Embolization of a Cavernous Sinus Dural Arteriovenous Fistula with Onyx via Direct Puncture of the Cavernous Sinus through the Superior Orbital Fissure

Asystole Resulting from the Trigemino-cardiac Reflex

A Case Report

N. AMIRIDZE, G. ZOARSKI, R. DARWISH*, A. OBUCHOWSKI, N. SOLOVEYCHIC

Department of Diagnostic Radiology and Nuclear Medicine,
University of Maryland School of Medicine; Baltimore, Maryland, USA

*Department of Anesthesia and Critical Care, University of Maryland School of Medicine; Baltimore, Maryland, USA

Key words: cavernous sinus dural arteriovenous fistula, Onyx embolization, trans-SOF approach, trigemino-cardiac reflex

Summary

Treatment of cavernous sinus dural arteriovenous fistula (CSDAVF) may be challenging. We describe a patient who had presented with progressive ocular symptoms due to CSDAVF requiring urgent interventional therapy. Initial attempts to embolize the fistula utilizing a transvenous approach through the inferior petrosal sinus failed because of difficult anatomy. Successful occlusion of the fistula was subsequently achieved with injection of ethylene vinyl alcohol copolymer, Onyx (EV3 Neurovascular, Irvine, CA, USA), via direct percutaneous puncture of the cavernous sinus through the superior orbital fissure. A brief period of asystole during the initial injection of Onyx may be the result of the trigemino-cardiac reflex.

Introduction

Cavernous sinus dural arteriovenous fistulas (or shunts) usually have a benign course, and may even resolve spontaneously. Emergent treatment is warranted, however, when the risk of permanent visual impairment is imminent, or when cortical venous hypertension predisposes to intracranial hemorrhage. Treatment may be challenging due to the small size of the

feeding arteries often arising from the cavernous internal carotid artery (ICA), the risk of inadvertent embolization of external to internal carotid artery collaterals, and the inconsistent and often discontinuous nature of the venous system. Endovascular treatment options include transvenous^{2,6,8} and transarterial embolization⁸. Endovascular treatment is sometimes combined with a surgical approach to the engorged orbital veins^{1,2}.

To our knowledge, this is the first case report of Onyx embolization of a CSDAVF utilizing a direct percutaneous puncture of the cavernous sinus via the superior orbital fissure (SOF).

Case Report

A 61-year-old Caucasian woman was admitted to an outside hospital for the treatment of nausea, vomiting, dehydration and headaches. She was placed on Tobromycin, but while still in the hospital she developed scleral injection, chemosis, blurred vision, foreign body sensation, excessive tearing and diplopia. CT and MRI of the brain revealed mild proptosis and minimal preseptal soft tissue swelling. Neuroophthalmological examination disclosed right sided chemosis and tortuous episcleral vessels. Intraocular pressures were elevated to 27 mm

Figure 1 CSDAVF before and after embolization. Lateral (A) and frontal (B) left ICA angiograms demonstrate early filling of the right cavernous sinus and orbital veins from meningeal branches of the left cavernous ICA. Lateral (C) and right trans-orbital (D) images demonstrate Onyx distributed within the right cavernous sinus and orbital veins. Lateral (E) and frontal (F) left ICA angiograms at 12 weeks demonstrate stable occlusion.

Figure 2 Trans SOF approach. (A) Return of blood through micropuncture needle as tip reaches the cavernous sinus. Lateral fluoroscopic image (B) demonstrates course of the micropuncture needle along the right orbital floor. Right transorbital (C) and lateral (D) images demonstrate the guidewire (C) and microcatheter (D) within the posterior right cavernous sinus, balloon wire within the right ICA.

Hg on the right, and 16 mm Hg on the left. There was vertical and horizontal diplopia and restricted ocular motion, more severe on the right. Repeat MRI of the brain and orbits with MRA and MRV revealed asymmetric dilatation of the right superior ophthalmic vein and increasing right-sided proptosis. MRV demonstrated mildly increased flow within the right cavernous sinus when compared to the left.

The patient was referred to Interventional Neuroradiology for evaluation.

The patient underwent a cerebral angiogram. CSDAVF supplied by multiple dural branches of bilateral internal carotid arteries

was documented. (Figure 1A,B demonstrates fistula filling from the left ICA). An initial attempt at endovascular occlusion of the fistula through the left IPS was unsuccessful because of the discontinuous nature of the venous channels; the IPS could not be identified for retrograde catheterization on the right. Further options for embolization, including injection of the right internal carotid artery with small PVA particles during distal balloon occlusion, were discussed with the patient and her neuroophthalmologist. On previous occasions we have accessed the cavernous sinus by way of retrograde catheterization through the facial, angu-

Figure 3 Patient before (A) and 8 weeks after (B) embolization. (Published with permission).

lar and superior orbital veins. On other occasions, we have employed a surgical approach to expose the superior orbital vein for retrograde catheterization. In this patient, however, the superior orbital vein was only moderately dilated, making surgical access impractical. The patient opted instead for occlusion of the cavernous sinus fistula via direct percutaneous puncture of the cavernous sinus through the SOF.

Standard transfemoral catheterization of right internal carotid artery was performed under general endotracheal anesthesia. A 4 mm x 2 cm Hyperglide balloon (EV3 Neurovascular, Irvine, CA, USA) placed into the cavernous portion of the right ICA and left uninflated. A trans-SOF approach to the right cavernous sinus was performed utilizing a 12 cm long 21 gauge needle from a long micropuncture introducer set (Cook Incorporated, Bloomington, IN, USA) placed through the 10 cm length 4 French micropuncture introducer with the inner introducer removed. The path of the needle along the inferolateral floor of the right orbit was monitored almost continuously with biplane fluoroscopy (Figure 2A,B).

The location of the Hyperglide balloon and microguidewire served as a guide to mark the position of the cavernous right ICA to avoid unintentional puncture of the carotid artery during transorbital needle placement into the cavernous sinus (Figure 2C). Blood returned through the needle at the expected level of the cavernous sinus (Figure 2A) The microguidewire from the micropuncture system was advanced through the needle and into posterior part of the cavernous sinus; the position of the wire was confirmed during right ICA angiogram.

The micropuncture sheath was advanced slightly over the microguidewire as the micropuncture needle was removed. An Eshelon-10

microcatheter (EV3 Neurovascular, Irvine, CA, USA) was advanced coaxially through the sheath over an X-pedion-10 microguidewire (EV3 Neurovascular, Irvine, CA, USA) and carefully manipulated into the posterior aspect of the cavernous sinus (Figure 2C,D). An angiogram through the microcatheter documented the tip in the desired position within the right cavernous sinus.

Embolization of the cavernous sinus with Onyx 34 was performed during inflation of the Hyperglide balloon within the right cavernous ICA to prevent retrograde flow of Onyx into the ICA lumen. Continuous fluoroscopic visualization as well as intermittent control angiograms through the right ICA guide catheter was utilized to monitor the progress and safety of Onyx injection. Special attention was given to avoid flow of Onyx to the left cavernous sinus and ICA via the circular sinus. A distribution of Onyx within the right cavernous sinus and orbital veins was achieved after injection of 1.3 cc (Figure 1C,D). The patient experienced a very brief period of asystole (less than 10 seconds) during initial part of the injection. There were no complications, and control angiograms through both ICAs demonstrated no residual filling of the fistula. The transorbital sheath was removed without hematoma.

The patient's postoperative neurological examination was initially at the immediate pre-procedure baseline. There was, however, noticeable improvement in ecchymosis and a reported decrease in diplopia overnight. Repeat MRI and MRA on postoperative day one demonstrated an artifact from Onyx at the level of the cavernous sinus, but an otherwise normal MRA/MRV. There was no evidence of residual fistula. The patient was discharged home on postoperative day 2 in a stable condition with the recommendation to continue Aspirin 325

mg daily to prevent progressive thrombosis of dilated veins and to preserve microcirculation during the period of normalizing orbital hemodynamics.

Three weeks after embolization the patient's neuroophthalmologic examination was significantly improved. She had full extraocular movements, and resolution of diplopia, echymosis and proptosis (Figure 3). Intraocular pressures were decreased to 17 mm Hg on the right and 10 mm Hg on the left. A follow-up angiogram at 12 weeks demonstrated stable occlusion of the CSDAVF (Figure 1E,F). The patient remains neurologically and ophthalmologically normal with resolution of her headaches, nausea and all orbital complaints.

Discussion

Direct trans-SOF approach to the cavernous sinus¹⁰ or indirect via the orbital veins⁹ was previously described in a few complicated cases and embolization of arteriovenous fistula performed utilizing coils as an embolic device. Lacking an approach to the posterior cavernous sinus through the IPS in our patient, we chose Onyx as the embolic material most likely to reach the fistula point in the posterior cavernous sinus. Our goal was to eliminate the fistula and to avoid incomplete occlusion that might have resulted from coil embolization, with possible subsequent redirection of venous drainage into the contralateral orbit. Recent literature^{3,5,7} and our own experience with Onyx embolization of dural AVFs is very encouraging, with complete fistula occlusion within one or two sessions. Durable results have been achieved without any recurrences or permanent complications in our small series.

Our patient experienced a brief period of asystole during the initial injection of Onyx. Bradycardia has been previously reported in a single case during transarterial embolization of DAVF with Onyx through middle meningeal artery⁴. We have observed bradycardia in cases of cavernous sinus and orbital AVF treatment with a brief asystole in two of our patients (including the one presented here) during transarterial or transvenous Onyx delivery into cavernous sinus or orbital vessels which resolved promptly with interruption of injection and the administration of atropine. We believe that one possible explanation of this phenomenon could be irritation of the trigeminal nerve within the cavernous sinus, producing a vagal reflex similar to the trigeminocardiac reflex, or oculocardiac reflex (Aschner phenomenon) during Onyx injection into ophthalmic arteries or veins. We now routinely inform the anesthesiologist prior to Onyx injection into the cavernous sinus or orbital vessels in anticipation of bradyarrhythmia.

Conclusions

Although transarterial or transvenous endovascular embolization remain the most commonly employed routes for access and treatment of CSDAVFs, direct percutaneous puncture of the cavernous sinus through the SOF may be warranted in certain cases. Occlusion of the fistula with Onyx resulted in a complete and durable cure without complications in our patient. Operators should be aware that direct injection of Onyx into the cavernous sinus or the orbital vessels may produce bradyarrhythmias as a result of the trigeminocardiac or oculocardiac reflex.

References

- 1 Berlis A, Klisch J et Al: Carotid cavernous fistula: embolization via a bilateral superior ophthalmic vein approach. *Am J Neuroradiol* 23: 1736-1738, 2002.
- 2 Cheng KM, Chan CM, Cheung YL: Transvenous embolisation of dural carotid-cavernous fistulas by multiple venous routes: a series of 27 cases. *Acta Neuroch (Wein)* 145: 17-29, 2003.
- 3 Cognard C, Januel AC et Al: Endovascular treatment of intracranial dural arteriovenous fistulas with cortical venous drainage: new management using onyx. *Am J Neuroradiol* 29: 235-241, 2008.
- 4 Lv X, Li Y et Al: Trigemino-cardiac reflex in embolization of intracranial dural arteriovenous fistula. *Am J Neuroradiol* 28: 1769-1770, 2007.
- 5 Nogueira RG, Dabus G et Al: Preliminary experience with onyx embolization for the treatment of intracranial dural arteriovenous fistulas. *Am J Neuroradiol* 29: 91-97, 2008.
- 6 Ringer AJ, Salud L, Tomsick TA: Carotid cavernous Fistulas: anatomy, classification, and treatment. *Neurosurg Clin N Am* 16: 279-295, viii, 2005.
- 7 Suzuki S, Lee DW et Al: Transvenous treatment of spontaneous dural carotid-cavernous fistulas using a combination of detachable coils and onyx. *Am J Neuroradiol* 27: 1346-1349, 2006.
- 8 Theaudin M, Saint-Maurice J-P et Al: Diagnosis and treatment of dural carotid-cavernous fistulas: a consecutive series of 27 patients. *J Neurol Neurosurg Psychiatry* 78: 174-179, 2007.
- 9 White JB, Layton KF et Al: Transorbital puncture for the treatment of cavernous sinus dural arteriovenous fistulas. *Am J Neuroradiol* 28: 1415-1417, 2007.
- 10 Workman MJ, Dion JE et Al: Treatment of trapped CCF by direct puncture of the cavernous sinus by infraocular trans-SOF approach. Case report and anatomical basis. *Interventional Neuroradiology* 8: 299-304, 2002.

Nana Amiridze, MD, PhD
 Assistant Professor
 Department of Diagnostic Radiology
 and Nuclear Medicine
 University of Maryland School of Medicine
 22 S. Greene St. Baltimore, MD 21201
 E-mail: amiridzen@umm.edu