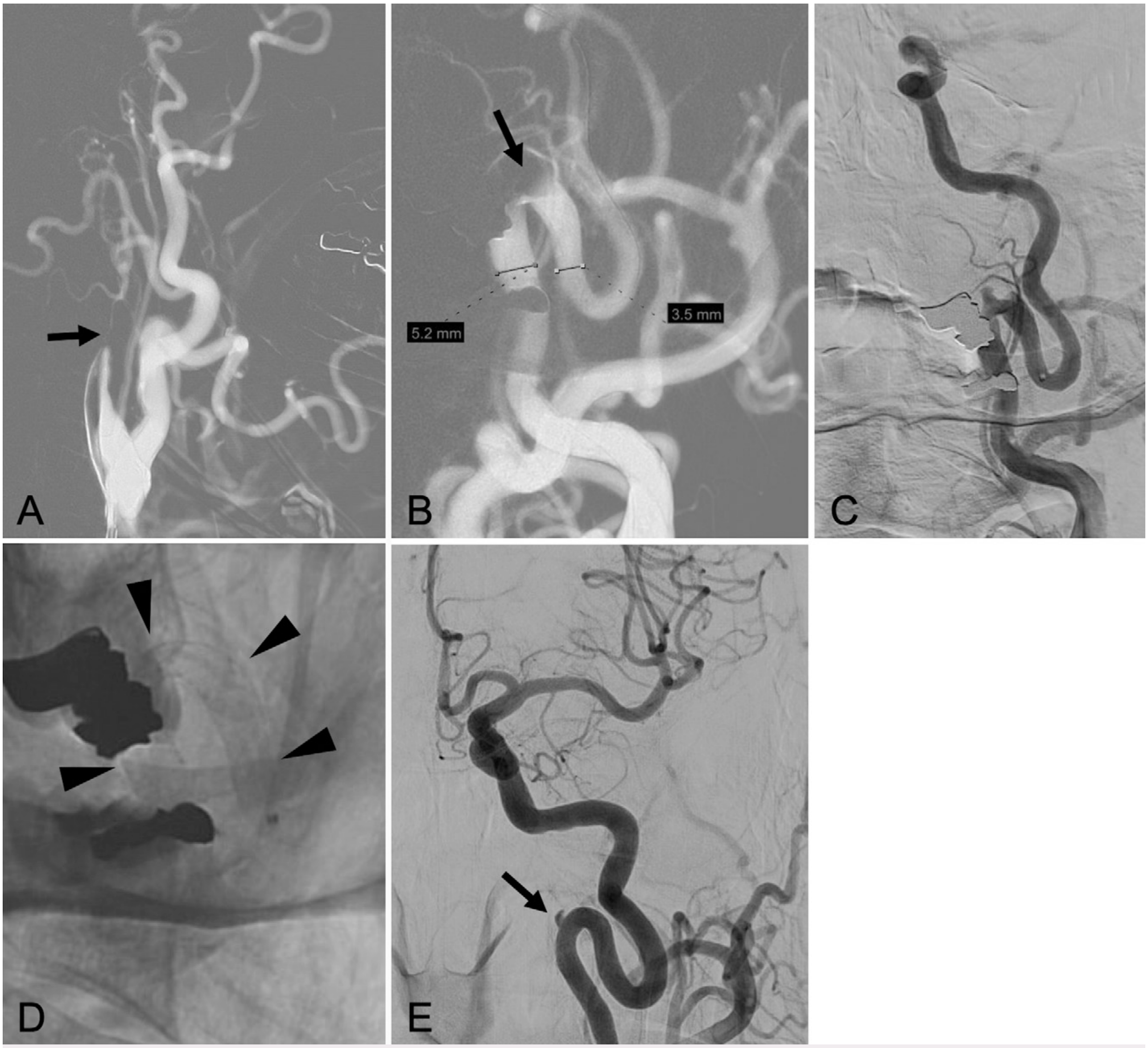

FIG. 1. A: Roadmap image of anteroposterior (AP) cervical view of a left CCA injection showing a defect of contrast filling, suggesting thrombus formation (*arrow*). **B:** AP view of a left CCA injection obtained immediately after distal navigation of a microcatheter, demonstrating improvement of the narrowing of the left ICA and filling in the pseudolumen (*arrow*), suggesting dissection rather than an atherosclerotic lesion. **C:** AP intracranial view of a left CCA injection demonstrating complete recanalization of the left ICA. **D:** An unsubtracted AP image obtained after placement of a PED, demonstrating sufficient dilatation of the stent (*arrowheads*). **E:** AP cervical view of the left CCA obtained 3 months after PED placement, showing good dilatation of a carotid tonsillar loop dissection with slight filling in the pseudolumen (*arrow*).

just before placement of a PED. We were unable to navigate a distal embolic protection device (Spider FX, Covidien) beyond the dissected loop. Several stent delivery systems, including a renal artery stent (Express SD Renal/Biliary Monorail, Boston Scientific) and peripheral artery stent (Zilver 518 Vascular Self-Expanding Stent, Cook Medical) were unable to traverse the loop. Therefore, the decision was made to attempt a PED placement. A PED-compatible microcatheter was advanced into the petrous ICA over a microwire, and a 5×16–mm PED was easily navigated distal to the tortuous artery and successfully deployed to cover the dissected cervical ICA loop, resulting in favorable anterograde flow (Fig. 1C and D). The patient was discharged to a rehabilitation facility on aspirin and ticagrelor with a maintenance dose on postoperative day 4. At the 3-month follow-up, the patient had no neurological deficit and a digital subtraction angiography obtained 3 months later revealed patency of the dissecting segment with minimal filling of the pseudolumen (Fig. 1E).

Case 2

A 54-year-old man presented with 2 hours of acute right-sided weakness with an NIHSS score of 8. He denied any history of trauma or cervical pain. CT angiogram demonstrated a right ICA occlusion. After receiving intravenous tissue plasminogen activator, the patient was transferred to our hospital for further workup. An angiogram and a right CCA injection revealed occlusion of the proximal ICA (Fig. 2A). A 6-Fr long sheath was advanced into the proximal ICA after systemic heparinization. Next, a microcatheter was advanced over a wire through the guide catheter into the distal intracranial ICA through the tonsillar loop of the cervical ICA, and angiography through the microcatheter demonstrated filling of the distal internal ICA and middle cerebral artery (Fig. 2B). To open the proximal ICA, a 6 × 30–mm

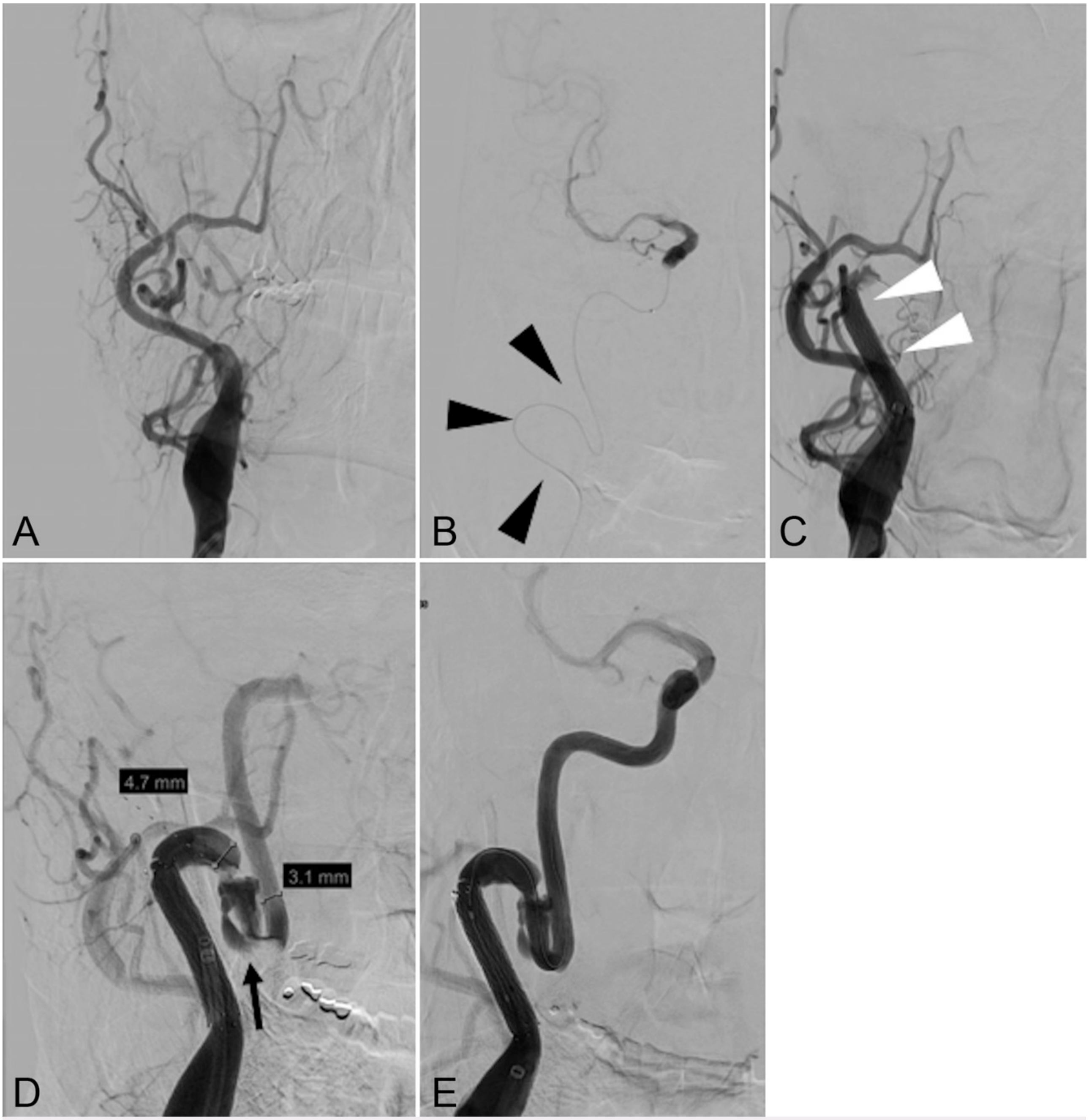

FIG. 2. A: AP view of a right CCA injection demonstrating cervical ICA occlusion. **B:** AP intracranial view of a right ICA injection from the microcatheter, demonstrating opacification of right middle cerebral artery. Note that the path of the microcatheter is highly tortuous and forms a tonsillar loop (*arrowheads*). **C:** AP cervical view of a right CCA injection obtained immediately after placement of a carotid stent, still showing ICA occlusion but improvement of filling in the stent (*arrowheads*). **D:** AP view of a right CCA injection obtained immediately after thrombectomy at the distal ICA, demonstrating flow restriction distal to the stenoocclusive segment with a pseudolumen at the tonsillar looped ICA (*arrow*). **E:** AP view of a right ICA injection obtained immediately after placement of a PED, demonstrating distal filling without flow restriction.

carotid stent (Protégé, Medtronic) was advanced over the exchange-length wire and deployed, resulting in opacification of the ICA proximally without distal filling (Fig. 2C). Thereafter, using the triaxial technique, an aspiration catheter (JET 7, Penumbra) was advanced over a microcatheter and exchange-length microwire through the occluded segment. While maintaining microwire access, the aspiration catheter was connected to suction and withdrawn. Diagnostic angiogram demonstrated partial recanalization and restricted flow distal to the dissecting segment in the descending portion of the hairpin loop (Fig. 2D). Considering the difficulty of deploying a carotid or peripheral stent through the looped segment, we decided to place a PED to open the vessel. The former triaxial system was again advanced to the distal ICA, and a 5 × 20–mm PED was successfully deployed to cover the dissecting lesion. Final angiography was performed, which demonstrated patency of the dissected segment with a small aneurysm (Fig. 2E). The patient was discharged home on aspirin and clopidogrel, with a maintenance dose on postoperative day 6, with a modified Rankin Scale score of 1.

Discussion

Observations

We present two cases of emergency recanalization of a carotid tonsillar loop dissection using a PED.

Although exact indications remain debatable, emergency endovascular stent reconstruction of the cervical CAD with a symptomatic patient should be performed to prevent progression to an ischemic infarct. Although most of the cervical CADs can be treated using a standard carotid stent system, this strategy would be challenging in lesions with a tortuous artery because a stiff and inflexible stent delivery system may not be able to traverse the tortuous segment.

However, as independent studies have demonstrated, redundancy itself is associated with spontaneous cervical carotid dissection and is considered to be a surrogate marker for a subclinical connective tissue disorder.[2,3] Therefore, stent recanalization techniques have clinical implications because the dissection often occurs in a loop or tortuous segment. In the cases described here, we experienced difficulties in advancing the stent delivery systems through the looped segments due to their inflexibility, although the microwire or microcatheter was easily navigated.

In the past, carotid loop dissections were successfully treated using a low-profile intracranial stent, such as Enterprise (Codman Neurovascular) and Neuroform (Target/BSC/Smart Therapeutics), because the stent delivery system and the stent itself are flexible.[6,7] However, because their low pore density and radial force may cause thrombus migration from the pseudolumen into the stents and insufficient opening of the stenoocclusive segment, these devices may not be appropriate for carotid dissection. In contrast, Zussman et al.[8] demonstrated the efficiency of telescoping-stent reconstruction of the carotid tonsillar loop dissection using Zilver self-expanding peripheral stents. However, in one of the present cases (case 1), this stent delivery system could not progress through the looped segment, whereas the PED delivery system was easily navigated through the lesion. Therefore, because of their flexible design that facilitates greater accessibility, protection of thrombus prolapse, and higher radial force, PEDs were felt to enable the device to conform better to the vessel curve than other stents, especially in the looped and thrombosed lesion.

We also should note that PEDs are designed to open about 0.25 mm beyond their nominal diameter, and the largest diameter would be around 5.25 mm. In the present cases, we could deploy PEDs at the lesion segment because the diameter of the carotid artery was smaller than the maximal nominal diameter of the PED. When the lumen diameter is greater than 5.25 mm, a SURPASS flow diverter (Stryker Neurovascular) may be better to prevent stent migration or shortening.[6,9–11]

Lessons

Our case demonstrates the utility of PEDs for emergency recanalization of cervical CAD associated with significant tortuosity.

References

1. Leys D, Bandu L, Hénon H, et al. Clinical outcome in 287 consecutive young adults (15 to 45 years) with ischemic stroke. *Neurology*. 2002;59(1):26–33.
2. Kim BJ, Yang E, Kim NY, et al. Vascular tortuosity may be associated with cervical artery dissection. *Stroke*. 2016;47(10): 2548–2552.
3. Giossi A, Mardighian D, Caria F, et al. Arterial tortuosity in patients with spontaneous cervical artery dissection. *Neuroradiology*. 2017; 59(6):571–575.
4. Ohta H, Natarajan SK, Hauck EF, et al. Endovascular stent therapy for extracranial and intracranial carotid artery dissection: single-center experience. *J Neurosurg*. 2011;115(1):91–100.
5. Lubicz B, Collignon L, Raphaeli G, et al. Flow-diverter stent for the endovascular treatment of intracranial aneurysms: a prospective study in 29 patients with 34 aneurysms. *Stroke*. 2010;41(10):2247–2253.
6. Rahal JP, Gao B, Safain MG, et al. Stent recanalization of carotid tonsillar loop dissection using the Enterprise vascular reconstruction device. *J Clin Neurosci*. 2014;21(7):1141–1147.
7. Pride GL Jr, Replogle RE, Rappard G, et al. Stent-coil treatment of a distal internal carotid artery dissecting pseudoaneurysm on a redundant loop by use of a flexible, dedicated nitinol intracranial stent. *AJNR Am J Neuroradiol*. 2004;25(2):333–337.
8. Zussman BM, Gross BA, Ares WJ, et al. Stent reconstruction of carotid tonsillar loop dissection using telescoping peripheral stents. *Intervent Neurol*. 2018;7(3-4):189–195.
9. Cohen JE, Gomori JM, Rajz G, et al. Urgent off-label use of the pipeline flow diverter stent in selected ischemic cerebrovascular conditions: thrombotic segments and tortuous arteries. *J Neurointerv Surg*. 2015;7(9):671–675.
10. Brzezicki G, Rivet DJ, Reavey-Cantwell J. Pipeline embolization device for treatment of high cervical and skull base carotid artery dissections: clinical case series. *J Neurointerv Surg*. 2016;8(7): 722–728.
11. Amuluru K, Al-Mufti F, Roth W, et al. Anchoring pipeline flow diverter construct in the treatment of traumatic distal cervical carotid artery injury. *Intervent Neurol*. 2017;6(3-4):153–162.

Disclosures

Dr. Ajith Thomas serves on the Data Safety and Monitoring Board of the SCENT flow diverter trial with funds paid to the institution.

Author Contributions

Conception and design: Thomas, Akamatsu, Moore, Ogilvy. Acquisition of data: Akamatsu, Moore, Ogilvy. Analysis and interpretation of data: Thomas, Ogilvy. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: Thomas, Akamatsu, Gomez-Paz, Ogilvy. Approved the final version of the manuscript on behalf of all authors: Thomas. Administrative/technical/ material support: Moore. Study supervision: Ogilvy.

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