Transvenous Occlusion of a Dural Cavernous Sinus Fistula Using a New Expandable Hydrogel-Platinum Coil (Hydrocoil[®])

H. MORSI, G. BENNDORF, R. KLUCZNIK, M. MAWAD

Department of Radiology, The Methodist Hospital, Baylor College of Medicine, Houston; USA

Key words: dural cavernous sinus fistula, transvenous occlusion, Hydrocoils[®]

Summary

Hydrogel-coated platinum coils (Hydrocoils[®]) are currently under clinical investigation for their efficacy to improve anatomic results of endovascular occlusion of cerebral aneurysms. A case is presented in which this new expandable coil type was added to bare platinum coils in order to accelerate the transvenous occlusion of a dural cavernous sinus fistula (DCSF).

A 53-year-old woman presenting with mild left-sided eye redness and diplopia due to a DCSF (type D) underwent transvenous occlusion using bare platinum coils (Trufill[®]) and hydrogel coated coils (Hydrocoil[®]).

After successful catheterization of the cavernous sinus, bare platinum coils were densely packed and eventually combined with Hydrocoils[®] which resulted in immediate and complete occlusion of the fistula. No technical or clinical complication occurred.

The new expansile hydrogel-coated platinum coil (Hydrocoil[®]) can be successfully combined with bare platinum coils to accelerate transvenous occlusion of an AV-shunting lesion. Controlled volume expansion after deployment of this device offers potential benefits for occlusion of dural arteriovenous fistulas in other locations or for parent vessel occlusions in the treatment of giant or large complex aneurysms.

Case Report

A 53-year-old woman presented with a recent onset of mild left sided eye redness and diplopia. Digital subtraction arteriogram (DSA) showed a small dural arteriovenous fistula of the right cavernous sinus (CS, figure 1A,B). The AV-shunt was located within the posterior aspect of the right CS and supplied by the meningeohypophyseal trunk (MHT) and branches of the external carotid artery (ECA).

Under general anesthesia and systemic anticoagulation the right femoral artery and vein were punctured. A 6F-guiding catheter was introduced into the right internal jugular vein and advanced through the facial vein up to the angular vein. A microcatheter (Prowler Plus[®], Cordis) was then navigated through the angular and superior ophthalmic vein and placed within the right CS where its position was confirmed by a venogram (figure 1C).

Numerous detachable bare platinum coils (TrueFill[®], Cordis) were deployed into the posterior cavernous sinus and packed as tightly as possible to occlude the AV-fistula (figure 1D). Although reasonable dense packing was achieved within the posterior CS, the resulting effect on the AV-shunting flow was minimal. Subsequently, the packing of the anterior CS was augmented using four hydrogel-coated detachable

platinum coils (Hydrocoil®, Micro Vention, Inc.) which resulted in a significant reduction of the AV-shunting. No additional coils were used. Subsequent control arteriogram (figures 1E,F), obtained 15 minutes later, showed complete disappearance of the fistula. The postoperative course was uneventful. 48 hours following the endovascular treatment she was discharged from the hospital with improving symptoms.

Discussion

We report a case of DCSF, successfully treated with a combination of bare platinum coils and Hydrocoils®. Various anatomical and haemodynamic factors may influence the efficacy of transvenous occlusion of a fistula: location, unilateral or bilateral and the degree of the associated AV-shunting. Other factors that may contribute to a good anatomic result include the exact placement of the coils at the fistula site, the packing density and thrombogenic properties of the material.

Early reports on transvenous embolization have advocated the use of fibered coils as embolic material, due to their superior thrombogenicity compared to bare metallic coils⁴. Fibered coils in the early period of TVO, however, were non-detachable and non-retrievable. Untoward migration, loose packing of these coils and their unpredictable detachment mechanism have been the main disadvantages. Several authors have proposed to use detachable bare platinum coils such as GDCi^{1,7} instead of fibered coils. Although less thrombogenic, they can be accurately deployed and very densely packed creating a better mechanical

blockage of the AV-shunting through the CS, compensating for their lack of thrombogenicity. If complete occlusion is not achievable they still can be combined with fibered coils to promote additional thrombosis^{1,3,6}.

Transvenous injection of NBCA, as a highly thrombogenic agent, can be considered to enhance intracavernous thrombosis. However, this technique, although very effective, carries the risk of untoward migration into cavernous sinus tributaries potentially leading to venous ischemia and infarction. The injection of NBCA should be, therefore, reserved for selected cases. A new generation of detachable fibered coils has been recently introduced. They combine the advantages of high thrombogenicity and controlled detachment. These coils can be effectively used to improve anatomic results of transvenous occlusion techniques.

The hydrogel-coated platinum coil represents a new device, consisting of carrier platinum coil coupled with an expansile hydrogel material, which undergoes a nine fold increase in volume when placed into a physiological environment⁵. As recently demonstrated in an animal study by Kallmes⁵, this device has the potential to fill residual aneurysm cavities during coil embolization and thus preventing coil compaction. Promoting the occlusion process of an AV-shunt in a controlled fashion, while saving bare platinum coils at the same time is a unique ability of the hydrogel coil and of potentially significant interest for various other endovascular techniques. In the case reported here, we believe that volume expansion of the hydrogel further contributed to the blockage of the AV-shunt and therefore to the complete occlusion of the fistula. The Hydrocoil® device offers the advantages of controlled occlusion of AV-shunts and of reducing the number of platinum coils needed to achieve this purpose. This will not only reduce the costs of treatment but may also lower the risk of cranial nerve deficit that can occur following a dense packing of bare platinum coils.

In conclusion, we report the successful combined use of a new expansile hydrogel-coated platinum coil (Hydrocoil®) with bare platinum coils for transvenous complete occlusion of a dural cavernous sinus fistula. Controlled volume expansion after deployment of this device offers potential benefits in the transvenous embolization of dural arteriovenous fistulas in other locations or in parent vessel occlusions for giant or complex aneurysms.

←
Figure 1 A) Initial right internal carotid arteriogram showing a Type D fistula of the right posterior cavernous sinus (single arrowhead), supplied by the meningeohypophyseal trunk and draining into the anterior cavernous sinus (double arrow head) and the right superior ophthalmic vein (arrow). B) Initial right external carotid arteriogram showing the arteriovenous shunt supplied by dural branches from the middle meningeal, accessory meningeal artery and the artery of the foramen rotundum. C) Right cavernous sinus venogram after successful navigation of a microcatheter through the facial vein and the superior ophthalmic vein (arrow) into the posterior cavernous sinus (double arrow head). D) Non-subtracted (native) view demonstrating the packing of bare platinum detachable coils (True fill®) in the posterior cavernous sinus (double arrowhead) followed by the packing of hydrogel coils in the anterior cavernous sinus (triple arrow head). E-F) Control arteriogram of the right internal and external carotid artery after 15 minutes reveals the complete occlusion of the AV-shunting.

References

- 1 Benndorf G, Bender A 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* 54: 42-54, 2000.
- 2 Biondi A, Milea D et Al: Cavernous sinus dural fistulae treated by transvenous approach through the facial vein: report of seven cases and review of the literature. *Am J Neuroradiol* 24: 1240-1246, 2003.
- 3 Cheng KM, Chan CM, Cheung YL: Transvenous embolization of dural carotid cavernous fistulas by multiple venous routes: a series of 27 cases. *Acta Neurochir* 145: 17-29, 2003.
- 4 Halbach VV, Higashida RT et Al: Transvenous embolization of dural fistulas involving the cavernous sinus. *Am J Neuroradiol* 10: 377-383, 1989.
- 5 Kallmes DF, Fujiwara NH: New expandable hydrogel-platinum coil hybrid device for aneurysm embolization. *Am J Neuroradiol* 23: 1580-1588, 2002.
- 6 Klisch J, Huppertz HJ et Al: Transvenous treatment of carotid cavernous and dural arteriovenous fistulae: results for 31 patients and review of the literature. *Neurosurgery* 53: 836-856, 2003.
- 7 Mawad M, Klucznik R, Boniuk M: Endovascular treatment of dural arteriovenous malformations of the cavernous sinus with GDC (abstract). *Neuroradiology* 38: 319, 1996.
- 8 Meyers PM, Halbach VV et Al: Dural carotid cavernous fistula: definitive endovascular management and long-term follow-up. *Am J Ophthalmol* 134: 85-92, 2002.

Goetz Benndorf, M.D.
Department of Radiology
Baylor College of Medicine
One Baylor Plaza, Houston
TX 77030
E-mail: benndorf@bmc.tmc.edu

GENERAL COMMENT

The authors report the successful transvenous occlusion of a cavernous sinus dural arteriovenous fistula using a combination of bare platinum coils and Hydrocoils®. Hydrocoils® are platinum coils covered by an expandable hydrogel polymer designed to obtain a denser packing in aneurysms.

Dural AVF without cortical venous reflux, like the case reported, have a benign natural history and the treatment offered should not be associated with significant morbidity. In addition to the need to preserve the outflow of all normally draining veins, in benign dural AVF the transvenous approach should obtain a complete occlusion of the fistula avoiding the iatrogenic rerouting of the venous drainage that could convert a benign dural AVF into a much more aggressive one with cortical venous reflux. Actually the present DAVF could have benefited from manual compression of the superior ophthalmic vein at the medial canthus.

New improvements in the armamentarium of the interventional neuroradiologist associated with better outcomes of our patients are always welcome, namely in this situation achieving a higher cure rate with less associated mass effect.

I look forward to further studies with more patients, clinical and imaging follow-up in which the authors' speculations regarding the reduction of mass effect, number of coils used and cost of transvenous embolization with Hydrocoils® are evaluated.

Pedro VILELA