CASE REPORT

Treatment of post-traumatic carotid–cavernous fistulas using pipeline embolization device assistance

Nisha Pradeep,¹ Robert Nottingham,¹ Anthony Kam,¹ Dheeraj Gandhi,² Nasser Razack¹

¹Neurointerventional Associates, PA, St Petersburg, Florida, USA

²University of Maryland, Baltimore, Maryland, USA

Correspondence to

N Razack, Neurointerventional Associates, PA, 335 31st St. South, St. Petersburg, FL 33712, USA; Spflmd67@gmail.com

Accepted 31 July 2015

SUMMARY

This report describes two cases of post-traumatic, high flow carotid–cavernous fistulas that demonstrated residual shunting after initial embolization with coils and Onyx, and that were successfully closed with pipeline embolization devices. Following their combined endovascular treatments, the patients experienced clinical improvement of symptoms with durable obliteration of the fistulous communications.

BACKGROUND

Carotid–cavernous fistulas (CCFs) consist of an abnormal communication between the internal carotid artery (ICA) and the cavernous sinus, arising spontaneously or more commonly secondary to trauma. Recent literature has described various methods of endovascular treatment for CCFs.^{1–3} However, complex lesions remain problematic and may require parent vessel sacrifice.⁴ This paper describes the adjunctive use of pipeline embolization devices (PEDs) for closing complex CCFs while preserving the parent ICA.

CASE PRESENTATION

Case No 1

The first patient was a 28-year-old man who had been involved in a physical altercation and fall, resulting in multiple facial fractures of the zygomatic arch, antrum of the maxillary bone, medial orbital wall, cribriform plate, sphenoid bone, and frontal sinus. After surgical correction of the facial fractures and extensive rehabilitation, the patient still experienced visual difficulties and cranial nerve deficits from his initial presentation. On physical examination, the patient had a left abducens nerve palsy, partial ptosis with a left lateral field cut, pulsatile tinnitus, and mild exophthalmos of the left eye. A cerebral angiogram demonstrated a high flow, direct CCF of the left ICA with anterior and posterior venous drainage (figure 1A, B).

Case No 2

A 23-year-old man presented to the emergency room with gunshot wounds. A bullet entered his left sphenoid plate via his external auditory canal towards the base of his skull. Damage from the wound resulted in a left facial nerve palsy. Initial CT showed metallic fragments adjacent to his left pterygoid plates. There were also fragments adjacent to the horizontal petrous carotid canal with

possible carotid injury. The initial CT angiogram did not display vascular disruption.

Four days later, the patient presented with advancing exophthalmos, significant swelling to the face and orbital area, as well as the continued facial droop on the left side. He also displayed deficits of cranial nerves III, IV, and VI over the next week. A cerebral angiogram confirmed the clinical suspicion of a high flow, direct left CCF.

TREATMENT

Case No 1

The patient was pretreated with aspirin and clopidogrel. Platelet P2Y12 function testing was performed to verify adequate platelet inhibition. Using a single wall micropuncture technique, arterial access was obtained into the right femoral artery. Venous access was obtained from a right common femoral approach. Using the right internal jugular vein, access was gained into the inferior petrosal sinus and then to the left cavernous sinus. Two PEDs were deployed in the left ICA across the fistulous communication from a transarterial approach. A control angiogram showed marked fistulous connection remained across the left cavernous carotid artery and subsequent venous sinuses. For this reason, three coils were deployed within the left cavernous sinus from a transvenous approach. The Hyperglide balloon (Covidien) was then navigated across the parent artery defect. From a transvenous approach under fluoroscopy, Onyx HD-500 (Covidien) was injected into the sinus with slight protrusion of Onyx into the inferior petrosal sinus and superior ophthalmic vein. The balloon was inflated and deflated during this injection to protect the lumen of the ICA.

Case No 2

Similar to the first case, arterial and venous access were obtained from right common femoral arterial and venous approaches. A PED was deployed across the petrous–cavernous carotid junction from a transarterial approach. Onyx was injected into the left cavernous sinus from a transvenous approach. A post-procedure angiogram showed near complete resolution of the CCF, with a few minor fistulous connections in the petrous segment of the ICA. Two months following the initial procedure, a follow-up cerebral angiogram identified a distinct arteriovenous fistula from the left petrous carotid artery. The microcatheter could not be

CrossMark

To cite: Pradeep N, Nottingham R, Kam A, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2015-011786

Figure 1 (A) Lateral and (B) oblique views of the left internal carotid artery show a direct carotid–cavernous fistula. (C) Lateral post-procedure angiogram shows successful endovascular repair with the assistance of pipeline embolization devices. (D) Three month follow-up angiogram shows resolution of the left, direct carotid–cavernous fistula.

navigated through the arterial defect into the recipient vein, and a retrograde transvenous approach was not possible. An attempt to bridge the arterial defect using a Viabahn stent (Gore, Flagstaff, Arizona, USA) was unsuccessful; therefore, the Gore covered stent was replaced with a PED, which was placed across the petrous fistula. An immediate angiogram showed a reduced but persistent fistulous connection.

OUTCOME AND FOLLOW-UP

Case No 1

Three months later, a follow-up cerebral angiogram showed that a minor remnant of the CCF persisted below the region of the frontal sinus with an arterial supply from the distal branch of the ophthalmic artery ([figure 1C](#)). However, the previously identified CCF was completely obliterated ([figure 1D](#)). Although the patient's abducens nerve palsy persisted, his

exophthalmos and left lateral field deficit significantly improved at his 3 month follow-up visit.

Case No 2

Four months later, a cerebral angiogram showed persistent fistulous communication across the petrous cavernous junction—a third PED was deployed into the left M1 segment in order to treat this abnormal communication. Seven months later, a repeat angiogram showed a completely remodeled ICA and occlusion of the CCF ([figure 2C](#)).

DISCUSSION

Given its unique braided design and low porosity, a PED may have unique application in reconstructing a damaged or torn carotid artery. Similar to its role in the treatment of large ICA aneurysms, the PED helps to divert blood flow away from the

Figure 2 (A) Initial lateral projection of the left internal carotid artery indicates a large, direct carotid–cavernous fistula. (B) Lateral view following pipeline embolization devices deployment across the left petrous cavernous junction demonstrates markedly reduced but persistent arteriovenous shunting. (C) Lateral view of the 7 month follow-up angiogram shows resolution of the fistulous communication.

fistulous connection while preserving the parent vessel. Adjunctive coiling of the cavernous sinus is feasible without the risk of coil prolapse into the parent vessel. Although cases have been treated using covered stents, the stiffness of such stents can be prohibitive and increases the likelihood of mechanically induced vasospasm. Other aneurysm bridging devices, such as the Neuroform (Stryker, Fremont, California, USA) and Enterprise (Codman, Raynham, Massachusetts, USA) stents are unlikely to be of similar effectiveness in complex CCFs due to their high porosity.

The successful treatment of a direct CCF with PEDs alone has been reported by Nadarajah *et al.*⁵ Although they described a successful case, the sump effect of these high flow fistulas drove to keep the communication open despite PED placement; therefore, closure required the placement of multiple overlapping devices. Additional limitations of PED use include risks of postoperative hemorrhages and periprocedural ischemic strokes,

the need for long term dual antiplatelet therapy, high procedural costs, and the lack of long term follow-up data. One of the major limitations to the use of PEDs in patients with traumatic CCFs is the requirement for dual antiplatelet therapy. As such, these devices can rarely be placed in the acute setting when additional injuries are present. A staged treatment, such as one that uses coils and Onyx to resolve cortical venous reflux or large pseudoaneurysms, followed by a more complete embolization with a PED, could prove to be efficacious. In light of these challenges, a primary approach that utilizes traditional techniques for CCF occlusion, such as coiling or liquid embolization, later combined with the synergistic effect of PEDs seems more favorable.

As our cases illustrate, PED placement appears to be an effective option given that residual shunting is likely to be slow flow in nature and amenable to closure with flow diversion. It is preferable to a deconstructive strategy, particularly in situations where the distal collateral flow is poor.

Learning points

- ▶ Two patients with post-traumatic, direct carotid–cavernous fistulas (CCFs) were treated successfully with the assistance of pipeline embolization devices (PEDs). Following the procedures, both patients experienced clinical improvement from their initial presentation.
- ▶ Braided stent design and low porosity of PEDs aid in vascular remodeling of a torn internal carotid artery (ICA) and allow for coil embolization of the cavernous sinus without risk of coils prolapsing across the ICA defect into the parent artery.
- ▶ Certain low flow or residual fistulas may thrombose as a result of PED bridging across the ICA defect.
- ▶ Future studies with a larger number of patients will be useful in determining the safety and efficacy of these devices in the setting of direct CCFs.

Contributors NP and RN co-wrote the case report, reviewing the literature, detailing the procedure, and managing patient information. AK and DG were responsible for multiple revisions of the drafts and images used. NR identified, performed, and managed the cases as guarantor.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Chun GFH, Tomsick TA. Transvenous embolization of a direct carotid cavernous fistula through the pterygoid plexus. *AJNR Am J Neuroradiol* 2002;23:1156–9.
- 2 Linfante I, Lin E, Knott E, *et al.* Endovascular repair of direct carotid-cavernous fistula in Ehlers-Danlos type IV. *J Neurointerv Surg* 2015;7:e3.
- 3 Zaidat OO, Lazzaro MA, Niu T, *et al.* Multimodal endovascular therapy of traumatic and spontaneous carotid cavernous fistula using coils, n-BCA, Onyx and stent graft. *J Neurointerv Surg* 2011;3:255–62.
- 4 Miller NR. *Clinical neuro-ophthalmology*. Vol 1, 6th edn. Philadelphia, USA: Lippincott Williams & Wilkins, 2005:2263–96.
- 5 Nadarajah M, Power M, Barry B, *et al.* Treatment of a traumatic carotid-cavernous fistula by the sole use of a flow diverting stent. *J NeuroInterv Surg* 2012;4:e1.

Copyright 2015 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <http://group.bmj.com/group/rights-licensing/permissions>.
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

For information on Institutional Fellowships contact consortiasales@bmjgroup.com

Visit casereports.bmj.com for more articles like this and to become a Fellow