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Technical Notes

Y-stent-assisted coiling for large wide-neck dysplastic middle cerebral artery bifurcation aneurysm: An update to procedural technique

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ABSTRACT

Background: The endovascular treatment of complex middle cerebral artery (MCA) aneurysms, particularly dysplastic large MCA bifurcation aneurysms, can pose significant technical challenges. We aim to present three cases illustrating the technical nuances and challenges often encountered in Y-stent-assisted coiling (Y-SAC) for such aneurysms and provide an update on technical nuances.

Methods: We present three consecutive cases of dysplastic MCA aneurysms, each >10 mm with a wide neck. We successfully performed Y-SAC in all cases on the first attempt using the "around the world" technique and used Neuroform Atlas Stent (Stryker Neurovascular, California, USA) as a distal anchor to reduce the microcatheter loop. Immediate final digital subtraction angiography showed adequate occlusion of all aneurysms.

Results: All patients tolerated the procedure well and were discharged home on postoperative day (POD) 1 in all cases. The first patient required a second coiling at the aneurysm neck 6 months after initial treatment, with complete protection of the dome. The second patient's 6-month follow-up angiogram showed complete occlusion of the aneurysm with patency of all MCA branches. Unfortunately, the third patient failed to comply with dual antiplatelet therapy after discharge and developed stent thrombosis 3 months postprocedure and passed away.

Conclusion: Y-SAC is a reasonable option for large, wide-neck, MCA bifurcation aneurysms in patients who are not fit for microsurgical clipping and/or bypass surgery. Complex endovascular techniques, including aneurysm encircling and the "Atlas Stent Anchor" technique, may be necessary to complete the procedure successfully.

Keywords: Aneurysm, Dysplastic, Middle cerebral artery bifurcation, Neuroform atlas stent, Procedural technique, Y-stent-assisted coiling

INTRODUCTION

Historically, microsurgical clipping has been the primary intervention for middle cerebral artery (MCA) aneurysms.[13] It can be technically challenging for large dysplastic aneurysms because the neck of the aneurysm may incorporate one or both M2 divisions, putting the patient at risk for either stroke or incomplete aneurysm occlusion.[4] Certain patients may be medically unfit for a long and complex microsurgery. Therefore, there is a need for good endovascular alternatives. Stand-alone or balloon-assisted coiling often cannot permanently protect the M2 branches. Intrasaccular devices (e.g., Woven EndoBridge – [WEB]) are limited in size and may not be an option for larger aneurysms.[9] Intraluminal flow diversion devices are not usually an option for MCA bifurcation aneurysms.[12] We present three cases of Y-stent-assisted coiling (Y-SAC) as an approach to treat large wide-neck dysplastic MCA bifurcation aneurysms and provide a technical update for these complex endovascular procedures.

MATERIALS AND METHODS

All three patients presented with unruptured large dysplastic MCA bifurcation aneurysms [Figures 1a, 1b, 1c]. Dual antiplatelet therapy (DAPT) was started 2 weeks before all procedures and platelet reactivity units to clopidogrel confirmed responder status. Femoral access was obtained with a 6-Fr short sheath. A Benchmark guide catheter (Penumbra, Alameda, CA) was positioned in the distal cervical internal carotid artery (ICA). A 5 Fr Sofia intermediate catheter (MicroVention, California, USA) was placed in the cavernous ICA. An SL-10 microcatheter (Stryker Neurovascular, Fremont, California, USA) was navigated over Synchro 2 microwire (Stryker Neurovascular, Fremont, California, USA) first into the more challenging M2 branch through an "around the world" technique [Figures 2a, 2b, 2c]. Neuroform Atlas Stent (Stryker Neurovascular, Fremont, California, USA) 4.5 × 30 mm was partially deployed as an anchor, and microcatheter loop was reduced, and the entire stent was deployed [Videos 1 and 2]. The second stent was deployed through the first stent. The aneurysm was then occluded using Target coils (Stryker Neurovascular,

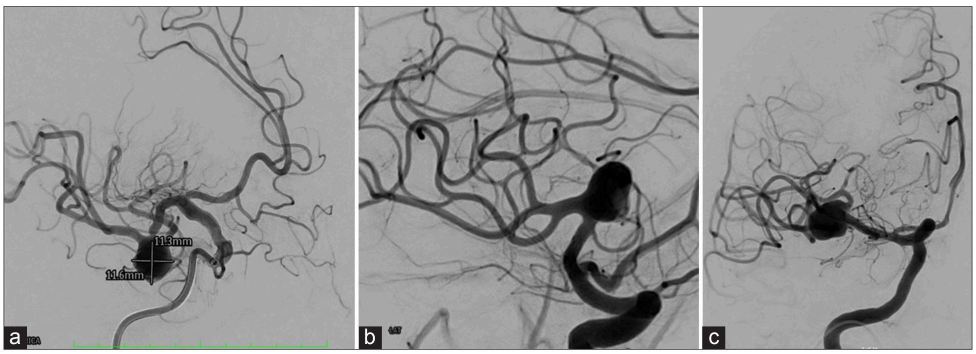


Figure 1: (a)Patient1: 70-year-old male presented with a large unruptured right middle cerebral artery (MCA) bifurcation aneurysm. He was reluctant to undergo open surgery and, therefore, chose an endovascular treatment. Large unruptured 11.3 × 11.6 mm right MCA bifurcation aneurysm, which was pointing anteriorly and inferiorly. (b)Patient 2: 82-year-old female whose work-up for left-sided facial droop and weakness showed an unruptured large dysplastic right MCA bifurcation aneurysm. Large unruptured dysplastic right MCA bifurcation aneurysm measuring 10 × 10 mm, which was pointing anteriorly and superiorly, and incorporating both M2 branches. (c)Patient 3: 57-year-old female with autosomal dominant polycystic kidney disease, end stage renal disease and history of ischemic stroke who had a prior left MCA aneurysm that was clipped two decades ago. She presented with a new unruptured dysplastic right MCA bifurcation aneurysm. Given her complex medical and surgical history, and importantly, her significant previous contralateral stroke, we felt that microsurgical treatment with clipping and/or bypass surgery was not a good option for her. The aneurysm measured 12 ×12 × 10 mm, and dome was irregular in shape. It did not have a definable neck with both M2 branches arising from the aneurysm itself.

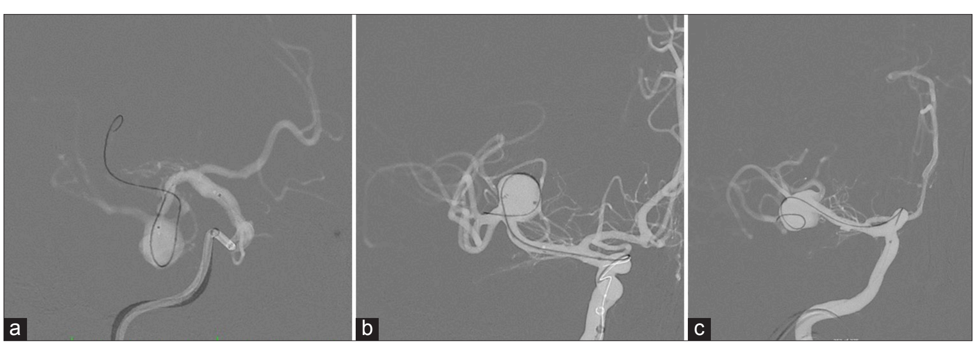
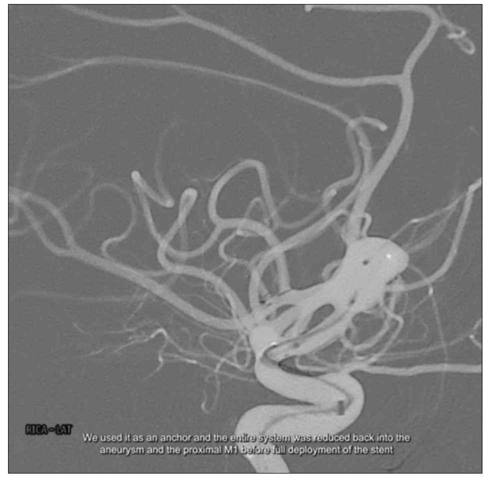


Figure 2: Microcatheter and Microwire were navigated into right M2 branch through 'around the world' technique. (a): Patient1; (b): Patient 2; (c): Patient 3.

Video 1: The video shows the case 2 patient's digital subtraction angiography anteroposterior view. We used the Neuroform Atlas Stent (Stryker Neurovascular, Fremont, California, USA) as an anchor to reduce the microcatheter loop.



Video 2: The video shows the case 2 patient's digital subtraction angiography lateral view. We used the Neuroform Atlas Stent (Stryker Neurovascular, Fremont, California, USA) as an anchor to reduce the microcatheter loop.

Fremont, California, USA). Final digital subtraction angiography (DSA) demonstrated adequate immediate occlusion (Raymond–Roy 2 or better) of all aneurysms and patency of all MCA branches [Figures 3a, 3b, 3c], Figure 3a with highlights of the stents in red dots).

RESULTS

All patients tolerated the procedure well and were discharged home on postoperative day (POD) 1. At the 6-month follow-up angiogram, there was slightly increased filling at the base of the first patient's aneurysm due to coil compaction, and the aneurysm was re-coiled for complete occlusion [Figure 4a]. The second patient's 6-month follow-up angiogram showed complete occlusion of the aneurysm with patency of all MCA branches [Figure 4b]. Unfortunately, the third patient failed to comply with DAPT after discharge and developed stent thrombosis 3 months postprocedure and passed away.

DISCUSSION

The treatment of large, dysplastic, and wide-neck MCA bifurcation aneurysms can be challenging with either microsurgical or endovascular techniques. Y-SAC is a good option, but advanced endovascular techniques are necessary. In this report, we provide an update on endovascular maneuvers to make this procedure successful. Conventional coiling of such dysplastic wide-neck aneurysms is not feasible because the coils would herniate into the parent artery. To address this, balloon-assisted coiling (BAC) was introduced by Moret *et al.*[11] and stent-assisted coiling (SAC) by Higashida *et al.* was published in 1997.[7] However, multiple studies have shown the superiority of SAC compared to BAC due to the permanent "scaffold" across the aneurysm ostium.[2,10,14] In the setting of endovascular treatment for unruptured MCA bifurcation aneurysms, the focus of interest has shifted from BAC to SAC. There are various types of stent options.[1] An open cell design is preferred for Y-stent-assisted coiling. All the aneurysms presented in our cohort were large dysplastic MCA bifurcation aneurysms with wide necks, incorporating one or two M2 branches. Therefore, it is crucial to cover both M2 branches with stents. The Y-SAC technique, first introduced by Chow *et al.*, in 2004 [3], has since been extended to various intracranial aneurysm locations, though it remains most used in basilar tip aneurysms. The Neuroform Stent (Stryker Neurovascular, Fremont, California, USA) was the first self-expanding nitinol stent approved by the Food and Drug Administration in 2002 for the treatment of wide-necked intracranial aneurysms.[5,8] Later, iterations of stent design allow for a lower profile delivery, better scaffolding, and higher conformability to the vessel wall than the previous generation.[8] Most importantly, it can be deployed in a Y configuration, which makes it our stent-of-choice. The WEB embolization device (Sequent Medical Inc., Aliso Viejo, California, USA) is also a viable treatment option. However, the aneurysms presented here are characterized by their significant size, dysplastic nature, and non-definable neck, which make it impossible to select an appropriate size of the WEB device to effectively seal the aneurysm-parent vessel interface while preserving the parent and branch vessel's patency.

In the current cohort, Y-SAC was feasible in all cases on the first attempt. Several steps facilitated procedural success. First, it is essential to identify and stent the more challenging M2 branch based on vessel diameter and angulation. Second, in large aneurysms with turbulent intra-aneurysmal flow, it may be difficult to navigate the microwire into the outflow

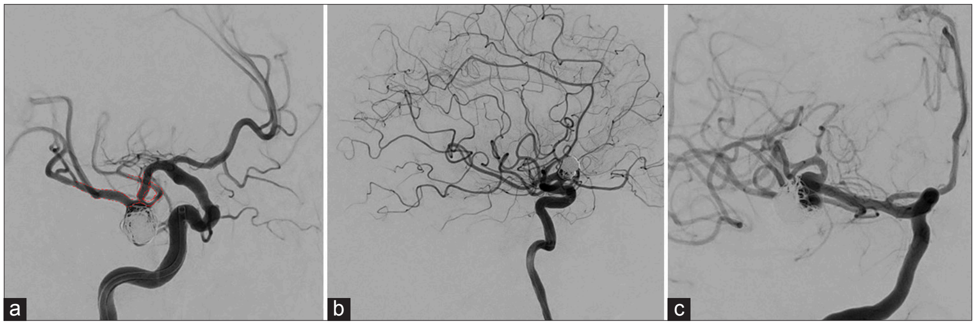


Figure 3: (a)Patient 1: Digital subtraction angiography (DSA) demonstrated adequate occlusion of the aneurysm and patency of all middle cerebral artery (MCA) branches immediately after initial treatment (Raymond Roy class 2). Highlights of the stents in red dots. (b)Patient 2: DSA demonstrated adequate occlusion of the aneurysm and patency of all MCA branches immediately after initial treatment (Raymond Roy class 2). (c)Patient 3: DSA demonstrated adequate occlusion of the aneurysm and patency of all MCA branches immediately after initial treatment (Raymond Roy class 3).

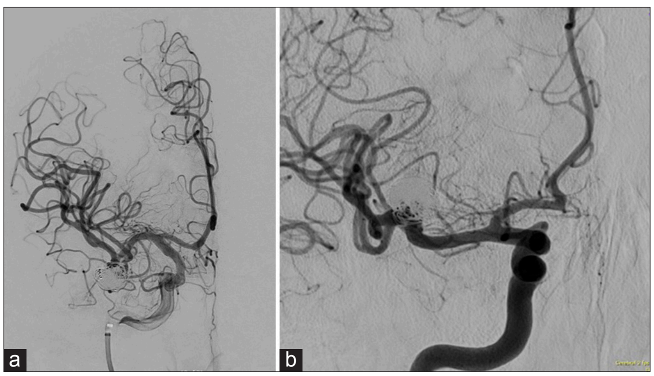


Figure 4: (a)Patient 1: We recoiled the patient's aneurysm neck at 6 months post initial treatment. Final digital subtraction angiography(DSA) demonstrated almost complete occlusion of the aneurysm and patency of all middle cerebral artery (MCA) branches. (Raymond Roy class 2). (b)Patient 2: Complete occlusion of the aneurysm and patency of all MCA branches 6 months after treatment (Raymond Roy class 1).

branch without using the "around the world" technique. Several techniques have been described for the reduction of the microcatheter loop. In our cases, partial retraction of the microwave followed by the microcatheter did not achieve loop reduction. Instead, we successfully used the Neuroform Atlas Stent as a distal anchor and carefully reduced the loop, followed by complete stent deployment [Videos 1 and 2]. Premature stent deployment before loop reduction must be avoided as it would cause the proximal stent to float within the aneurysm. A longer stent (24 or 30 mm) is, therefore, recommended. Third, we found that it is safer and more efficient to re-enter the first stent after deployment by tracking the microcatheter over the stent lead wire. This guarantees the entry into the true lumen of the stent and avoids the microwire entanglement, which can push the stent forward. Finally, after placing the second stent, use the stent lead wire again to track the microcatheter back into the stent construct before entering the aneurysm for coiling. Alternatively, a 2nd microcatheter can be jailed up front and used for coiling.

In all our cases, the stent placement and aneurysm coiling were done in a single stage, and we observed no intraoperative complications. Although the first patient required a second coiling at the aneurysm neck, most patients demonstrated complete or near-complete occlusion of the aneurysms with patency of all MCA branches and stable neurological baseline at the 6-month follow-up. Unfortunately, the third patient, who failed to comply with DAPT after discharge, developed in-stent occlusion 3 months postprocedure and was deceased. This highlights the critical importance of consistently using DAPT after intracranial stent placement. All patients were discharged home on POD 1, resulting in significantly shorter hospital stays compared to traditional surgical clipping. Finally, we want to highlight that the advantage of Y-SAC goes beyond aneurysm embolization, and the stent is thought to achieve endothelial remodeling for a more durable occlusion. As shown in the ATLAS investigational device exemption (IDE)premarket approval study, the Raymond–Roy 1 occlusion rates were 84.7% at 12 months and morbidity of <5%.[6,15]

CONCLUSION

Y-SAC is a reasonable option for large, wide-neck MCA bifurcation aneurysms in patients who are not fit for microsurgical clipping and/or bypass surgery. Complex endovascular techniques, including aneurysm encircling and the "Atlas Stent Anchor" technique, may be necessary to complete the procedure successfully.

Ethical approval

The Institutional Review Board has waived the ethical approval for this study

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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