CASE REPORT

Onyx embolization of dural arteriovenous fistulas of the cavernous sinus through the superior pharyngeal branch of the ascending pharyngeal artery

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SUMMARY

We report three cases of dural arteriovenous fistula (DAVF) of the cavernous sinus treated by Onyx injection through the superior pharyngeal branch of the ascending pharyngeal artery. The treatment of choice of DAVFs of the cavernous sinus is endovascular, and it is preferentially done via transvenous occlusion of the cavernous sinus. The cavernous sinus can be reached through either the inferior petrosal sinus or the superior ophthalmic vein. When these venous routes are occluded, the first attempt is to pass through the occluded inferior petrosal sinus, but sometimes this attempt can fail. In some cases there are small transosseous feeders to the fistula arising from the superior pharyngeal branch of the ascending pharyngeal artery. When all of the more conventional approaches are unattainable, this route can be attempted. In our experience, it allowed safe and rapid occlusion of the fistula.

BACKGROUND

Dural arteriovenous fistulas (DAVFs) are abnormal connections between arteries and veins in the dura mater; they can be a consequence of a cranial trauma, a thrombophlebitic process that involved a dural sinus, or neurosurgery.^{1 2} The cavernous sinus is a frequent location for DAVFs; chemosis, diplopia, and proptosis are the most common symptoms of DAVFs of the cavernous sinus.¹ Draining veins of DAVFs of the cavernous sinus are most often the superior ophthalmic vein and the inferior petrosal sinus, allowing transvenous occlusion of the fistula with different techniques and approaches.^{3–6}

Sometimes catheterization of the superior ophthalmic vein or the inferior petrosal sinus is not achievable, or the fistula drains entirely into cortical veins. In these cases, catheterization of the occluded inferior petrosal sinus can be successful, allowing the cavernous sinus to be reached.^{1 4}

Transarterial embolization of cavernous sinus DAVFs with Onyx (EV3, Irvine, California, USA) or other liquid embolic agents has a higher risk of embolic complications because of the great number of anastomoses between the dural branches of the external carotid artery (middle meningeal artery, ascending pharyngeal artery (APA), accessory meningeal artery, etc) and the internal carotid artery, ophthalmic artery, or vertebral artery.⁷

We report three cases of cavernous sinus DAVFs treated by Onyx embolization through the superior pharyngeal branch of the APA.

CASE PRESENTATION

Three patients (two women and one man, aged 55, 73, and 75 years, respectively) with cavernous sinus DAVFs were treated by Onyx embolization through the superior pharyngeal branch of the APA in the neurointerventional division of our hospital between December 2011 and May 2013. During the same period, eight cavernous sinus DAVFs in total were treated at our institution.

All patients had chemosis on the same side of the fistula; two patients also suffered exophthalmos and diplopia.

All patients had a type D fistula, according to the Barrow classification of DAVFs of the cavernous sinus, receiving feeding arteries from both external and internal carotid arteries of both sides.

In all cases, the cavernous sinus was 'isolated' because it was not reachable through the superior ophthalmic vein or through the inferior petrosal sinus. Venous drainage of the fistula was directed into the cerebral cortical veins; in two patients it also involved the cortical veins of the posterior cranial fossa.

TREATMENT

All endovascular procedures were performed under general anesthesia and via a right femoral artery approach, using a 6 F femoral artery sheath and a 6 F guiding catheter. A preliminary six vessel cerebral angiography was always performed to understand the vascular anatomy of the fistula (figure 1).

In two cases, catheterization of the cavernous sinus through the inferior petrosal sinus or the superior ophthalmic vein was attempted before the arterial approach through the APA.

In all cases the superior pharyngeal branch of the APA was achieved with a Marathon 1.5 microcatheter (EV3) and a Traxcess microguidewire (Microvention, Tustin, California, USA). The tip of the microcatheter was always at the cranial extremity of the vault of the nasopharynx, and superselective angiography showed injection of the fistula through small transclival arteries (figure 2).

The appropriate projection was selected to immediately recognize any possible penetration of Onyx towards the internal carotid artery.

Injection of a small amount (2, 1, and 0.5 mL) of Onyx 18 (figure 3) was enough to completely occlude the fistulas in two cases (figure 4), without any substantial reflux; in one case, the first of the series, Onyx injection achieved almost complete occlusion of the fistula with slow residual

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Figure 1 (A) Left external carotid artery angiogram in lateral view demonstrates the fistula and cortical venous drainage; the superior ophthalmic vein is partially thrombosed (arrow). (B) Right ascending pharyngeal artery injection in frontal view; the arrow points to its superior pharyngeal branch.

visualization of the draining vein that was confirmed at the 6 month control angiography. In this case, the injection possibly did not completely obliterate the fistula because Onyx did not completely fill the sinus and the feeders of the fistula; it was also our first experience with this approach, and almost complete obliteration was considered suitable to reduce the risk of hemorrhage.

At the end of all of the endovascular procedures, the patients awoke with no new neurological symptoms, and a CT scan was performed to exclude periprocedural intracranial adverse events and to ensure that the cast of Onyx was only in the clivus and cavernous sinus.

During the postoperative period, all patients received medical therapy with corticoids and low molecular weight heparin for 5 days.

OUTCOME AND FOLLOW-UP

All patients experienced complete remission of their ocular symptoms within 3 weeks.

In the case with residual fistula at 6 months, a new endovascular procedure to completely occlude the fistula was considered not necessary because flow in the draining vein slowed down significantly and we considered this as a reduction in the risk of hemorrhage; no more follow-up angiographies were suggested.

DISCUSSION

Venous drainage is the main feature of a DAVF, modifying the prognosis and the indication to treatment depending on whether or not the cortical veins are involved. As reported by Cognard *et al*,² drainage in the cortical veins makes the

Figure 2 (A) The tip of the microcatheter (arrow) in the superior pharyngeal branch of the ascending pharyngeal artery and (B) a contrast injection that shows the fistula reached through some small intraosseous branches.

prognosis significantly worse, increasing the annual mortality risk up to 10.4% and the risk of any neurological event to 15%.

DAVFs with cortical venous drainage, either direct or recruited, because of their high rate of hemorrhage and venous infarction, need to be occluded.

Figure 3 The cast of Onyx at the end of injection.

Figure 4 Right (A) and left (B) common carotid artery angiograms show complete occlusion of the fistula.

The advent of Onyx caused a paradigm shift in the treatment of DAVFs; since the first case of occlusion of a DAVF with Onyx reported in 2006 by Rezende *et al*,⁸ several other case reports and case series have been published.^{7 9–12} Onyx embolization, alone or combined with other embolization materials, is now the treatment of choice for most DAVFs.

Surgical and radiosurgical treatment of DAVFs of the cavernous sinus are, respectively, difficult and with low rates of occlusion⁴; their treatment of choice is endovascular and it is preferentially done via transvenous occlusion of the cavernous sinus. The cavernous sinus can be reached either through the inferior petrosal sinus or through the superior ophthalmic vein (mainly through the facial vein with femoral access or by direct puncture after surgical exposition of the vein).^{5 6 13} More difficult is the access through the superior petrosal sinus.¹⁴

In some cases both the inferior petrosal sinus and the superior ophthalmic vein are occluded, and the fistula drains in the cortical veins or in small partially thrombosed orbital veins. In these cases, endovascular occlusion of the fistula becomes difficult because of the lack of any venous access to the cavernous sinus. Currently, the first attempt in such situations is through the occluded inferior petrosal sinus, with good chances of reaching the point of fistula.¹ Some authors proposed the percutaneous transorbital extraconic puncture of the cavernous sinus, in case of lack of any venous route.^{15–17} Direct puncture of the cortical vein after craniotomy was also proposed.¹⁸

Transarterial injection of Onyx to occlude DAVFs of the cavernous sinus is limited by possible embolic complications related to the numerous anastomoses between the most frequent arterial feeders to the fistula (middle meningeal artery, accessory meningeal artery, internal maxillary artery, and neuromeningeal branch of the APA) and the carotid siphon or the ophthalmic artery through their meningeal branches to the cavernous sinus. Moreover, there is the risk of cranial nerve palsies due to compression in the osseous foramina or to ischemic injury related to occlusion of the vasa nervorum.^{3 19}

In some cases there are some small transosseous feeders to the fistula arising from the superior pharyngeal branch of the APA; these are branches that normally supply the bone tissue of the clivus, which are connected with the dural arteries of the medial wall of the cavernous sinus.²⁰

We performed injections of Onyx in the superior pharyngeal branch of the APA in three cases to occlude aggressive DAVFs of

the cavernous sinus that were not reachable by more common venous catheterization routes. In addition to the ocular symptoms that prompted the diagnosis, all patients had cortical venous drainage of the fistulas, which significantly increases the risk of cerebral hemorrhage or venous infarction, and hence a conservative approach was not considered suitable.

Catheterization of the superior pharyngeal branch of the APA is safe because it is completely extracranial and far away from the origin of the neuromeningeal branch of the APA, lowering the risk of occlusion of this branch due to Onyx reflux.

Onyx injection in our cases was safe and no complications occurred; neither embolic through anastomosis with the meningeal branches of the internal carotid artery nor cranial nerve injuries.

Surprisingly, Onyx reached the fistula rapidly and easily. Despite the fact that the tip of the microcatheter was lodged in the extracranial tissues, distant from the point of the fistula, and the arterial network to the fistula was entirely intraosseous, we had minimum reflux of Onyx in only one case.

This is the first report of Onyx, or any other embolizing material, injection in the superior pharyngeal branch of the APA to occlude DAVFs of the cavernous sinus. APA is generally considered a high risk artery for endovascular procedures because of its numerous anastomoses with the internal carotid artery and the vertebrobasilar system.²⁰ These connections are mainly through the neuromeningeal branch. Therefore, its superior pharyngeal branch can be considered safer.

Learning points

- ▶ Onyx embolization of dural arteriovenous fistulas of the cavernous sinus through the superior branch of the ascending pharyngeal artery (APA) can be considered a safe and rapid procedure.
- ▶ This approach can be attempted in cavernous sinus fistulas that lack easily accessible venous routes and drain into the cortical veins.
- ▶ Type C and D fistulas of the Barrow classification are amenable to this form of treatment when injection of the APA demonstrates some filling of the fistula from its superior pharyngeal branch.

Contributors All authors contributed to the work presented through study design, manuscript composition, and/or critical review.

Competing interests

Patient consent Obtained.

Ethics approval The study was approved by the institutional review board.

Provenance and peer review Not commissioned; externally peer reviewed.

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