Microsurgical removal of Onyx HD-500 from an aneurysm for relief of brainstem compression

Case report

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The authors report the successful removal of Onyx HD-500 from an aneurysm sac by means of ultrasonic aspiration. This 46-year-old woman presented with progressive spasms of her left arm and leg due to mass effect and compression on the right cerebral peduncle 5 years after endovascular treatment of an unruptured giant posterior communicating artery aneurysm with Onyx HD-500. No filling of the aneurysm was detected on angiography.

The patient underwent a right pterional craniotomy and the aneurysm was opened to remove the Onyx mass. However, contrary to expectations, the aneurysm was still patent, filling with blood between the Onyx mass and the aneurysm wall. Under temporary clipping of the carotid artery, the Onyx mass within the aneurysm was removed in a piecemeal fashion using an ultrasonic aspirator and the aneurysm was then successfully clipped. The patient experienced significant improvement of the spasm after surgery. Angiography showed complete occlusion of the posterior communicating artery aneurysm.

It is rarely necessary to remove embolization material such as Onyx HD-500, and little is known about the most appropriate surgical technique. This case report demonstrates that removal can be safely accomplished by means of ultrasonic aspiration. (DOI: 10.3171/2009.10.JNS09668)

KEY WORDS • Onyx • compression • aneurysm • clip placement • ultrasonic aspiration

SURGICAL clipping of incompletely obliterated cerebral aneurysms following endovascular treatment with platinum coils and removal of the coil mass for compression syndromes has been extensively described in the literature.4,5,9,10,12 In contrast, there are few data related to problems associated with the use of the liquid embolic agent Onyx HD-500 (ev3, Inc.) for endovascular treatment of aneurysms, and to our knowledge there are no data on appropriate techniques for surgical removal of this solid polymer material.

In this case report, we describe the successful removal of Onyx HD-500 from an aneurysm sac with ultrasonic aspiration.

Abbreviations used in this paper: ACA = anterior cerebral artery; ACoA = anterior communicating artery; AICA = anterior inferior cerebellar artery; DMSO = dimethyl sulfoxide; EVOH = ethylene vinyl alcohol; MCA = middle cerebral artery; PCoA = posterior communicating artery.

Case Report

History and Presentation. This 46-year-old woman presented with a slowly progressive debilitating spasm of her left arm and to a lesser degree her left leg, unresponsive to oral baclofen treatment and transcranial magnetic stimulation.

She had been treated in another hospital for a subarachnoid hemorrhage (Hunt and Hess Grade II) 5 years previously in 2004. Angiography at that time showed a large PCoA aneurysm on the right side as well as a left PCoA aneurysm and an AICA aneurysm. Surgical clipping of the symptomatic left PCoA aneurysm had initially been attempted, but it failed and the aneurysm was subsequently treated endovascularly with detachable coils. The right PCoA aneurysm and the AICA aneurysm had been scheduled for later treatment. Six months later, the large right PCoA aneurysm was embolized with Onyx HD-500 with balloon support and the AICA aneurysm was treated.
Surgical removal of Onyx HD-500

with detachable coil embolization. Follow-up angiograms had shown occlusion of all 3 aneurysms over time.

**Imaging Findings.** Magnetic resonance imaging revealed an Onyx mass substantially compressing the right cerebral peduncle (Fig. 1). Angiography confirmed the presence of an occluded PCoA aneurysm on the right side with mass effect (Fig. 2). A decision was made to attempt partial resection of the Onyx embolization material to alleviate the compression on the cerebral peduncle.

**First Operation.** The patient underwent a right pterional/pretemporal craniotomy with partial removal of the zygomatic arch to facilitate more downward retraction of the temporal muscle. The dura mater was opened and the sylvian fissure widely split. The right carotid artery and the A1 and M1 segments of the circle of Willis were dissected free. The PCoA aneurysm embolized with Onyx appeared to fill at the neck of the aneurysm between the Onyx mass and the aneurysm wall but more peripherally the aneurysm appeared occluded. On opening the aneurysm distal to the neck to remove the Onyx mass compressing the cerebral peduncle, however, the aneurysm was found to be still patent, filling with blood between the Onyx mass and the aneurysm wall. This small hole in the aneurysm wall was glued with fibrin sealant to stop the bleeding. It was clear that resection of the Onyx mass and subsequent clipping of the aneurysm would not be possible without temporary clipping. As this would require a significant clipping time and it was not known whether the patient would tolerate this (despite a patent ACoA segment), we discontinued surgery and decided to perform a balloon test occlusion of the right proximal carotid artery the following day.

**Balloon Test Occlusion.** This study showed sufficient vascularization of the right cerebral hemisphere through the left carotid artery and ACoA segment with synchronous venous phase. More importantly, the patient tolerated this test (20-minute right carotid artery occlusion time) well without any neurological deficit during the test period.

**Second Operation.** The second surgical procedure was performed on the same day as the balloon test occlusion. The wound was reopened and the sylvian fissure was widely opened again. The aneurysm and the carotid artery, including its bifurcation into the MCA and ACA, were visualized (Fig. 3A and B). The internal carotid artery was temporarily clipped just distal to the orifice of the ophthalmic artery and just below the bifurcation into the MCA and ACA, isolating the aneurysm from circulation.

The aneurysm was opened distal to its neck. The Onyx mass was dense, hard, and impossible to remove with microsurgical scissors. Removal was attempted with a high-speed drill with a 1-mm fine diamond bit, but despite irrigation this gave rise to excessive heat and smoke and little progress was made in removing the mass. Finally, an ultrasonic aspirator was tried and this proved to be the ideal tool to resect the mass, fragmenting the Onyx into smaller pieces that could be subsequently removed by suction and microsurgical forceps (Fig. 3C). The ultrasonic aspirator was very useful for fragmentation of the mass.
mass, which could not be removed in one piece from the interpeduncular cistern. The Onyx mass was in general not adherent to the aneurysm wall except for some minor adhesions near the neck of the aneurysm. After removal of the Onyx, the remnant of the aneurysm was clipped along its neck using 2 curved 7-mm Sugita aneurysm clips, with the carotid artery remaining patent (Fig. 3D). Subsequently, after hemostasis and rinsing with saline, the dura mater was sutured, the bone flap replaced, the temporal muscle approximated, and the subcutis and skin were closed in layers.

Postoperative Course. The postoperative course was uneventful except for some headache. The patient experienced some improvement of her muscle spasm in the immediate postoperative period and a significant improvement was noted on follow-up at 3 months. Angiography showed complete occlusion of the right PCoA aneurysm (Fig. 4). Magnetic resonance imaging revealed adequate removal of the Onyx mass and demonstrated that the cerebral peduncle had to a large extent regained its original configuration (Fig. 5).

Discussion

Onyx HD-500 is a liquid embolic agent made up of 20% EVOH copolymer dissolved in DMSO, “with suspended micronized tantalum powder added to provide contrast for visualization under fluoroscopy” (http://www.ev3.net/neuro). It was developed for the treatment of intracranial, saccular, sidewall aneurysms that have a wide neck (≥ 4 mm) or a dome-to-neck ratio < 2 and are not suitable for treatment with detachable coils. In the treatment of intracranial aneurysms, the material, as currently used, is constrained by the placement of a balloon over the neck of the aneurysm. The material solidifies completely over a period of about 10 minutes with diffusion of the solvent (DMSO). The clinical application of Onyx started in 1999 and since then several studies have been published about its safety and efficacy. The formulation used for embolization of aneurysms differs significantly from the formulations used for treatment of cerebral arteriovenous malformations in that it contains a substantially higher percentage of EVOH and is therefore far more viscous.

In contrast to the endovascular treatment of cerebral aneurysms with detachable coils, embolization of aneurysms with the liquid embolic agent Onyx HD-500 is still under development. Several studies suggest that Onyx HD-500 can produce occlusion rates that are comparable to or even better than the reported endovascular occlusion rates achieved with existing coil devices. However, a large single-center study showed that endosaccular packing with balloon assistance may not be adequate for stable long-term results in large or giant aneurysms (recanalization rate of 36%).

Although Onyx embolization of intracranial aneurysms seems to be safe and effective, there are no published data available about the surgical removal of this solid polymer material from a previously embolized aneurysm. A minority of coiled aneurysms may give rise to compression symptoms that may even worsen over time, and this will likely also apply to aneurysms treated with Onyx.

The findings in this case report emphasize the need for better understanding of the clinical and pathological sequelae induced by embolization of cerebral aneurysms using Onyx HD 500, especially in aneurysms producing signs and symptoms related to mass effect. Although this report is limited to a single case, several lessons can be learned. First, aneurysms embolized with Onyx HD-500 may be patent, with leakage between the Onyx material and the aneurysm wall that may remain undetected by angiography. Second, these embolized aneurysms may give rise to progressive compression symptoms, possibly due to a chronic pulsatile hammering effect, similar to what has been described in microvascular compression, which may resolve after removal of the material. Third, Onyx may not adhere to the aneurysm wall. This may result in blood filling the tiny space between the aneurysm wall and the Onyx mass; this phenomenon may be misinterpreted as the Mach effect on digital subtraction angiography due to the high density of the Onyx material. Fourth, the best way to remove the Onyx is by using the ultrasonic aspirator, which is able to fragment the Onyx mass into smaller pieces.
Finally, the progressive nature of the symptoms in this case may be due to a pulsatile compression component, as the space between the Onyx and the aneurysm wall was filling, with the right peduncle being already compressed by the Onyx mass.

Conclusions

Although embolization of cerebral aneurysms with Onyx HD-500 is effective in most patients, this case illustrates that the aneurysm may still be patent between the Onyx mass and the aneurysm wall despite ostensibly adequate occlusion on angiography. Ultrasonic aspiration is an effective and safe tool for piecemeal removal of an Onyx mass causing compression symptoms.

Disclaimer

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References