Beneficial Remodeling of Small Saccular Intracranial Aneurysms after Staged Stent Only Treatment: A Case Series

Eric M. Nyberg, MD,* and Theodore C. Larson, MD†

Background: We evaluated the effect of stent alone treatment for small intracranial aneurysms that were not amenable to coil embolization without prior stent reconstruction. *Methods:* This case series was conducted in the neurosurgical service at a tertiary care hospital in Denver, Colorado. Nine patients were electively treated for intracranial aneurysms. All patients had a single low porosity stent reconstruction device placed across the neck of a small intracranial aneurysm. The main outcome measures were changes in aneurysm size and parent vessel morphology during follow-up. *Results:* Nine patients underwent stent alone treatment for unruptured intracranial aneurysms. The mean follow-up period was 9.6 months (range 6-17 months). There were no cases of periprocedural morbidity or aneurysm rupture during follow-up. All aneurysms decreased in size, and 3 of 9 aneurysms were gone at follow-up. In addition, at follow-up all parent vessels demonstrated straightening about the aneurysm site. *Conclusions:* Beneficial remodeling with a decrease in the size of small intracranial aneurysms may be seen after treatment with a single stent alone, particularly if the aneurysm arises at an arterial bend or bifurcation. This phenomenon may be related to a degree of straightening of the parent artery, improving hemodynamic conditions about the aneurysm site. **Key Words:** Intracranial aneurysm—stent—vascular remodeling.

Endovascular treatment of intracranial aneurysms (IAs) often includes the placement of a Neuroform stent (Stryker, Kalamazoo, MI) or Enterprise vascular reconstruction device (VRD; Codman Neurovascular, Raynham, MA), particularly if the aneurysm has a wide neck or unfavorable dome to neck ratio. Stent reconstruction devices were originally designed to create a frame at the neck that prevents coil herniation[1]; however, other mechanisms of aneurysm treatment with these devices have been investigated, including the creation of flow disruption or diversion and the provision of scaffolding for re-endotheliazation.[2] Computational flow dynamics analysis has suggested that stent reconstruction may reduce wall shear stress (WSS) and aneurysmal inflow.[3-5]

We present 9 cases of staged, elective aneurysm treatment in which placement of a stent reconstruction device alone resulted in straightening of the parent artery with subsequent angiographic remodeling and decrease in aneurysm size. In each of these cases, at the time the patients returned for coiling, the aneurysm had decreased significantly in size and coiling was not attempted. Staging treatment in this manner may allow the aneurysm to shrink in some patients, thereby precluding the need to expose them to the risk of coil embolization.

Methods

Subjects and Data Collection

Under an institutional review board–approved protocol, a review of our institutional database yielded 45 aneurysms <7 mm that underwent endovascular treatment between July 2010 and June 2011. Of these, 33

From *Vista Radiology, Knoxville, Tennessee; and †Intermountain Neurosugery, St. Anthony's Hospital, Denver, Colorado.

Received May 30, 2012; revision received July 10, 2012; accepted September 19, 2012.

Address correspondence to Eric M. Nyberg, MD, Vista Radiology, 2001 Laurel Avenue, Knoxville, TN 37916. E-mail: ericmnyberg@gmail.com.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2012.09.012

aneurysms were treated with coil embolization alone, including 6 aneurysms treated in the setting of subarachnoid hemorrhage. Three were treated with stent and coil embolization and 9 were treated with stent remodeling alone. Therefore, 9 of 39 (23%) electively treated small aneurysms during this period underwent presumed staged treatment with stent remodeling; these cases are described herein.

These 9 cases were performed in 6 patients (3 men and 3 women) who were between 42 and 70 years of age (average 57 years; Table 1). All cases were elective, but 2 patients had previously suffered subarachnoid hemorrhage from other, previously treated aneurysms, and 2 other patients reported remote histories suspicious for a sentinel bleed. A staged approach to treatment was preferred in these patients to allow the stent to become endothelialzed, reducing the risk of stent migration along curvatures and allowing for increased stability during coil embolization. All patients were premedicated with dual antiplatelet therapy consisting of 75 mg of clopidogrel and 325 mg of aspirin per day for 5 days before treatment. Clopidogrel was continued for 1 month postprocedure, and aspirin was continued indefinitely. Of the 9 aneurysms, 2 were located at the anterior communicating artery complex, 4 were located in the intracranial vertebral arteries, 1 at the superior cerebellar artery origin, and 1 on the posterior cerebral artery P2 segment. All IAs were small (<7 mm).

All patients presented for staged elective aneurysm treatment and were treated with either an Enterprise VRD (4 cases), Neuroform stent (2 cases), or a Wingspan stent (Stryker; 3 cases). Volumetric aneurysmal filling was estimated using Angiosuite software (Cascade Medical LLC, Knoxville, TN). Indications for treatment included history of subarachnoid hemorrhage from other, previously treated aneurysms (cases 7, 8, and 9); recurrence of previously ruptured and coiled aneurysm (case 6); and history suspicious for sentinel bleed several weeks earlier (case 1). Cases 2, 3, 4, and 5 were in patients with multiple aneurysms, potentially putting them at increased risk of hemorrhage. Discussion regarding the use of Humanitarian Device Exemption devices was part of the consent process for each patient, and additional device-specific consent forms were completed per the institutional review board protocol. A Wingspan stent was used in cases with perianeurysmal stenosis of the parent artery.

Description of Technique

All procedures were performed under general anesthesia. Systemic heparinization was initiated before stent deployment with the goal of maintaining the activated clotting time at 2 to 3 times the baseline. A 6-Fr Envoy guide catheter (Codman Neurovascular) was placed in the distal cervical internal carotid artery for the anterior communicating artery aneurysms or the proximal cervical vertebral artery for posterior circulation aneurysms. Working projections were obtained from reconstructed 3-dimensional rotational angiography in most cases. Under roadmap conditions, a Prowler Select Plus catheter (Codman Neurovascular, Raynham, MA), Neuro Renegade Hi Flo catheter (Stryker, Kalamazoo, MI), or Wingspan system was advanced into the parent artery distal to the neck of the aneurysm over a 0.014-inch Synchro wire. The stent reconstruction device was then advanced across the neck of the aneurysm and deployed according to the manufacturer's guidelines. Final control angiography was performed and all catheters were removed. Hemostasis was obtained with a closure device.

All patients returned 4 to 8 weeks later for coil embolization; however, diagnostic angiography revealed that the aneurysms were found to have decreased in size such that coiling would have been challenging if not impossible. Therefore, they were scheduled for follow-up

Table 1. *Aneurysm size pre and post stent reconstruction*

Case no.	Age (y)	Location	Device*	Largest diameter (mm)/volume (mm^3)	Follow-up interval (months)	Result at follow-up	Volumetric decrease
1	56	IC vertebral	Wingspan	6.2/30.61	11.5	Complete resolution	100%
2	54	IC vertebral	Enterprise	3.2/12.63	8	2.5/6.62	48%
3	54	IC vertebral	Enterprise	3.3/4.18	11	2.3/3.66	23%
4	70	IC vertebral (proximal)	Wingspan	2.4/3.58	10	1.5/1.77	51%
5	70	IC vertebral (distal)	Wingspan	5.9/76.95	10	Complete resolution	100%
6	42	Ant comm complex	Enterprise	4.0/15.41	6.5	2.5/5.47	65%
7	63	Ant comm complex	Enterprise	2.6/6.26	17	1.0/0.38	94%
8	59	Superior cerebellar	Neuroform	2.2/2.58	6	1.8/1.90	26%
9	59	Postcerebral P2	Neuroform	1.2/0.90	6	Complete resolution	100%

Abbreviations: Ant comm, anterior communicating; IC, Intracranial.

*Wingspan and Neuroform stents are manufactured by Stryker (Kalamazoo, MI). The Enterprise vascular reconstruction device is manufactured by Codman Neurovascular (Raynham, MA).