CASE REPORT

Blind endovascular catheterization and direct access of an occluded superior ophthalmic vein for treatment of carotid cavernous fistula

Ali Alaraj, Bobby Kim, Gerald Oh, Victor Aletich

Department of Neurosurgery,
University of Illinois at
Chicago, Chicago, Illinois, USA

Correspondence to

Dr A Alaraj, Department of
Neurosurgery, University of
Illinois at Chicago,
912 S Wood Street, MC-799,
Chicago, Illinois 60612, USA;
alaraj@uic.edu

SUMMARY

We describe a case of an elderly patient who presented with right-sided ophthalmoplegia, proptosis, chemosis, and increased intraocular pressure. An angiogram showed feeding vessels from the bilateral internal and external carotid arteries. Our initial attempt to blindly probe the inferior petrosal sinus was unsuccessful. This was followed by a right anterior orbitotomy exposing the superior ophthalmic vein which was directly cannulated with an 18 gauge angiocatheter. However, a proximal third of the superior ophthalmic vein within the orbit which was thrombosed was probed blindly. The thrombosed vein was cannulated with a microcatheter to obtain coil embolization of the carotid cavernous fistula. The implications of the procedure are discussed, given that, to our knowledge, such an endeavor has never been performed.

BACKGROUND

Carotid cavernous fistula (CCF) refers to an abnormal communication between the internal carotid artery (ICA) or one of its branches or the external carotid artery (ECA) and the cavernous sinus.^{1 2} The typical triad of symptoms includes exophthalmos, ocular bruit, and conjunctival chemosis. Endovascular treatment remains the gold standard for treatment through the trans-venous or trans-arterial routes. Endovascular accesses through a cut down on the superior ophthalmic vein (SOV) have been widely used, in addition to blindly probing a non-visualized inferior petrosal sinus (IPS). In this case, we illustrate a novel approach of combining direct access to the SOV along with blind probing of the proximal occluded SOV to treat a symptomatic CCF (figures 1–8).

CASE PRESENTATION

The patient was elderly, with progressive right eye pain, proptosis, redness, congestion, and decline in visual acuity. On examination the patient had 20/200 vision, with an afferent papillary defect and intraocular pressure of 39 mm Hg in the right eye.

INVESTIGATIONS

This was further evaluated with a diagnostic cerebral angiogram that demonstrated an indirect type right-sided CCF, with small arterial feeders from the bilateral meningohypophyseal branches of the ICA and ECA. The fistulous connection mostly to the posterior compartment of the right cavernous sinus, with filling of the medial and anterolateral

portions of it, before the venous drainage connected with the SOV and inferior ophthalmic veins (IOV). The most proximal segment within the SOV appeared to be occluded with reconstitution of the mid segment of the SOV from collaterals from the IOV. There was no venous drainage into the facial vein. The most distal aspect of the SOV appeared also to be occluded within the orbit, closer to the orbital rim. No venous outflow could be seen through any of the IPSs. Initial attempt at retrograde cannulation of the non-visualized/occluded right IPS failed.

TREATMENT

Attempt at embolization of the arterial feeders from the right ECA with Onyx (eV3-Covedian, Irvine, California, USA) also failed because of the small caliber of the feeder vessels and poor distal penetration of the embolic agent. A right anterior orbitotomy was performed, where the distal third of the SOV within the orbit was cannulated with an 18 gauge cannula. Selective angiography confirmed the occlusion of the proximal third of the SOV with connection to the cavernous sinus through collaterals from the IOV. An attempt to cross a collateral vein connecting the SOV to the IOV failed because of tortuosity of this collateral

Figure 1 Right internal carotid artery angiogram (lateral view) showing early filling of the right cavernous sinus. No opacification of the inferior petrosal sinus is seen. There is faint filling of the superior ophthalmic vein and inferior ophthalmic veins.

To cite: Alaraj A, Kim B, Oh G, et al. *BMJ Case Rep* Published online: [please include Day Month Year] doi:10.1136/bcr-2013-010704

Figure 2 Right external carotid artery angiogram (lateral view) showing early filling of the right cavernous sinus (indirect carotid cavernous fistula) with minimal filling of both the superior ophthalmic vein (thin arrow) and inferior ophthalmic veins. No contrast is seen filling beyond the posterior aspect of the cavernous sinus (thick arrow) into the inferior petrosal sinus.

veins. Then, under roadmap guidance, a 0.012 inch Headliner microwire (Terumo, Somerset, New Jersey, USA) was blindly introduced into the occluded portion of the SOV and then into the cavernous sinus. A 1.9 French Prowler-14 microcatheter (Cordis-Codman, Raynham, Massachusetts, USA) was introduced over the microwire and positioned into the most posterior aspect of the cavernous sinus. Selective angiography showed no drainage into the IPS. The cavernous sinus was coiled posteriorly to anteriorly until the SOV and IOV were disconnected from the cavernous sinus.

OUTCOME AND FOLLOW-UP

The patient had a decrease in intraocular pressure to 15 mm Hg on the second day after treatment and vision improved to 20/80 at the 1 month follow-up.

Figure 3 Left internal carotid artery (ICA) angiogram showing early fistulous filling of the right cavernous sinus through cavernous ICA branches (indirect carotid cavernous fistula).

Figure 4 Selective catheterization and angiography through a cannula introduced via a cut down of the superior ophthalmic vein (SOV). The proximal segment of the SOV appears to be occluded, with indirect connections of the SOV (long arrows) through the inferior ophthalmic veins to the cavernous sinus. Short arrow indicates the in posterior aspect of the cavernous sinus, at the junction with the occluded inferior petrosal sinus.

DISCUSSION

Endovascular options are the mainstay of treatment for direct high flow CCFs. Current CCF treatment of choice includes endovascular embolization of the patent blood vessel using detachable balloons, coils, stents, or liquid embolic agents via a trans-arterial or trans-venous route.³⁻⁷ In the past, the trans-arterial approach was commonly used; however, in patients with tortuous or sclerotic arteries, reaching the fistula site may be challenging, and the trans-arterial approach may be accompanied by other complicating factors, including migration of the

Figure 5 Selective catheterization and angiography of the right cavernous sinus. The microcatheter is introduced through a cannula directly into the distal segment of the superior ophthalmic vein (SOV). The microcatheter is blindly introduced through a thrombosed segment of the proximal SOV (long arrows), retrograde into the most posterior aspect of the cavernous sinus (short arrow).

Figure 6 Saved roadmap imaging during coiling of the right cavernous sinus. The coil obliteration proceeds from the most posterior aspect of the cavernous sinus, medial to the carotid artery and then anteriorly.

Figure 8 Right internal carotid artery (ICA) angiogram (lateral view) showing the final result after coil obliteration of the right cavernous sinus. No early filling of the right cavernous sinus is seen. The relation of the coil mass with respect to the ICA is seen (posterior, medial, then anterior).

embolic agents to the cerebral vasculature³ and revascularization of the fistula after initial success.⁸⁻⁹ In the modern era, the trans-venous approaches have been proven to be the first option for patients with CCF.

The trans-venous approach has a low risk and 90% success rate in all CCF cases with a higher clinical and anatomical cure rate.¹⁰⁻¹¹ The trans-venous approach via the IPS was the first established route and is still the most commonly used method today.¹²⁻¹³ When the IPS cannot be visualized filling early through the fistula, or in the delayed venous phase, blind cannulation of the IPS has been widely used.¹⁴ In about 31% of patients, the IPS cannot be catheterized due to plexiform architecture.¹⁴⁻¹⁵ The technique of opening an occluded IPS was published by Halbach in 1988 where he performed access to the cavernous sinus through an occluded non-opacified IPS in

two patients.¹⁶ Later this technique was used by other groups.¹²⁻¹⁴ It has been hypothesized that occlusion of the CCF through a thrombosed IPS is safe and yielded a favorable clinical outcome.¹²⁻¹⁴ The technique involves using a 0.035 inch or smaller microwires blindly through the internal jugular vein retrograde along the trajectory of the IPS towards the cavernous sinus. This will create a trajectory on black roadmap to advance the microcatheter. However, when access to the IPS is restricted due to thrombosis or no communication between the IPS and fistula site, other routes may be considered; an anterior approach via a facial vein and SOV may also be used.¹⁷⁻²¹ The superior petrosal sinus and pterygoid plexus may serve as alternative routes when it receives significant venous drainage from CCFs.²²⁻²⁴

In direct exposure of the SOV approach, surgical exposure and retrograde catheterization was documented, and its outcome was favorable if the SOV was sufficiently dilated and if there was significant venous drainage to the SOV.²⁵⁻²⁶ The direct SOV approach is used if the facial vein cannot be visualized or seen to be too tortuous.²⁵⁻²⁷ Direct puncture of the cavernous sinus has also been described,²⁸⁻²⁹ with direct injection of Onyx into the SOV close to the cavernous sinus. Potential complications include retro-orbital hematoma, optic nerve injury, and/or ICA injury.

Endovascularly blindly probing a thrombosed or sclerotic SOV, as presented in this case report, when other venous routes were inaccessible, has not previously been published as we have presented. In summary, although there are established trans-venous routes in treating CCFs, thrombosed or inaccessible venous routes may render endovascular occlusion of CCFs very difficult. Therefore, in addition to a blind approach via a non-visualized IPS, our blind approach via a thrombosed SOV provides yet another viable route in the treatment of CCFs. Potential complications of blind catheterization of a thrombosed vein include perforation during advancement of the sharp microwire. The guidewire should be advanced under gentle rotation while following its path on the roadmap.

Figure 7 Final result of coil sacrifice of the right cavernous sinus, coiling of all the chambers of the cavernous sinus, with obliteration of the anteromedial segment of the cavernous sinus, resulting in disconnection of the arterial blood reflux into the orbit.

Learning points

- Understand treatment options for carotid cavernous fistulas.
- Review the standard trans-venous approach for carotid cavernous fistulas.
- Highlight the importance of the superior ophthalmic vein cut down option for treatment.
- Learn the technical skills for a blind venous approach for carotid cavernous fistulas.

Contributors All authors contributed to the manuscript; they reviewed and approved the final version of the manuscript.

Ethics approval The institutional review board of the University of Illinois at Chicago approved the study.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Ringer AJ, Salud L, Tomsick TA. Carotid cavernous fistulas: anatomy, classification, and treatment. *Neurosurg Clin N Am* 2005;16:279–95, viii.
- 2 Barrow DL, Spector RH, Braun IF, et al. Classification and treatment of spontaneous carotid-cavernous sinus fistulas. *J Neurosurg* 1985;62:248–56.
- 3 Gemmete JJ, Chaudhary N, Pandey A, et al. Treatment of carotid cavernous fistulas. *Curr Treat Options Neurol* 2010;12:43–53.
- 4 Debrun GM, Vinuela F, Fox AJ, et al. Indications for treatment and classification of 132 carotid-cavernous fistulas. *Neurosurgery* 1988;22:285–9.
- 5 Katsiridis V. Treatment of dural arteriovenous fistulas. *Curr Treat Options Neurol* 2009;11:35–40.
- 6 Elhamady MS, Wolfe SQ, Farhat H, et al. Onyx embolization of carotid-cavernous fistulas. *J Neurosurg* 2010;112:589–94.
- 7 Fages-Caravaca EM, Tembl-Ferrairó JI, Lago-Martin A, et al. Direct carotid-cavernous fistulas: endovascular treatment using a detachable balloon. *Rev Neurol* 2001;33:533–6.
- 8 Irie K, Kawanishi M, Kunishio K, et al. The efficacy and safety of transvenous embolization in the treatment of intracranial dural arteriovenous fistulas. *J Clin Neurosci* 2001;8(Suppl 1):92–6.
- 9 Quinones D, Duckwiler G, Gobin PY, et al. Embolization of dural cavernous fistulas via superior ophthalmic vein approach. *AJNR Am J Neuroradiol* 1997;18:921–8.
- 10 Meyers PM, Halbach VV, Dowd CF, et al. Dural carotid cavernous fistula: definitive endovascular management and long-term follow-up. *Am J Ophthalmol* 2002;134:85–92.
- 11 Gemmete JJ, Ansari SA, Gandhi DM. Endovascular techniques for treatment of carotid-cavernous fistula. *J Neuroophthalmol* 2009;29:62–71.
- 12 Benndorf G, Bender A, Lehmann R, et al. Transvenous occlusion of dural cavernous sinus fistulas through the thrombosed inferior petrosal sinus: report of four cases and review of the literature. *Surg Neurol* 2000;54:42–54.
- 13 Yamashita K, Taki W, Nishi S, et al. Transvenous embolization of dural carotid-cavernous fistulae: technical considerations. *Neuroradiology* 1993;35:475–9.
- 14 Lekkhong E, Pongpech S, Ter Brugge K, et al. Transvenous embolization of intracranial dural arteriovenous shunts through occluded venous segments: experience in 51 patients. *AJNR Am J Neuroradiol* 2011;32:1738–44.
- 15 Shiu PC, Hanafee WN, Wilson GH, et al. Cavernous sinus venography. *Am J Roentgenol Radium Ther Nucl Med* 1968;104:57–62.
- 16 Halbach VV, Higashida RT, Hieshima GB, et al. Transvenous embolization of direct carotid cavernous fistulas. *AJNR Am J Neuroradiol* 1988;9:741–7.
- 17 Biondi A, Milea D, Cognard C, et al. Cavernous sinus dural fistulae treated by transvenous approach through the facial vein: report of seven cases and review of the literature. *AJNR Am J Neuroradiol* 2003;24:1240–6.
- 18 Hanneken AM, Miller NR, Debrun GM, et al. Treatment of carotid-cavernous sinus fistulas using a detachable balloon catheter through the superior ophthalmic vein. *Arch Ophthalmol* 1989;107:87–92.
- 19 Miller NR, Monsein LH, Debrun GM, et al. Treatment of carotid-cavernous sinus fistulas using a superior ophthalmic vein approach. *J Neurosurg* 1995;83:838–42.
- 20 Monsein LH, Debrun GM, Miller NR, et al. Treatment of dural carotid-cavernous fistulas via the superior ophthalmic vein. *AJNR Am J Neuroradiol* 1991;12:435–9.
- 21 Benndorf G, Bender A, Campi A, et al. Treatment of a cavernous sinus dural arteriovenous fistula by deep orbital puncture of the superior ophthalmic vein. *Neuroradiology* 2001;43:499–502.
- 22 Mounayer C, Pötin M, Spelle L, et al. Superior petrosal sinus catheterization for transvenous embolization of a dural carotid cavernous sinus fistula. *AJNR Am J Neuroradiol* 2002;23:1153–5.
- 23 Yoshida K, Melake M, Oishi H, et al. Transvenous embolization of dural carotid cavernous fistulas: a series of 44 consecutive patients. *AJNR Am J Neuroradiol* 2010;31:651–5.
- 24 Jahan R, Gobin YP, Glenn B, et al. Transvenous embolization of a dural arteriovenous fistula of the cavernous sinus through the contralateral pterygoid plexus. *Neuroradiology* 1998;40:189–93.
- 25 Goldberg RA, Goldey SH, Duckwiler G, et al. Management of cavernous sinus-dural fistulas. Indications and techniques for primary embolization via the superior ophthalmic vein. *Arch Ophthalmol* 1996;114:707–14.
- 26 Theaudin M, Saint-Maurice JP, Chapot R, et al. Diagnosis and treatment of dural carotid-cavernous fistulas: a consecutive series of 27 patients. *J Neurol Neurosurg Psychiatry* 2007;78:174–9.
- 27 Reis CV, Gonzalez FL, Zabramski JM, et al. Anatomy of the superior ophthalmic vein approach for direct endovascular access to vascular lesions of the orbit and cavernous sinus. *Neurosurgery* 2009;64(Suppl 2):318–23.
- 28 White JB, Layton KF, Evans AJ, et al. Transorbital puncture for the treatment of cavernous sinus dural arteriovenous fistulas. *AJNR Am J Neuroradiol* 2007;28:1415–7.
- 29 Elhamady MS, Peterson EC, Aziz-Sultan MA. Onyx embolization of a carotid cavernous fistula via direct transorbital puncture. *J Neurosurg* 2007;114:129–32.

Copyright 2013 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