In Reply: Safety, Efficacy, and Durability of Stent Plus Balloon-Assisted Coiling for the Treatment of Wide-Necked Intracranial Bifurcation Aneurysms

To the Editor:

We would like to thank Dr Raper and Dr Abla[1] for their comments regarding our recent study[2] entitled "Safety, efficacy, and durability of stent plus balloon-assisted coiling for the treatment of wide-necked intracranial bifurcation aneurysms."

The modern endovascular surgery of intracranial aneurysms started with the simple coiling of narrow-necked side wall aneurysms.[3] Over the last 20 yr, several sophisticated techniques such as balloon remodeling, stent-assisted coiling, dual-stenting, flow diversion, and intrasaccular flow disruption have been developed to extend the scope of endovascular neurosurgery to include the treatment of wide-necked and bifurcation aneurysms.[4-8] Endovascular neurosurgery still continues to evolve new strategies for a safer and durable treatment of wide-necked and complex bifurcation aneurysms. Considering the complexity and heterogeneity of this disease, each patient should have a tailored treatment plan for their particular aneurysm.[9] Stent plus balloon-assisted coiling is one of the endovascular options that could be applied for the treatment of unruptured complex bifurcation aneurysms with an appropriate vascular anatomy. The main strategy of this endovascular technique is that it could obviate the requirement for the implantation of a second stent to protect the side branches in a complex bifurcation anatomy. In this study, we investigated the efficacy and safety of this endovascular technique for the treatment of wide-necked bifurcation aneurysms.[2] As a limitation of this retrospective study, the methodology did not include any control patient group treated with alternative endovascular techniques or clipping, to compare the outcomes. However, the clinical and angiographic results were promising and satisfactory. Ninety percent of the coiled complex bifurcation aneurysms remained totally occluded at the end of a mean follow-up period of 25.5 mo. And, during the follow-up period, only 1 basilar bifurcation aneurysm required retreatment (1.8%). No patient with an anterior circulation aneurysm required retreatment. The endovascular procedures caused a morbidity in 3.3% (the modified Rankin Scale $\leq$ 2) and no mortality. These results showed that stent plus balloon-assisted coiling is an effective, safe, and durable treatment option for wide-necked complex bifurcation aneurysms located at posterior as well as anterior cerebral circulation.

The stent plus balloon-assisted coiling technique includes the coiling of wide-necked bifurcation aneurysms while protecting the side branches with a temporary inflation of a balloon catheter and deployment of a stent.[2] This technique often necessitates simultaneous catheterization of 2 side branches and also the aneurysm sac with 2 microcatheters and a balloon catheter. Dr Raper and Dr Abla[1] commented that stent plus balloon-assisted coiling technique can be performed by 1 microcatheter and 1 balloon catheter if a stent is deployed first, and then the stent delivery catheter can be used to cross the stent into the aneurysm.[1] We partly agree with Dr Raper and Dr Abla that the stent plus balloon-assisted coiling technique can be safely performed by using 2 microcatheters only if a laser-cut stent with an open-cell structure is used. However, it is safer to jail the coiling microcatheter inside the aneurysm sac if a braided stent is preferred (Figure). The braided stents have relatively smaller cell sizes compared to those of the open-cell stents, and an attempt to cross through the small-sized cells of a braided stent may result in dislocation of the stent into the aneurysm sac or deformation of the stent. Because the braided stents enable resheating and stent repositioning of maneuvers, which may be required at the initial stages of the stent plus balloon-assisted coiling procedure, we preferred to implant braided stents in the majority of our cases (90.2%).[2] A neurovascular long sheath with an internal lumen diameter $\geq$ 0.88 inch (Axs Infinity LS [Stryker Neurovascular, Fremont, California], Neuron Max 088 [Penumbra, Alameda, California], Fubuki 8F [Asahi Intecc, Aichi, Japan]) can accommodate two 1.7F microcatheters plus a balloon catheter with a distal shaft diameter $\leq$ 2.2F. The neurovascular long sheaths have a soft distal tip and supportive proximal shaft. In our cases, the distal tip of the guiding sheath was placed in the distal cervical segment of the internal carotid artery or distal V2 segment of the vertebral artery.

We agree with Dr Raper and Dr Abla that simultaneous use of 3 microcatheters might increase the potential risk of thromboembolism.[1] To reduce this potential risk, we used the low-profile microcatheters (with a distal shaft diameter of 1.7F) for both coiling and stent delivery. Furthermore, the precise control of the blood pressure and activated clotting time (ACT) during the entire endovascular operation help reduce the risk of intraprocedural thromboembolic events. We started intraprocedural heparin infusion with a bolus dose of 50 IU/kg following the placement of a guiding sheath into the target artery. Then, the infusion rate was adjusted, targeting an ACT value between 250 and 300 s. Prevention of catheter-induced vasospasm is another important issue for the avoidance of intraprocedural thromboembolic complications. Intra-arterial nimodipine infusion during the endovascular operation impedes the microcatheter-induced vasospasm.

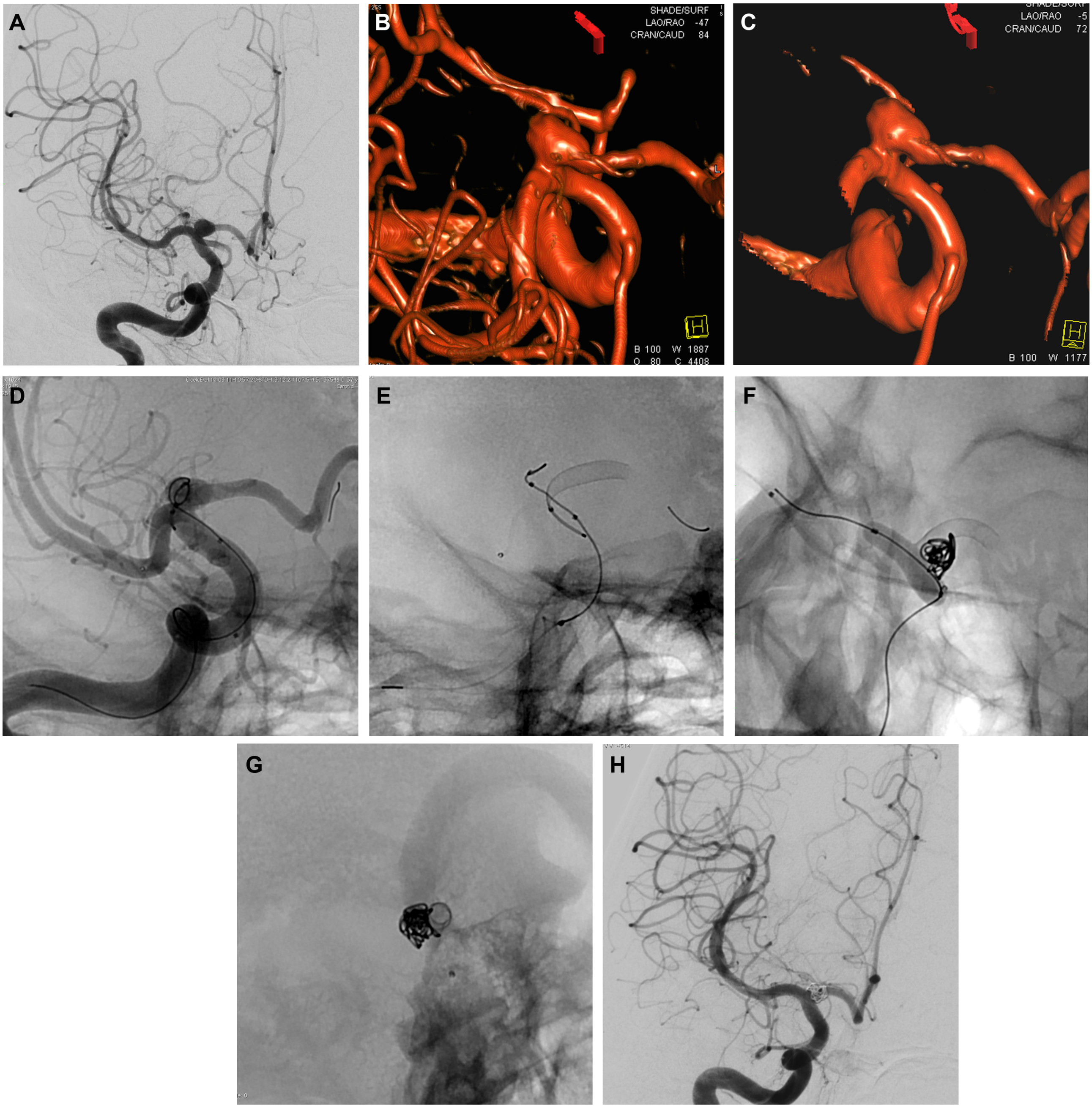

FIGURE. *Angiography images obtained during the stent plus balloon-assisted coiling procedure in a patient with right internal carotid artery (ICA) bifurcation aneurysm.* **A**, *Digital subtracted angiography (DSA) image shows the wide-necked aneurysm located at the bifurcation of right ICA.* **B** *and* **C**, *3-dimensional reconstructed angiography images demonstrate that the wide-necked aneurysm has fusiform and saccular components. The A1 segment of the anterior cerebral artery (ACA) is originating from the aneurysm sac.* **D** *and* **E**, *Nonsubtracted angiography images show that a low-profile braided stent (Silk Vista [Balt, Montmorency, France]) is partially deployed to prevent the protrusion of coils into the A1 segment of ACA. A balloon catheter (HyperGlide [Medtronic, Dublin, Ireland]) is placed into the ICA bifurcation to protect the M1 segment of middle cerebral artery and ICA. The coil delivery microcatheter is jailed inside the aneurysm sac.* **F**, *Nonsubtracted angiography image shows the full deployment of the stent following a sufficient coil mesh formed inside the aneurysm sac to prevent the protrusion of the proximal flares of the stent into the sac. The inflated balloon helps in the precise deployment of the stent.* **G**, *Nonsubtracted angiography image obtained in lateral projection demonstrates the fully deployed stent in the ACA and coil package inside the aneurysm sac.* **H**, *DSA image obtained just after the completion of the endovascular procedure shows the complete occlusion of the aneurysm and patency of all vessels.*

Funding

This study did not receive any funding or financial support.

Disclosures

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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https://doi.org/10.1093/neuros/nyab323