Endovascular treatment of a fusiform basilar artery aneurysm using multiple “in-stent stents”

Technical note

R. Webster Crowley, M.D.,1 Avery J. Evans, M.D.,2 Neal F. Kassel, M.D.,1 Mary E. Jensen, M.D.,2 and Aaron S. Dumont, M.D.1,2

Departments of 1Neurological Surgery and 2Radiology, University of Virginia Health System, Charlottesville, Virginia

Fusiform aneurysms of the basilar artery present difficult challenges for the treating physician. On one hand, these aneurysms are difficult and dangerous to treat. On the other, the relatively high rupture rate, risk of thromboemboli, and the frequent presence of mass effect on the brainstem often demand treatment rather than observation. While conservative treatment may be reasonable in an elderly patient, the relative resiliency and the larger lifetime cumulative risks of pediatric patients are compelling arguments for treatment. With the advancement of endovascular techniques some of these lesions have become treatable without the high morbidity and mortality rates associated with open surgical treatment, albeit with risks of their own. The authors present the case of a fusiform aneurysm arising from a severely tortuous basilar artery in a 22-month-old boy. The aneurysm was successfully treated using flow diversion by placing multiple intracranial stents without coil embolization. This allowed for thrombosis of the aneurysm and resolution of the mass effect on the brainstem without compromising blood flow to the brainstem. (DOI: 10.3171/2009.2.PE908468)

Key Words • basilar artery • intracranial aneurysm • stent endovascular treatment

Abbreviations used in this paper: AICA = anterior inferior cerebellar artery; BA = basilar artery; PCA = posterior cerebral artery.

Methods

Patient Examination

This 22-month-old boy originally presented to medical attention when his family noticed that he was not meeting his developmental milestones. His prior history was significant for prenatal maternal drug use that lasted throughout her entire pregnancy, and the patient had been adopted by his current family shortly after birth. On questioning, the mother stated that the patient was able to crawl, but he could not walk. She also reported that he had difficulty swallowing, as well as a slight right hemiparesis that had not changed over the preceding months. The patient underwent a pediatric neurodevelopmental assessment that included MR imaging of the brain. The MR imaging revealed an unruptured mid-BA aneurysm, and the patient was subsequently referred for neurosurgical evaluation.

The physical examination was significant for a mild increase in tone in the right upper extremity, and the pa-
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Patient was noted to favor his left side significantly. Otherwise the physical findings were unremarkable. Laboratory examinations, including HIV screening, were similarly unremarkable.

Cerebral angiography revealed a fusiform mid-BA aneurysm that had enlarged since MR imaging had been performed, measuring ~15.5 × 16 × 9.9 mm (Fig. 1). The aneurysm extended from a point distal to the AICA to the superior cerebellar arteries, with an eccentric outpouching. The BA was noted to be severely tortuous.

**Endovascular Treatment**

Because of the progressive enlargement of the aneurysm, its associated symptoms, and the age of the patient, the decision was made to proceed with treatment. The fusiform nature and the location of the aneurysm made surgical clipping less desirable. Consideration was given to trapping the aneurysm or performing hunterian ligation, either surgically or endovascularly; however, after prolonged discussions with the family, the decision was made to attempt to treat the aneurysm endovascularly while preserving the parent artery. The patient was pretreated with 162 mg of aspirin for the 4 days leading up to his endovascular treatment.

After obtaining access in the right common femoral artery, a 5 Fr guide catheter was advanced into the left vertebral artery. After diagnostic injections reconfirmed the previously noted aneurysm, a 4.5 × 37–mm Cordis Enterprise microstent (Cordis Neurovascular) was advanced through the guide catheter into the BA, centering it over the aneurysm. The distal tines of the stent were located in the distal BA, proximal to the origins of the PCAs, and the proximal tines were placed just rostral to the origins of the AICAs. With placement of the Enterprise microstent, decreased flow was observed within the aneurysm, and the BA was noted to straighten slightly.

After placement of the first stent, a second Enterprise microstent measuring 4.5 × 28 mm was advanced into the BA and deployed within the previous stent, centered within the stent, across the neck of the aneurysm. The flow into the aneurysm was further decreased, and the BA straightened further. Lastly, a third Enterprise microstent measuring 4.5 × 22 mm was deployed within the previously placed stents, again centering over the neck of the aneurysm. With the placement of the third stent, prolonged stasis was seen within the aneurysm, and the BA was changed in configuration so that it was now significantly straightened. A subsequent control angiogram noted patency of the stents, and flow stasis within the aneurysm (Figs. 2 and 3).

**Results**

The patient tolerated the procedure well and was...
transferred to the pediatric intensive care unit for overnight observation. The patient was noted to be somewhat lethargic after the procedure; however, he quickly recovered and returned to his baseline status within 24 hours of treatment. After 2 days of postprocedural observation he was discharged home with instructions to take aspirin 81 mg twice a day.

The patient returned 4 months later for a follow-up angiography and MR imaging/MR angiography. The angiogram revealed that the aneurysm was almost completely excluded from the circulation, with only minimal filling of the left superior posterior aspect of the aneurysm. The BA was completely straight, and there was no in-stent stenosis. Normal flow was seen in the bilateral PCAs, superior cer-

Fig. 3. Preprocedural (left) and immediately postprocedural (right) anteroposterior images. The BA is significantly less tortuous, and increased filling of the PCA territory is observed.

Fig. 4. Cerebral angiograms obtained 4 months after placement of stents. Left: Anteroposterior image revealing a near complete straightening of the BA, with preserved antegrade flow. A small residual aneurysm is noted arising from the left side of the BA; however, most of the aneurysm has thrombosed. Right: Lateral image again showing near complete thrombosis of the aneurysm.

Fig. 5. Axial T2-weighted MR images obtained ~3 months prior to treatment (A–C), and at the time of follow-up 4 months after stent placement (D–F). A significant decrease in the size of the BA lumen is seen postprocedurally, as is an improvement in the mass effect on the brainstem. There is no evidence of brainstem infarction.

ebellar arteries, AICAs, and posterior inferior cerebellar arteries (Fig. 4).

The MR imaging/MR angiography studies confirmed the findings of the angiogram, suggesting that the aneurysm had thrombosed. No evidence of infarction was seen in the brainstem or cerebellum, and the previously observed mass effect on the brainstem had largely resolved (Fig. 5). The patient was discharged without further treatment, and is scheduled for MR imaging/MR angiography in 12 months’ time.

Discussion

We have described a large fusiform aneurysm of the BA that was successfully treated with a stent-in-stent
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technique without coil embolization. The treatment of fusiform aneurysms of the BA is extremely difficult for a variety of reasons, including their proximity to the brainstem and the exiting cranial nerves, the presence of perforating vessels, and the surgical approaches necessary to access the BA.

Because of the difficulty of treating fusiform arteries of the BA, a variety of techniques have been reported. Many of these, however, have entailed complete occlusion of anterograde blood flow through the vertebral arteries into the affected BA segment, with or without trapping of the aneurysm. These treatments can be especially dangerous when the aneurysm involves perforating arteries, in which case sacrifice of the diseased segment can result in disastrous brainstem infarction. Similarly, problems may arise with proximal occlusion of the BA in cases in which collateral supply from the anterior circulation is suboptimal, a situation that may require surgical bypass to augment blood flow to the distal portions of the BA.

With continued advancements in endovascular techniques, intracranial stents have been shown to be useful in the treatment of fusiform and wide-necked aneurysms. In 1997, Higashida et al. first described the treatment of an intracranial aneurysm by using stent-assisted coil embolization. Since that first report, the successful application of this technique has become well-documented. Shortly after the utility of intravascular stents became apparent, several stents were developed primarily for use in the treatment of intracranial aneurysms, including the Neuroform and Enterprise stents.

In 2004, Fiorella et al. published their experience with the Neuroform microstent (Boston Scientific/Target) in which they described 4 patients whose aneurysms were treated with stents without concomitant coil embolization. Zenteno et al. later described their experience with “sole stenting” using coronary stents, and deemed it a plausible treatment for intracranial aneurysms. Using this method they effectively treated aneurysms of the vertebrobasilar junction, a technique that has since been applied to aneurysms in other locations.

The main theory behind the success of “sole stenting” is that by altering the flow dynamics of the parent artery, the stent is able to induce thrombosis of the aneurysm and effectively exclude the aneurysm from the parent artery. Fiorella et al. recently reported on their experience with the Pipeline embolization device (Chestnut Medical), a relatively new endovascular implant that capitalizes on this concept by excluding the aneurysm from the circulation while redirecting blood flow in the parent artery.

In our case, the particularly tortuous BA created several sharp angles that were points of high stress and flow turbulence. By redirecting the flow and correcting the tortuosity of the BA, we were able to induce thrombosis within the aneurysm while keeping the BA patent, avoiding ischemic injury to the adjacent brainstem. Unlike placing multiple overlapping stents in a telescoping fashion, a technique that is often done to ensure complete coverage of the aneurysm neck, the placement of multiple stents within each other served to create more flow diversion as well as straighten the BA. This straightening in turn diverted even more flow away from the aneurysm, contributing to the continued aneurysmal thrombosis. In addition, we were able to avoid placing coils, which might have, at least temporarily, increased mass effect on an already compromised brainstem.

Conclusions

We have presented a unique case in which multiple in-stent stents were deployed to divert blood flow away from a large BA aneurysm in a pediatric patient. By redirecting flow away from the aneurysm and straightening the parent BA, successful thrombosis of the aneurysm occurred without accompanying compromise of the perforating branches to the brainstem.

Disclaimer

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References


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Address correspondence to: Aaron S. Dumont, M.D., Department of Neurological Surgery, University of Virginia Health System, Box 800212, Charlottesville, Virginia 22908. email: asd2f@virginia.edu.