CASE REPORT

Occlusion of M1 segment after superficial temporal artery-middle cerebral artery bypass in a giant M1 aneurysm with Onyx-34 injected via a double-lumen balloon under balloon inflation

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SUMMARY

A 29-year-old patient attended our institution for recurrent strokes related to a giant partially thrombosed M1 aneurysm. Superficial temporal artery-middle cerebral artery (STA-MCA) bypass and subsequent occlusion of both the aneurysm and the dysplastic M1 segment were planned. However, owing to the shortness of the non-dysplastic segment of M1 and the risk of occlusion of the lenticulostriate arteries, the use of a double-lumen balloon was considered for coiling and subsequent injection of Onyx. STA-MCA bypass was performed using a regular technique. Endovascular occlusion of both the aneurysm and the parent artery was subsequently performed by means of coils and Onyx-34 that was injected via the Ascent balloon under balloon inflation. No complications were recorded and no stroke was observed on control MRI. The injection of Onyx-34 through a double-lumen balloon under balloon inflation is a quick and safe technique for precise occlusion of a parent artery.

BACKGROUND

Giant/large aneurysms of the middle cerebral artery (MCA) are rare¹ and may be revealed by compressive symptoms or distal thrombus migration when intrasaccular thrombosis is present.² More rarely, rupture may be observed.³ The treatment of giant/large MCA aneurysms, whether surgical or endovascular, is challenging.^{4,5} Selective embolization is often associated with a high rate of recurrence⁶ and may fail to relieve compressive symptoms. Moreover, there is a risk of distal thrombus migration during selective coiling in cases of intrasaccular thrombosis. Parent artery occlusion is as an efficient technique for the management of carotid siphon and some distal giant/large aneurysms.^{1,7} In some cases, such as M1 segment aneurysms, parent artery occlusion cannot be performed safely and flow-diverter stents are a promising alternative for the management of such aneurysms. However, positioning of the stent may be difficult or even impossible in some cases owing to the tortuosity of the vessels or because of major difficulties in catheterizing the distal segment of the parent artery. Finally, even though it is controversial, some authors have reported occlusion of small branches covered by flow-diverter stents.⁸ Thus, in the case of giant/large aneurysms of the M1 segment,

superficial temporal artery (STA)-MCA bypass and subsequent endovascular occlusion of the M1 segment may be a safer strategy.⁵

We report a case of successful occlusion of the M1 segment secondary to STA-MCA bypass in a 38.5 mm M1 partially thrombosed aneurysm revealed by strokes. The original procedure was performed by means of coils and Onyx-34 (eV3, Irvine, California, USA) with a double-lumen balloon (Ascent Codman Neurovascular, Raynham, Massachusetts, USA) under balloon inflation (figure 1).

CASE PRESENTATION

A 29-year-old man presented at our institution with left hemiparesis. Brain MRI (3T) revealed acute ischemic stroke in the deep territory of the right MCA (figure 2A) and a 38.5×30.5 mm giant aneurysm was depicted by three-dimensional time of flight acquisition (figure 2B). The aneurysm was partially thrombosed, as shown by acquisition of FLAIR-weighted images, with an 'onion-like' pattern (figure 2C).

Six months later the patient presented with a new episode of left hemiparesis. Diffusion-weighted imaging (DWI) results were consistent with a new acute ischemic stroke in the deep territory of the right MCA (not shown). Digital subtraction angiography (DSA) was performed and confirmed the presence of a giant aneurysm of the right M1 segment with a circulating portion measuring 26 mm (figure 2D). This circulating portion had a triangular shape involving two-thirds of the lateral aspect of the M1 segment. DSA of the ipsilateral external carotid artery showed a STA with a satisfactory caliber (not shown).

After a multidisciplinary meeting including neurosurgeons and interventional neuroradiologists, the strategy chosen was to perform a STA-MCA bypass and subsequent occlusion of both the aneurysm and the dysplastic portion of the M1 segment. STA-MCA bypass was achieved using a regular technique^{9,10}: a terminolateral anastomosis with interrupted microsutures (Prolene 10.0, Ethicon, Johnson and Johnson, New Brunswick, New Jersey, USA) was performed between the frontal branch of the STA and a cortical branch of the MCA through a temporal craniectomy. Patency of the bypass was assessed by direct observation during surgery and by Doppler ultrasonography during the following

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Figure 1 Diagram of the Ascent double-lumen balloon showing (1) lumen dedicated to balloon inflation and (2) lumen dedicated to the microguidewire that is compatible with dimethyl sulfoxide and can be used for injection of Onyx. The tip of the device measures 3 mm.

days. The patient was discharged uneventfully. DSA was performed at 3 months and confirmed the patency of the STA-MCA bypass (figure 2E). Owing to the short length of the non-dysplastic segment of M1 and to the close relationship of the lenticulostriate arteries with the segment to occlude, the

strategy chosen was to inject Onyx-34 (eV3, Irvine, California, USA) via a double-lumen balloon (Ascent; Codman Neurovascular) under balloon inflation protection.

TREATMENT

Under general anesthesia, a 6 Fr Envoy guiding catheter (Cordis, Warren, New Jersey, USA) was placed at the subpetrous segment of the right internal carotid artery (ICA). 18-long size coils (3 GDC 18; Stryker, Fremont, California, USA) were placed in the bottom of the aneurysm sac via the second lumen of the Ascent balloon in order to provide support for more dense coil packing close to the neck of the aneurysm. The Ascent double-lumen balloon was then gently pulled and placed in front of the neck of the aneurysm. Dense coil packing was performed through the lumen of the Ascent balloon (long size Microsphere 18 (n=1), Microplex 18 (n=1) and Cashmere 14 (n=2);

Figure 2 (A) Axial diffusion-weighted image from a brain MRI (3T) performed after the onset of left hemiparesis. Hyperintense signal is seen within the right internal capsule, consistent with the diagnosis of acute ischemic stroke. (B) Three-dimensional time of flight acquisition showing a giant right M1 aneurysm. (C) Axial fluid attenuation inversion recovery (FLAIR) acquisition showing the 'onion pattern' within the aneurysm sac corresponding to thrombosis of different ages. (D) Right internal carotid artery (ICA) digital subtraction angiography (DSA), anteroposterior (AP) projection, clearly showing the giant aneurysm; note the shortness of the proximal non-dysplastic M1 segment (arrow). (E) Right external carotid artery (ECA) DSA, AP projection, performed after superficial temporal artery-middle cerebral artery (STA-MCA) bypass showing the patency of the anastomosis (arrow). (F) Snapshot from the roadmap during the endovascular procedure. Loose packing in the bottom of the aneurysm sac is seen which enables more dense packing at the neck of the aneurysm. All the coils were deployed via the second lumen of the Ascent balloon (arrow). (G, H) Injection of Onyx-34 under Ascent balloon inflation (I, arrowhead); (G: unsubtracted image, AP projection; H: blank roadmap, AP projection). Progression of the Onyx within the proximal cast of coils is demonstrated on the blank roadmap (H, arrow). (I, J) Final control right common carotid artery angiogram, AP projection; arterial phase (I) and capillary phase (J) showing satisfactory occlusion of both the aneurysm and the dysplastic segment of M1 and the supply of the cortical branches of the right MCA by the STA-MCA bypass. (K, L) MR perfusion (3T) performed 3 days after the endovascular procedure. (K: relative cerebral blood volume color map showing the absence of asymmetry in terms of perfusion between the two hemispheres; L: negative enhancement curve showing no significant difference between the delays in the time to peak between the two hemispheres). (M) MRI performed at 19-month imaging follow-up (axial FLAIR weighted image) showing shrinkage of the aneurysm sac.

Micrus/Codman) (figure 2F) under iterative balloon inflation. Finally, after balloon inflation, 3 ml Onyx-34 was injected under roadmap guidance (figure 2G,H) via the second lumen of the Ascent balloon in order to prevent delayed recanalization of the aneurysm. Satisfactory occlusion of both the sac and the parent artery was obtained. The dead space of the balloon was then flushed with dimethyl sulfoxide (DMSO) and the balloon was gently pulled to prevent migration of Onyx during removal of the device.

The procedure was performed under full intravenous heparinization (activated clot time 2–3 times baseline) which lasted 1 week. Methylprednisolone (120 mg) was injected intravenously during the procedure and continued for 1 week, decreasing progressively. No leakage of Onyx in the non-dysplastic proximal segment of M1 or occlusion of the lenticulostriate arteries was observed (figure 2I,J).

OUTCOME AND FOLLOW-UP

Control MRI did not show any stroke on DWI (not shown). MR perfusion acquisition was performed and showed no difference in relative cerebral blood volume between the right and left sides and no significant delay in time to peak in the right hemisphere (figure 2K,L).

The patient was discharged uneventfully and his clinical status remained stable with a slight right hemiparesis. No new neurological symptoms were recorded during clinical follow-up at 19 months; long-term MR follow-up at 19 months showed the patency of the STA-MCA bypass and the persistence of the occlusion in both the M1 segment and the aneurysm. Shrinkage of the thrombosed aneurysm sac was observed (39 mm vs 66 mm after the endovascular treatment; figure 2M).

DISCUSSION

The management of giant M1 aneurysms is challenging¹¹ and requires multidisciplinary management. Even though new devices such as flow-diverter stents have improved the treatment of such aneurysms, limitations like the difficulty in reaching distal segment catheterization, the need for dual antiplatelet therapy and the theoretical risk of occlusion of the perforators make the technique challenging and sometimes hazardous.¹²

Surgical bypass associated with M1 occlusion is a relatively safe technique and has been shown to be effective in the treatment of these aneurysms.^{13–14} However, the endovascular occlusion of the M1 segment may be more challenging when the origin of the dysplastic vessel is close to eloquent vessels such as the lenticulostriate arteries, as in our case. We therefore decided to use a double-lumen balloon which allowed both coiling and subsequent Onyx injection under balloon inflation by means of a single device.

The Ascent balloon is a double-lumen balloon mainly designed for the remodeling aneurysm coiling technique. The first lumen is dedicated to the inflation of the balloon while the second is used for insertion of the microguidewire that allows navigation of the device and accepts 0.014 inch microguidewires. Because of the two distinct lumens, the balloon can be inflated without a guidewire inside the lumen. Coiling can be performed via the second lumen, with or without concomitant balloon inflation.¹⁵ Moreover, this second lumen is DMSO compatible. This characteristic allows injection of Onyx without the risk of balloon rupture. The Onyx injection can be performed with or without balloon inflation. It is noteworthy that the tip of the device after the balloon distal marker measures 3 mm (figure 1).

To the best of our knowledge, this is the first reported case of embolization with Onyx through a double-lumen balloon in an intracranial location. Such use of the Ascent balloon has previously been described for parent artery occlusion with coils and Onyx of the cervical segment of the ICA in a case of post-radiotherapy ICA wound dehiscence and exposure,¹⁶ and for Onyx embolization of a high-flow mandibular arteriovenous malformation.¹⁷ We used Onyx-34 in our patient because it is more viscous than Onyx-18, which may have helped to occlude the proximal segment of the dysplastic vessel and prevent Onyx migration in the bottom of the aneurysm sac.

Thus, this technique has three advantages: (1) the precision of the occlusion site; (2) the rapid speed of the procedure (coiling and injection of Onyx through the same device); and (3) the reduction in the number of coils required to obtain parent artery occlusion.

CONCLUSION

The injection of Onyx-34 through a double-lumen balloon under balloon inflation seems to be a quick and safe technique for precise occlusion of a parent artery close to eloquent arteries.

Learning points

- ▶ STA-MCA bypass and subsequent aneurysm and parent artery occlusion is a valuable option in giant aneurysms of the M1 segment.
- ▶ Coils and Onyx can both be injected through a double-lumen balloon.
- ▶ Injection of Onyx through a double-lumen balloon under balloon inflation seems to be a safe and effective technique for precise occlusion of a parent artery.

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Competing interests None.

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REFERENCES

- 1 Biondi A, Jean B, Vivas E, *et al.* Giant and large peripheral cerebral aneurysms: etiopathologic considerations, endovascular treatment, and long-term follow-up. *Am J Neuroradiol* 2006;27:1685–92.
- 2 Little JR, St Louis P, Weinstein M, *et al.* Giant fusiform aneurysm of the cerebral arteries. *Stroke* 1981;12:183–8.
- 3 Horie N, Takahashi N, Furuichi S, *et al.* Giant fusiform aneurysms in the middle cerebral artery presenting with hemorrhages of different origins. Report of three cases and review of the literature. *J Neurosurg* 2003;99:391–6.
- 4 Shi ZS, Ziegler J, Duckwiler GR, *et al.* Management of giant middle cerebral artery aneurysms with incorporated branches: partial endovascular coiling or combined extracranial-intracranial bypass—a team approach. *Neurosurgery* 2009;65:121–9.
- 5 Weill A, Cognard C, Levy D, *et al.* Giant aneurysms of the middle cerebral artery trifurcation treated with extracranial-intracranial arterial bypass and endovascular occlusion. Report of two cases. *J Neurosurg* 1998;89:474–8.
- 6 Hayakawa M, Murayama Y, Duckwiler GR, *et al.* Natural history of the neck remnant of a cerebral aneurysm treated with the Guglielmi detachable coil system. *J Neurosurg* 2000;93:561–8.

- 7 Clarençon F, Bonneville F, Boch AL, *et al.* Parent artery occlusion is not obsolete in giant aneurysms of the ICA. Experience with very-long-term follow-up. *Neuroradiology* 2011;53:973–82.
- 8 Pistocchi S, Blanc R, Bartolini B, *et al.* Flow diverters at and beyond the level of the circle of Willis for the treatment of intracranial aneurysms. *Stroke* 2012;43:1032–8.
- 9 Amin-Hanjani S, Butler WE, Ogilvy CS II, *et al.* Extracranial-intracranial bypass in the treatment of occlusive cerebrovascular disease and intracranial aneurysms in the United States between 1992 and 2001: a population-based study. *J Neurosurg* 2005;103:794–804.
- 10 Sundt TM Jr, Whisnant JP, Fode NC, *et al.* Results, complications, and follow-up of 415 bypass operations for occlusive disease of the carotid system. *Mayo Clin Proc* 1985;60:230–40.
- 11 Gonzalez NR, Duckwiler G, Jahan R, *et al.* Challenges in the endovascular treatment of giant intracranial aneurysms. *Neurosurgery* 2006;59:S113–24.
- 12 Siddiqui AH, Kan P, Abila AA, *et al.* Complications after treatment with pipeline embolization for giant distal intracranial aneurysms with or without coil embolization. *Neurosurgery* 2012;71:E509–13.
- 13 Jafar JJ, Russell SM, Woo HH. Treatment of giant intracranial aneurysms with saphenous vein extracranial-to-intracranial bypass grafting: indications, operative technique, and results in 29 patients. *Neurosurgery* 2002;51:138–44.
- 14 Park EK, Ahn JS, Kwon do H, *et al.* Result of extracranial–intracranial bypass surgery in the treatment of complex intracranial aneurysms: outcomes in 15 cases. *J Korean Neurosurg Soc* 2008;44:228–33.
- 15 Clarençon F, Perot G, Biondi A, *et al.* Use of the Ascent balloon for a 2-in-1 remodeling technique: feasibility and initial experience: case report. *Neurosurgery* 2012;70:170–3.
- 16 Tjoumakaris SI, Dumont AS, Gonzalez LF, *et al.* A novel endovascular technique for temporary balloon occlusion and permanent vessel deconstruction with a single microcatheter. *World Neurosurg.* Published Online First 25 Jan 2012. doi: 10.1016/j.wneu.2012.01.032.
- 17 Fifi J, Niimi Y, Berenstein A. Onyx embolization of an extensive mandibular arteriovenous malformation via a dual lumen balloon catheter: a technical case report. *J Neurointerv Surg* 2013;5:e5.

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