Onyx Migration in the Endovascular Management of Intracranial Dural Arteriovenous Fistulas

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Summary

Onyx migration in the endovascular treatment of dural arteriovenous fistulas (dural AVFs) is uncommon. We describe five cases of Onyx migration to the heart and draining vein and its avoidance.

Between February 2007 and August 2008, Onyx migration was encountered in five patients with dural AVFs treated endovascularly at our institute. Procedures performed under general anesthesia consisted of two arterial approaches and three venous approaches.

Two patients with dural AVFs involving the transverse-sigmoid sinus were treated by transarterial embolization using Onyx-18 via the occipital artery and the posterior branch of the middle meningeal artery, respectively. A piece of Onyx was found in the right ventricle on post-embolization chest X-ray film in both patients, one developed tricuspid valve dysfunction requiring thoracic surgery and one was asymptomatic. The other three patients were treated with a combination of Onyx (34 or 18) and coils transvenously with venous Onyx migration leading to draining vein occlusion, one with dural AVF involving the tentorium died from venous rupture, two patients with bilateral dural AVFs of the cavernous sinus (one with deterioration of ocular symptoms and one without symptoms). Postoperative digital subtraction angiography confirmed the elimination of dural

AVF in one patient, and residual fistulae in three patients. The follow-up study ranging from two to nine months (average, 4.5 months). Three patients recovered to their full activities, while one had visual disturbance.

Although Onyx has been considered a controllable embolic agent, its migration to other locations causing clinical deterioration can occur. This problem should be noted and prevented.

Introduction

Intracranial dural AVFs are defined as abnormal connections between an arterial feeder and a dural venous sinus or leptomeningeal vein with the point of fistulization located within the dural leaflets¹⁻³. Transarterial Onyx embolization is now an established method of treatment for dural AVFs^{4,5}. Onyx can often penetrate to the point of fistulization with distal ligation of multiple feeders. Onyx has also been used to treat dural AVFs transvenously and complications caused by this technique have been described⁶. Migration of liquid embolic agent through an external carotid artery-internal carotid artery (ECA-ICA) anastomosis has been well recognized^{7,8}. However, Onyx migration in endovascular treatment of dural AVFs has not been reported before, but was encountered by us recently. This article describes the cases of Onyx migration to the heart and draining vein and its avoidance.

Patients and Methods

Between February 2007 and August 2008, 48 patients were treated for dural arteriovenous fistula by arterial and 17 patients by venous approaches at our hospital. Onyx migration was encountered in five patients with dural AVFs treated endovascularly at Beijing Tiantan Hospital. Two patients were treated transarterially and three were treated transvenously with Onyx.

The endovascular techniques we use have already been described^{1,4-6,9}. The clinical records and angiographic studies of these pa-

tients were reviewed retrospectively. They comprised two women and three men, ranging in age from 28 to 56 years (mean 43.6 years). Clinical follow-up data were graded according to the modified Rankin Score. The mean duration of the neurological follow-up was eight months (range one to 16 months).

The five patients presented with tinnitus (n=5), chemosis (n=2), sixth cranial nerve (CN-VI) palsy (n=1), subarachnoid hemorrhage (SAH)(n=1) and headaches (n=1) (Table 1). Venous drainage patterns were classified according to the system described by Cognard et al². One patient had Type IV, one had Type IIa+b,

Figure 1 Case 2. A 39-year-old woman presented with tinnitus and headaches caused by a left TS dural AVF (Cognard Type I-a+b). A) Lateral view of left ECA angiogram. B) Anteroposterior view of the left ICA angiogram. C) Anteroposterior view of the left vertebral artery (VA) angiogram. D) Anteroposterior view of the left ECA angiogram. The fistula was supplied by feeders from the left ECA, lateral tentorial artery of the left ICA and meningeal branches of the right vertebral artery with lateral mesencephalic vein (arrowheads) reflux via the superior petrosal sinus (arrows). E) Onyx-18 injection was performed via the left MMA. F) Fluoroscopic image after the procedure. G) The left common carotid artery angiogram shows incomplete obliteration of the fistula with a single Onyx injection. H) B-ultrasound examination of heart showing a foreign object in the right ventricle (arrow).

two had Type IIa and one had Type I fistula. Two patients were treated by transarterial approach and three were treated by transvenous approach.

Cardiac Onyx Migration

Cardiac Onyx-18 migration related to transarterial treatment with Onyx-18 occurred in two patients with dural AVFs involving the

transverse-sigmoid sinus (TS). One was treated with 0.8 ml Onyx via an occipital artery approach with residual fistula. Nine months after the procedure, the patient developed heart palpitation. Chest X-ray film showed a piece of Onyx in the right ventricle and B-ultrasound examination revealed dysfunction of the tricuspid valve. The Onyx was removed by cardiac surgery.

Table 1 Onyx migration in 5 patients with dural AVFs.

Patient No.	Age/Sex	Cognard Type	Symptoms	Suppliers	Drainage	Treatment access	Angiographic results	Onyx	Mechanism migration	Deficits	Treatment	Clinical Follow-up (mRS)
1.	28/M	I	Tinnitus	ECA(L)	TSS(L)	OA(L)	Incomplete	Heart	Via the shunt	3-tip valve	Cardiac surgery	9-m mRS=0
2.	39/F	IIa+b	Tinnitus Headaches	ECA(L) ICA(L) PCA(L)	TSS(L) SPS(L) BVR(L)	MMA(L)	Incomplete	Heart	Via the shunt	None	Followed	3-m mRS=0
3.	56/M	IIa	Tinnitus Chemosis(B)	ECA(B) ICA(B)	SOV(B) IPS(B)	IPS(R)	Incomplete	IPS(L)	Venous migration	Deterioration of ocular symptom(L)	Followed	4-m mRS=1 left decreased vision
4.	55/F	IIa	Tinnitus Chemosis(L) CNVI palsy(L)	ECA(B) ICA(B)	SOV(L) IPS(R)	FV(L) IPS(R)	Complete	Lung	Venous migration	None	Followed	2-m mRS=0
5.	40/M	IV	Tinnitus SAH	ECA(L) ICA(L)	BVR(L)	BVR(L)	Complete	BVR	Venous migration	Died of intracranial hemorrhage		Died

M, male; F, female; BVR, basal vein of Rosenthal; MMA, middle meningeal artery branches; OA, occipital artery; SOV, superior ophthalmic vein; IPS, inferior petrosal sinus; mRS, modified Rankin Score.

The other patient was treated via the posterior branch of the left middle meningeal artery (MMA) using Onyx-18 (Figure 1A-E). Although we injected Onyx under biplane fluoroscopy, we did not observe migration of this agent during the procedure. After injection of 0.5 ml Onyx under road-mapping via the left MMA, we did not observe the radio-opacity of Onyx and we checked the patient's chest immediately using X-ray. We found the Onyx winding with heart beat in the right ventricle. After waiting a few minutes, we injected Onyx again and it began to penetrate in the lesion (Figure 1F,G). After the procedure, B-ultrasound examination demonstrated a foreign body in the right heart ventricle (Figure 1H). We recommended close monitoring of this patient because she was asymptomatic.

Venous Onyx Migration

Three patients were treated with a combination of Onyx (34 or 18) and coils transvenously. A worsening of ocular symptoms was experienced in one patient with bilateral dural AVFs of the cavernous sinus (CS), followed by progressive spontaneous improvement. In this patient, we wanted to obliterate the bilateral dural AVF with Onyx via the right inferior petrosal sinus (IPS) and an intercavernous approach (Figure 2A-C). But the obliteration of the posterior part of the left CS could not be achieved and Onyx began to reflux into the right superior ophthalmic vein (SOV), which has been initially obliterated with detachable coils (Figure 2D-F). Angiography showed residual filling of the fistula with drainage to the left SOV after the procedure (Figure 2G). The patient developed left worsening of proptosis, and chemosis and reflux of Onyx into the right SOV was without clinical sequelae (Figure 2H). We attribute the symptoms to the occlusion of the left inferior petrosal sinus, which drained the fistula. In a second attempt, a direct access of the SOV via the facial vein was attempted to occlude the posterior part of the fistula, but failed. The patient was treated by carotid compression.

Case Reports

Patient 4 had a dural AVF involving the bilateral CS. Due to our early experience of the above patient, we treated this patient in two sessions. However, after embolization of the right CS via the right IPS, a single Onyx droplet attaching to the microcatheter dropped into the right internal jugular vein (IJV) as we retrieved the catheter. This patient did not present with new symptoms after the procedure and no abnormality was found by chest X-ray film and she was followed.

Patient 5 with a left tentorial dural AVF was treated transvenously via the internal jugular vein-transverse-sigmoid sinus-basal vein of Rosenthal (IJV-TS-BVR) approach. This patient did not wake up after the procedure and CT scanning showed an intracranial hemorrhage near the varix of the draining vein. We attributed the hemorrhage to the occlusion of the leptomeningeal vein. When the fistula was subtotally obliterated, Onyx migration occluded the distal draining vein and may have lead to venous varix rupture.

Clinical Outcome

In our four patients, three had a mRS score of 0, one had a mRS score of 1 with left decreased vision.

Discussion

The management of dural AVFs is an important topic of study, as these can be dangerous lesions and challenging for management¹⁰⁻²¹. The use of Onyx with a transarterial or transvenous approach has been considered a safe therapeutic alternative^{1,4-6,8,9,21-23}, but the uncontrollable aspects of this agent have not been well recognized. We describe here five adverse events caused by Onyx dislocation in the endovascular treatment of dural AVFs.

Cardiac Migration

Migration of Onyx to the heart is an unusual complication. We described two cases of this problem in transarterial Onyx-18 embolization for TS dural AVFs, which has not been reported previously. The fistulas were all on the left side. In the first patient, the fistula was initially treated with 0.8 ml Onyx-18. Cardiac Onyx migration was found because he developed cardiac palpitations with tricuspid valve dysfunction

nine months after the procedure. A piece of Onyx was revealed by a chest X-ray film examination in the right cardiac ventricle. Although there is no case describing the migration of Onyx to the heart, to our knowledge, we advocate a surgical approach in the management of Onyx migration to the heart because of dysfunction of the tricuspid valve. The displaced Onyx fragment can be successfully removed under direct visualization. Complete removal of the foreign body is much more readily confirmed with control of any suspicious bleeding or perforation undertaken in the direct operative field. The surgical approach was successful in our patient and he made an uneventful recovery. Migration of Onyx may have occurred when the liquid embolic agent was in its liquid state during injection. Although we inject Onyx under biplane fluoroscopy, this migration may be not observed due to slow injection and fast fistula shunt. The Onyx may also have migrated to the jugular vein early on and subsequently have traveled to the heart and pulmonary artery. Based on this experience, we found this migration in time in the second patient. This patient was asymptomatic and she was seen in the office at four-month follow-up and from a cardiac standpoint remains stable, asymptomatic, and in normal sinus rhythm. We recommend using a higher concentration of Onyx (Onyx-34) to promote faster solidification if the fistula shunt is fast and Onyx injection be stopped immediately if it cannot be seen under road-mapping.

Venous Migration

The transvenous endovascular approach has become a standard primary treatment for dural AVFs^{3,6,17,21,24-26}. Commonly used embolic agents include detachable platinum coils and NBCA. Provided the CS can be accessed via the venous route, Onyx is advantageous in that a fistula can be obliterated with a single infusion, regardless of size or the anatomic variability and complexity of the CS⁶. We have treated 16 cases (11 cases have been published) of dural AVFs of the CS successfully treated with Onyx or a combination of coils and Onyx transvenously. Coils are used to decrease flow in higher flow fistulas for controlled infusion. But recently, we have encountered three cases of adverse events caused by venous migration of Onyx, such as SOV, IPS and BVR. Proximal SOV Onyx migration is undesirable, because

there is a potential for occlusion of the episcleral venous drainage. Another potential disadvantage of venous embolization is that, if occlusion of the dural AVF is not achieved, subsequent access through this venous approach may be impossible. Thus, extra care needs to be taken when there is only one access route to the CS. As in our patients, a particularly higher risk may be related to embolization of dural AVF with leptomeningeal drainage and both parts of the bilateral type of dural AVF. We recommend using a higher concentration of Onyx (Onyx-34) initially to promote faster solidification in venous approaches and Onyx injection

should be slow. Onyx-18 could be used when the fistula shunt is nearly obliterated.

Conclusions

Although cardiac Onyx migration causing tricuspid valve dysfunction requiring thoracic surgery may be incredible, it actually happened to two of our patients.

The open approach proved safe and effective. Venous occlusion leading to deterioration or death can also occur using Onyx transvenously. These problems should be noted and prevented.

Figure 2 Case 3. A 56-year-old man who presented tinnitus and bilateral chemosis caused by a CS dural AVF. Right common carotid artery (A) and left common carotid artery (B) angiograms show a AVF involving bilateral CSs. C) the right CS was approached via the right IPS. We wanted to obliterate the bilateral dural AVF with Onyx via the right IPS and an intercavernous approach. But the obliteration of the posterior part of left CS could not be achieved and Onyx began to reflux into the right SOV, which had been initially obliterated with detachable coils. Fluoroscopic image (D) after embolization shows the Onyx cast. Note the left IPS is occluded. Right common carotid angiogram (E) and left common carotid angiogram (F) revealed complete obliteration of the right CS with Onyx migration to the right SOV (arrowheads) and residual fistula of the left cavernous sinus. G) Left common carotid angiogram, late arterial phase, showed the overflow of the left orbital. H) Picture obtained 2 hours after the procedure showing deterioration of the left ocular symptoms.

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