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INTERVENTIONAL NEURORADIOLOGY

The treatment of a dural carotid cavernous fistula (CCF) using Onyx via a transorbital approach: a technical note

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Abstract We report the successful case of embolisation of a Barrow D (White et al. in Am J Neuroradiol 28:1415–1417, 2007) dural carotid cavernous fistula (CCF) with bilateral external carotid artery and internal carotid arterial supply, using a direct percutaneous transorbital approach with the embolic agent Onyx. In particular, we highlight the properties of Onyx which make it suitable to treat the multi-compartmental nature of CCFs. The patient developed transient complications which may be related to the volume of embolic agent used, and we discuss this point further. This is still a developing technique, and we present our case as a technical note to aid those contemplating embolisation via a transorbital approach with Onyx.

Keywords Carotid cavernous fistula · Percutaneous transorbital approach · Onyx embolisation

Introduction

Traditionally, indirect CCFs have been treated through a variety of approaches. A trans-arterial approach is often difficult due to the small calibre of the feeding vessels making their catheterisation difficult. The mainstay of treatment has become a transvenous approach. This can be performed through the inferior petrosal sinuses or superior ophthalmic vein (SOV) via the facial vein. With both of these routes, the most common treatment for the fistula is embolisation with coils. The cavernous sinus is a complex multicompartmental structure, and coils may not provide adequate embolisation. Therefore, the liquid embolic agent Onyx may have advantages in these cases. Often, the inferior petrosal sinus is occluded and the SOV may be tortuous and difficult to catheterise from the femoral vein. In these circumstances, a direct approach via surgical exposure of the SOV has been well described.

More recently a direct percutaneous puncture of the SOV has been described although this is still a developing technique. To our knowledge this is the first report of treating a dural CCF fistula which drained into both sides of the cavernous sinus utilising Onyx.

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Case report and technique

A previously well 48-year-old male presented with a 3-month history of persistent headache in late 2009 to our University Hospital. He was initially investigated with a CT head and lumbar puncture, both of which were reported as normal. Over a 2-week period, his symptoms progressed, and he developed constant diplopia on looking to the left, increasing headache and photophobia. Clinical examination revealed that the proptosis and chemosis were worse in the right eye and clinically, he had a partial right third cranial nerve palsy.

Following an MRI, suggesting fullness in the cavernous sinus regions with an excessive number of vessels. A diagnostic cerebral angiogram was performed under general anaesthesia by a neuroradiology consultant in our interventional suite, with a view to progressing to embolisation. The angiogram showed an indirect dural carotid cavernous fistula. This drained into both sides of the cavernous sinus, a relatively rare finding. The external carotid supply was from distal internal maxillary branches and middle meningeal artery branches bilaterally (Fig. 1), with the internal carotid supply

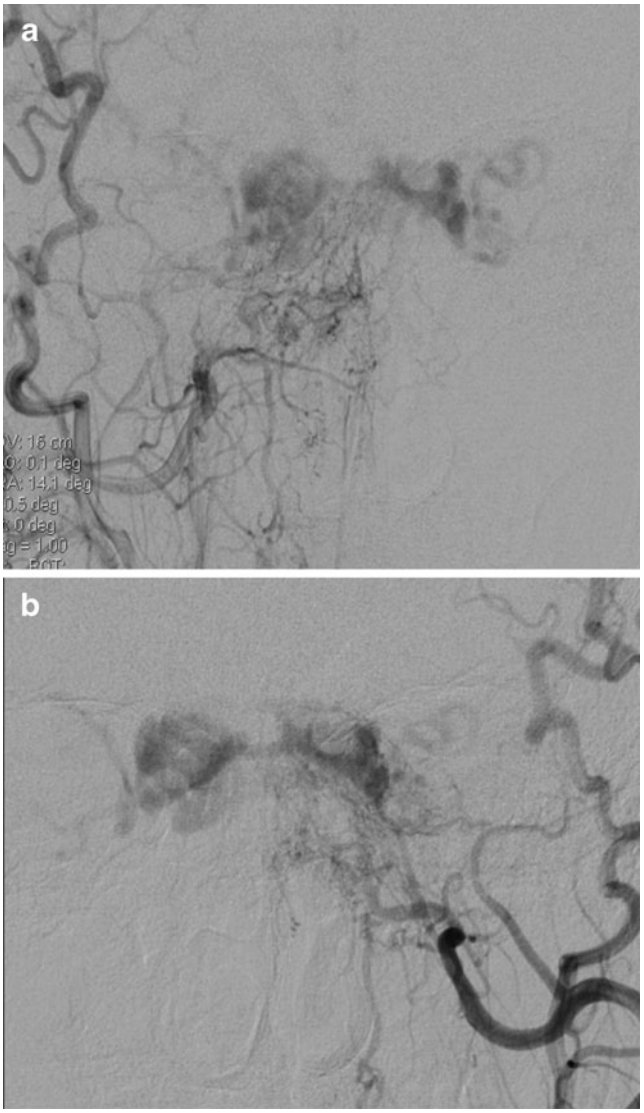

Fig. 1 Bilateral **a** *right* and **b** *left* external carotid anterioposterior angiograms showing dural fistulas involving both sides of the cavernous sinus. The fistulas are supplied by branches of the internal maxillary and middle meningeal arteries. Other images showed substantial cortical reflux

from meningeal and clival branches bilaterally. Both inferior petrosal sinuses were occluded, and both SOVs were tortuous and stenotic distally, the congested venous drainage was evident by the large amount of cortical venous reflux observed. Due to these venous access, issues a direct transorbital puncture was performed. It was also decided that Onyx should be used as the most suitable embolic material due to the extensive involvement of the sinus.

Utilising bilateral common femoral artery punctures, a 6F Neuropath guide catheter (Micrus Endovascular, Bishops Stortford, UK) was positioned into the left common carotid artery (CCA) and a 5F Neuropath guide catheter into the right CCA. The left orbit was used for the approach as this was the side of maximal fistula. A roadmap through the left CCA delineated the left internal carotid arterial (ICA) and also the cavernous sinus. The image intensifier was obliqued and positioned caudally, so that the left optic canal and superior ophthalmic fissure (SOF) were visualised (Fig. 2), and the medial and inferior aspect of the SOF was used as a target for the approach. A standard puncture needle (Kimal 18G) was advanced parallel to the floor of the left orbit towards the orbital apex and SOF, keeping inferior and lateral to the optic canal and also keeping medial to the genu of the cavernous ICA. Before the SOF was reached, the proximal SOV was entered, and it was possible to advance a wire through the needle into the cavernous sinus. Over this wire, a 4F sheath (Cordis, FL, USA) was introduced and an angiogram obtained. The cavernous sinus angiogram confirmed the correct placement and emphasised the degree of cortical venous reflux.

An Echelon 10-microcatheter (EV3 Endovascular Ltd, MN, USA) was introduced directly through the sheath and positioned into the right cavernous sinus. Onyx 34 (EV3 Endovascular Ltd, Minnesota, USA) was used as the embolic agent, as it was felt that using this viscosity would minimise the amount of cortical venous embolisation and also potential reflux into the ICA via the meningeal supply. With careful fluoroscopic control to minimise cortical vein, inferior petrosal sinus, and orbital vein reflux, a total of 2.8 ml was injected, until there was no right-sided fistula remaining. A second Echelon 10-microcatheter was positioned into the left side of the cavernous sinus, and a further 1.5 ml of Onyx 34 injected. This resulted in complete obliteration of the fistula (Fig. 3) with no significant filling with contrast. As the sinus had been completely embolised and the fistula closed, it was felt safe to remove the transorbital sheath. No angiographic complications or orbital haemorrhage was observed.

On completion of the embolisation the patient was noted to have a complete right-sided third cranial nerve palsy with no other new neurological deficit. As part of the post-procedural care, the patient was given 5 days of intravenous dexamethasone.

Initially. the recovery in eye movement was slow, but at 3 months, both eyes had returned to normal movement and vision. This has remained the case over the 1 year of clinical follow-up. The right third cranial nerve palsy (which was noted post-embolisation) has completely resolved. Follow-up MRI imaging was performed at 6 months (not shown). The cavernous sinus had reduced in volume, with no abnormal vessels seen.

Discussion

Despite advances in interventional neuroradiology, the treatment of indirect CCFs can be difficult, not least

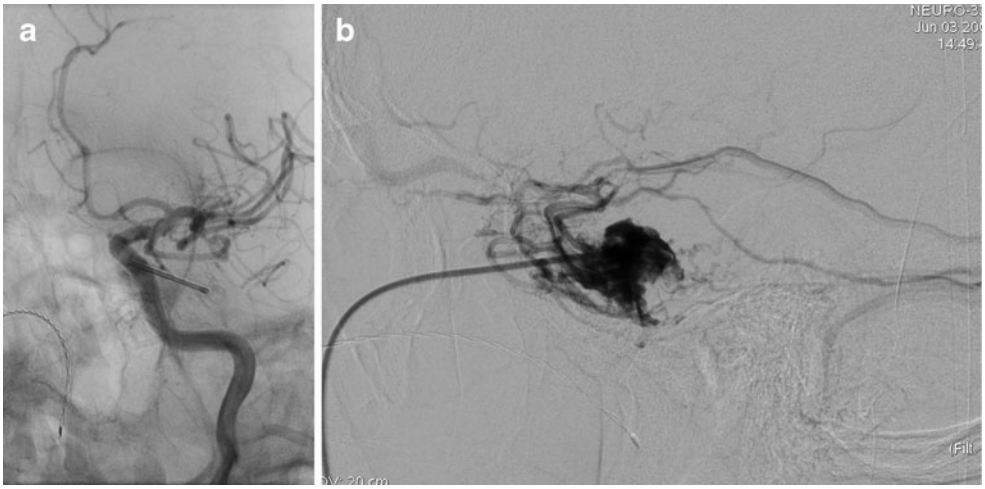

Fig. 2 **a** Unsubtracted left common carotid anterioposterior oblique angiogram demonstrating the puncture needle in position. The optic foramen is clearly seen. **b** Lateral projection cavernous sinus angiogram through the 4F sheath. The extensive cortical reflux and occluded inferior petrosal sinuses are clearly demonstrated. The superior ophthalmic vein stenosis is also visualised

because they are a relatively rare occurrence. Although they may have an indolent course, in those patients with a rapid deterioration of ocular symptoms or where there is cortical venous drainage, urgent interventional therapy is recommended [1]. Whilst having previously been described [1–7], this report is designed to highlight some of the advantages, difficulties and complications of the percutaneous transorbital route for direct puncture of the SOV in the superior orbital fissure.

The approach depends on the almost constant union of the superior and inferior ophthalmic veins extra-conally just prior to their drainage through the inferior and medial aspect of the superior orbital fissure. This means of accessing the cavernous sinus is a useful method of treating indirect carotid cavernous fistulae when the inferior petrosal sinus is occluded and the transfacial vein approach is tortuous [1–3]. In the case presented above, the puncture was without complication, although, clearly, it is important to remain extra-conal by advancing along the floor of the orbit [1].

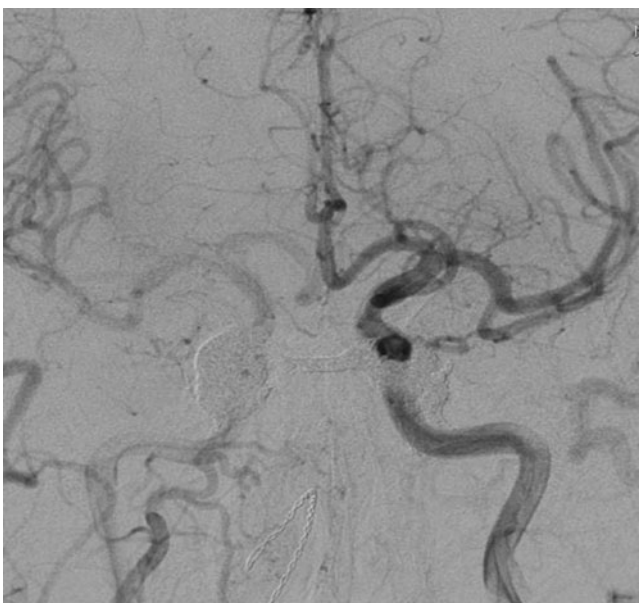

Fig. 3 Bilateral simultaneous anterioposterior common carotid angiograms performed post-embolisation with Onyx. There is no contrast seen in either cavernous sinus confirming complete obliteration of the fistula

Onyx has the advantage of having the ability to penetrate and occlude vessels that are of small calibre or those that are difficult to access via the standard catheter/coiling techniques [5]. It also allows sequential embolisation of the multi-compartmental anatomy of the cavernous sinus as well as the contralateral cavernous sinus. Onyx has advantages over conventional liquid embolic agents as it is non-adhesive, therefore allowing longer injection times [6] and thus more vessels and larger areas to be embolised. Injection of Onyx was halted when it was felt that there was potential for reflux through the meningohypophyseal trunk into the ICA. In addition, the volume of Onyx embolisation material that entered the cortical veins was closely controlled.

The embolised cavernous sinus with additional thrombosis may produce localised mass effect, which in turn may result in transient compressive cranial neuropathies of the 3rd, 4th, 5th and 6th cranial nerves [7]. The greater volume of Onyx injected into the right cavernous sinus as compared with the left side, may have had an effect due to an increased amount of mass effect, giving rise to the right 3rd cranial nerve palsy. The precipitation properties of Onyx allow embolisation of the cavernous sinus but may also result in inadvertent embolisation of vasa nervosum producing cranial nerve ischemia/infarction [7]. Although possible, an embolic cause of the 3rd nerve palsy, from one of the arterial guide catheters would seem unlikely. The potential of transient and permanent cranial nerve deficits should be clearly explained to the patient at the time of consent.

Conflicts of interest statement We declare that we have no conflict of interest.

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