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Using Onyx in endovascular embolization of internal carotid artery large or giant aneurysms

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ABSTRACT

Background and purpose: Internal carotid artery (ICA) large or giant saccular aneurysms is challenging for endovascular coil embolization and surgical clipping with a high recanalization and rebleeding rate. We report our results using Onyx in the endovascular treatment of ICA large or giant saccular aneurysms.
Methods: During 2008–2010, 5 patients with 5 large or giant saccular aneurysms in ICA were treated with a liquid embolic agent (Onyx; Micro Therapeutics, Irvine, CA). One aneurysm was small (<10 mm), 2 were large (≥10 mm, <25 mm) and 2 were giant saccular aneurysms (≥25 mm). Of 3 female and 2 male patients, 3 were incidental and 2 had bleeding. Selective embolization was performed with Onyx alone or a combination with coils. Clinical and anatomic outcomes were assessed with the Modified Glasgow Outcome Scale and follow-up angiography was performed at 4–21 months (mean 12.2 months).
Results: Complete aneurysm occlusion was obtained in all of the aneurysms on immediate control angiogram. There was not any procedure-related complication. No recanalization was observed at the follow- up periods. There were 2 ICA occlusions in giant ICA aneurysms. The 5 patients were all clinically asymptomatic at follow-up.
Conclusion: Endovascular embolization with Onyx is a useful treatment for ICA large or giant aneurysms, which is unsuitable for coiling or surgical treatment.

Different methodologic approaches have been developed for the treatment of large, wide-necked and other complicated dysplastic aneurysms: balloon-remodeling-techniques [1,2], stent-assisted coil occlusion [3,4], or parent vessel occlusion with or without extracranial/intracranial (EC/IC) bypass [5,6]. ICA large or giant aneurysm is a challenge for endovascular coil embolization with recanalization and reruptured risk [7,8]. Surgical clipping in intracranial ICA aneurysms usually cause a high mordity and mortality rate [9,10]. The covered stent in endovascular treatment of wide-necked aneurysms of ICA has recently been reported [11]. A new endovascular method is to fill the aneurysms with the liquid embolic agent Onyx (Micro Therapeutics, Irvine, CA). Experimental application of this technique has been described elsewhere [12–14]. Aneurysm treatment with Onyx in humans was introduced by Mawad et al. [15]. The Cerebral Aneurysm Multicenter European Onyx (CAMEO) trial [16] recently reported successful treatment of mostly large and giant aneurysms by using selective obliteration of the sac with Onyx HD500. Anatomic and clinical results are very encouraging, with a high rate of stable occlusion. The present report describes our experience with the liquid embolic agent Onyx 34 in the treatment of 5 ICA large or giant aneurysms treated at the Beijing Tiantan Hospital, Beijing, China.

1. Methods

Between June 2008 and September 2010, 5 patients with 5 intracranial ICA large or giant aneurysms were treated in our department by means of selective embolization with a liquid embolic agent (Onyx 34; Micro Therapeutics). There were 3 females and 2 males with a mean age of 39.2 years (range, 36–45 years). All patients underwent conventional angiography of both carotid arteries and vertebral arteries. Three aneurysms were cavernous and 2 were paraclinoid. Aneurysms were classified according to their size as follows: small, less than 10 mm; large, 10–25 mm; or giant, greater than 25 mm. Multiple aneurysms were seen in 1 patient. The 5 aneurysms were considered to be difficult or unsuitable for regular endovascular or surgical treatment: large and giant size, or re-rupture of a previously coiled aneurysm. All patients signed an informed consent form before treatment. One small aneurysm and 1 reruptured coiled aneurysm were treated by selective embolization with a liquid embolic alone, and 3 patients underwent

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Table 1
ICA aneurysms treated with Onyx injection.

Patient No.	Sex/age	Clinical presentation	History of trauma	Location	Size (mm)	Treatment	Onyx volume (mL)	Results	Follow-up (months)	Clinical outcome (GOS)
1	M/37	Nasal bleeding	Yes	Cavernous	6 × 8	Balloon assistance	1.7	100%	21	5
2	F/45	SAH	No	Paraclinoid	16 × 20	Balloon assistance	3	100%	21	5
3	F/36	Incidental	No	Cavernous	22.6 × 29.4	Balloon assistance	5	100%	10	5
4	F/38	Incidental	No	Cavernous	31 × 38	Balloon assistance	8	100%	4	5
5	M/40	Incidental	Yes	Paraclinoid	18 × 20	Balloon assistance	3.5	100%	5	5

treatment with a combination of detachable coils and liquid embolic.

1.1. Endovascular Onyx embolization

In all patients, the endovascular treatment was performed with the patient under general anesthesia and systemic heparinization. Systemic heparinization was started with 3000 U of heparin bolus, with an additional 1000 U/h to keep the activated clotting time above 250. Systemic heparinization was prolonged for 24 h after treatment.

Right femoral access was obtained through percutaneous femoral artery punctures, and a 6F guiding catheter (Cordis Corp., Miami Lakes, FL) was inserted into the parent vessel. In all patients, the first step of the endovascular procedure consisted of a "seal test" to confirm that the liquid embolic could be delivered within the aneurysm lumen without risks of migration into the cerebral circulation. A remodeling balloon (HyperGlide; Micro Therapeutics) was positioned across the aneurysm neck, and another microcatheter was simultaneously placed inside the aneurysm through the same guiding catheter. During balloon inflation, contrast material was injected under road mapping within the aneurismal sac to confirm the absence of any leakage into the parent artery, which was defined as a positive seal test.

Depending on the therapeutic strategy, coils or liquid embolic was delivered first to occlude the major part of the aneurysm sac. Technique of coil embolization has already been described in the literature [17,18]. For delivery of liquid embolic, the dead space of the microcatheter was filled with 0.25 mL of the solvent DMSO to prevent precipitation of the liquid embolic within the lumen of the catheter. The aneurysm was obliterated slowly and progressively by using small injections (0.1–0.2 mL/min) of Onyx 34 (8% ethyl vinyl alcohol/92% DMSO) while simultaneously inflating the balloon across the aneurysm neck. The polymer solidified within 2 or 3 min, during which time the balloon remained inflated (maximum 5 min) (Figs. 1 and 2). After the last injection, the catheter was aspirated to avoid any possible injection of liquid embolic that may still be within the lumen of the catheter. After endovascular treatment, patients were transferred to the intensive care unit where fluid balance, neurologic status, and blood pressure were carefully monitored.

1.2. Anatomic and clinical outcomes

Immediately after treatment, patients were evaluated with angiography to document aneurysm obliteration. The follow-up period was 4–21 months (mean 12.2 months). Follow-up angiograms were compared with angiograms obtained immediately after embolization. Clinical outcome was graded according to a modified Glasgow Outcome Scale [19].

2. Results

This series comprised 5 patients with 1 small, 2 large and 2 giant large or giant aneurysms, including 1 that was previously treated with coil embolization at local hospital. Three patients presented with asymptomatic, 1 with a Hunt-Hess grade 3 SAH and 1 with nasal bleeding. The small and retreatment aneurysms were treated by means of endovascular obliteration with liquid embolic alone. In the other 3 large or giant aneurysms, detachable coils (Microplex, Microvention, Aliso Viejo, FL) were placed before Onyx injection. The total amount of liquid embolic injected into the aneurysmal sac varied from 1.7 to 8 mL. No procedure-related complication occurred. Endovascular treatment resulted in 5 complete occlusions (Table 1). Overall clinical outcome was excellent in all patients. Late asymptomatic ICA thrombosis was seen in 2 patients with giant ICA aneurysms.

3. Discussion

This study shows that selective embolization of intracranial ICA large or giant aneurysms using Onyx 34 is feasible and effective in a selected population. Anatomic results and clinical outcomes are encouraging especially because the selected aneurysms were judged difficult or unsuitable for regular endovascular or surgical treatment.

3.1. Outcomes of surgical treatment

Many papers have been published on surgery for ICA aneurysms [9,10,20,21]. They report varied mortality from 0 to 13.8% and morbidity up to 26.8%. The complication rates associated with surgical treatment are 0–25% and the complete obliteration rates of aneurysms are 66.7–100%. The mean age of these studies is 42–50 years old patients with SAH rate of 0–80.8%, mostly large and giant but some small aneurysms, which are comparable to those in our study. Despite the advantages and improvement in surgical techniques there remains a significant morbidity and mortality associated with surgical treatment of these aneurysms.

3.2. Endovascular coiling results

The advent of adjunctive techniques, such as stent- or balloon-assisted coiling, has made possible the endovascular occlusion of an increasing number of ruptured and unruptured intracranial aneurysms. There has been only few reported series of ICA aneurysms treated with endovascular coiling. Hauck et al. [22] reported a 26.7% complete obliteration rate of paraclinoid aneurysms without any complication and death. Heran et al. [23] achieved complete occlusion in their 47% cases with a mortality of 11.8%. Roy et al. [24] reported 28 cases with 3 death (10.7%), 1 permanent morbidity (3.6%) and 50% complete obliteration rate. In other 2 papers [8,25], the reported higher complete obliteration rates of paraclinoid aneurysms were 87.3% and 88.9% with complication rate of 18.3% and 0%. In our series, favorable clinical outcome (GOS Scores 4–5) was achieved in all of patients at follow-up, with a complete occlusion of the aneurysms.

3.3. Onyx HD500 embolization

In experienced hands, balloon remodeling of wide-neck aneurysms is an important adjunct to coil embolization, even in

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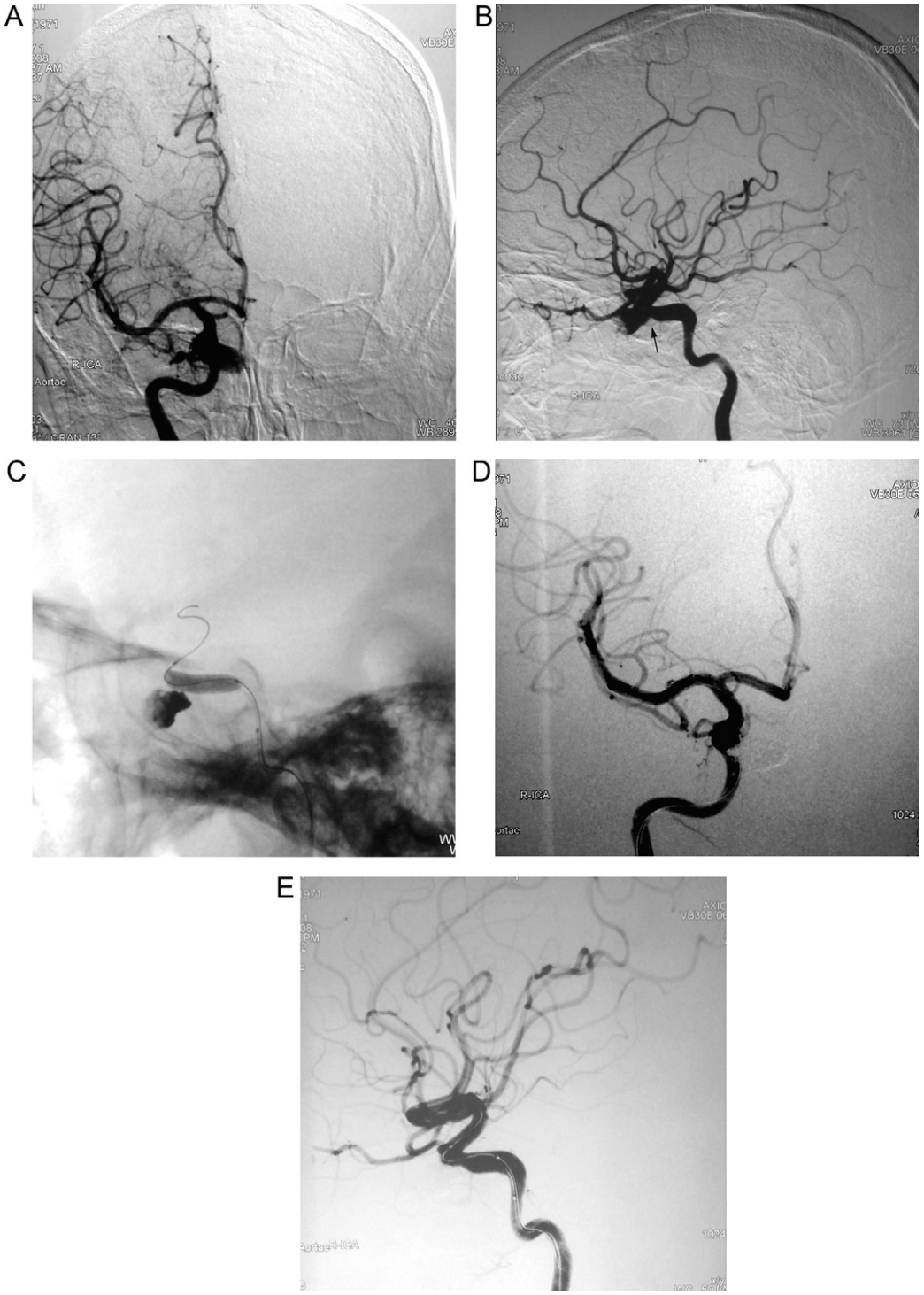

Fig. 1. A 37-year-old male presented with nasal bleeding and had a history of head trauma 1 month ago. (A) and (B) Right ICA angiograms, frontal view (A) and left view (B), show a small cavernous ICA aneurysm (arrow). (C) Fluoroscopic image obtained during balloon inflation and delivery of liquid embolic. (D) and (E) Post-embolization angiograms obtained immediately after treatment show complete occlusion of the aneurysm and patency of the ICA.

the acute phase, without the need for prolonged antiplatelet therapy [1]. Mawad et al. [15] published the first clinical series of Onyx embolization of 11 large and giant cavernous ICA aneurysms, with 82% complete immediate occlusion and 91% at 6- and 12-month follow- up. The first multicenter study on Onyx embolization of intracranial aneurysms was published in 2004 [16]. In this study, 97 patients with 100 aneurysms were treated; 80% of the aneurysms were large or giant and were stable 1 year after embolization. At the 1-year follow- up, there was complete occlusion in 93% of the small aneurysms, in 77% of the large aneurysms, and in 57% of the giant aneurysms, with an overall aneurysm occlusion rate of 79%. Retreatment was necessary in 10% of patients, with 2% mortality and 8% permanent morbidity. The main criticisms of the study were the high rates of complications, in particular ICA occlusion, and the lack of experience of many interventionists who participated in the study.

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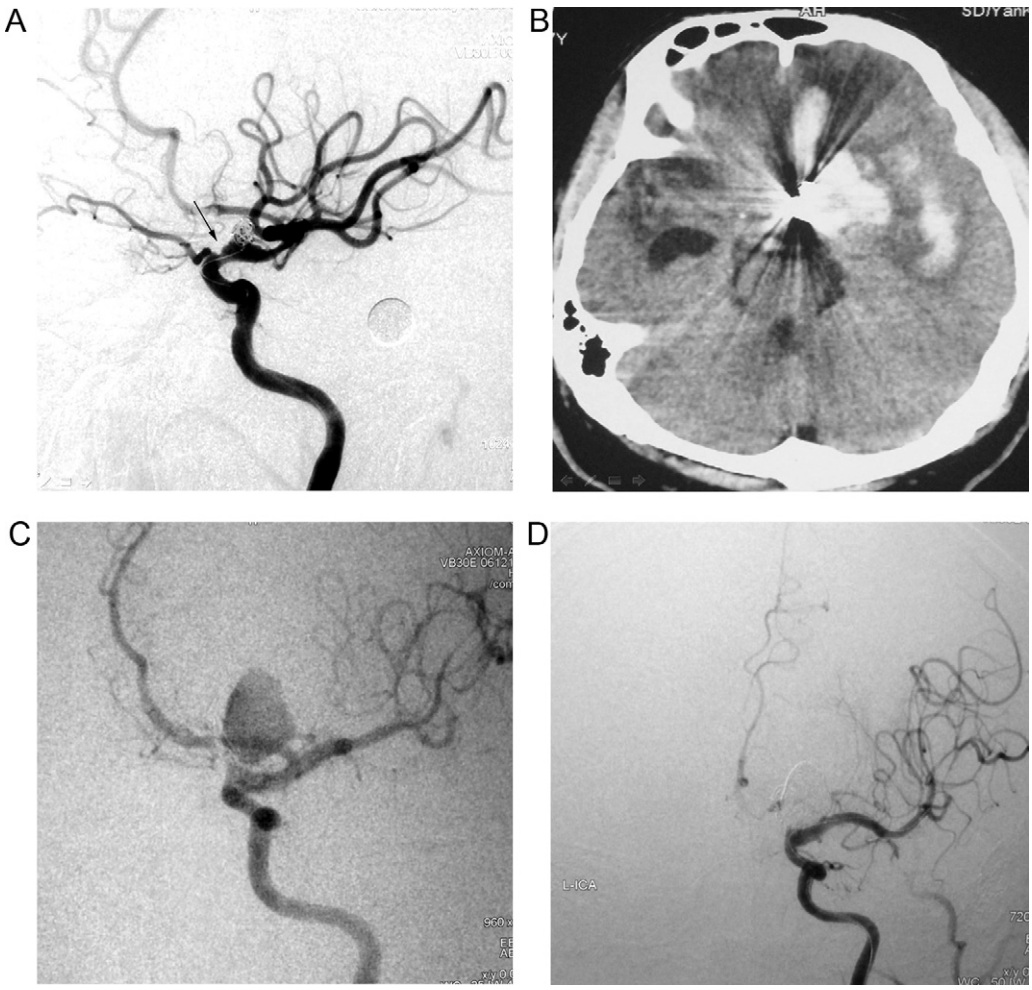

Fig. 2. A 45-year-old female presented with a second SAH from a coiled aneurysm. (A) Left ICA angiogram shows a paraclinoid aneurysm (arrow), which was coiled 3 months ago at a local hospital. (B) CT scanning shows SAH from the coiled aneurysm. (C) Left ICA angiogram shows the regrowth of the aneurysm. (D) Left ICA angiogram obtained after endovascular treatment using Onyx shows complete occlusion of the aneurysm.

3.4. Onyx 34 embolization

Technical improvements like Onyx high- density, quick- stop syringe, and longer remodeling balloons have been introduced to lower the rate of leakage and distal migration of Onyx and Onyx of lower density was also used in intranial aneurysm embolization. In 2005, Lubicz et al. [26] published a series of 41 aneurysms treated with Onyx 34, 30 of which were large or giant aneurysms. Intracranial stents were used in 15 patients. Among the large and giant aneurysms, there was complete occlusion in 63% and 57%, respectively, on follow- up. There was recanalization in 9 aneurysms (32%), all of them large or giant and partially thrombosed. Retreatment was necessary in 10% of patients. There were 4 complications (10%) and 1 death. Distal Onyx migration and parent vessel occlusion were the main complications observed. In our study, a complete occlusion was achieved in all cases. The high rate of complete occlusion is related to Onyx's capacity to overcome 3 aspects of the difficulty of occluding wide- neck small aneurysms and large and giant ones: as a liquid, it can fill 100% or almost 100% of the aneurysm cavity; it use a balloon remodeling technique, allowing better neck and parent vessel reconstruction.

3.5. ICA thrombosis

ICA stenosis or thrombosis continues to occur and is likely related to the high rate of endothelial hyperplasia that can accompany Onyx embolization [27]. This is evident in our 2 patients who were treated for 2 giant aneurysms. As the stenosis was asymptomatic in most of the cases reported in the literature and their treatment was effective, without complications, it seems that there are no concerns regarding the use of Onyx, compared with the difficulties of treating this kind of challenging lesion with other materials.

The problem with the use of liquid material for aneurysmal exclusion is thought to be the leakage of the material into the parent artery during injection [26,27]. Onyx injection needs to be very well controlled at a very low speed to avoid leakage. The technique of selective embolization with liquid embolic appears thus challenging and requires a great amount of experience in the endovascular treatment of intracranial aneurysms including the use of the remodeling technique [27]. We believe that this endovascular approach must not be proposed as a first-line therapeutic option in the care of patients with those aneurysms that are known to be well managed by endosaccular coiling.

4. Conclusion

Endovascular obliteration with liquid embolic seems feasible, safe, and effective for the treatment of ICA large or giant aneurysms, which is unsuitable for endovascular coiling and surgical clipping.

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Conflict of interest

None.

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