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Operative Technique

Double waffle-cone technique using twin Solitaire detachable stents for treatment of an ultra-wide necked aneurysm

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ABSTRACT

Several stent-supported coiling techniques have been devised for treating wide-necked bifurcation aneurysms including the Y-stent and waffle-cone constructs. The Y-stent technique is not technically possible with obtusely oriented daughter vessels, and the waffle-cone method is inadequate for aneurysms with necks exceeding the stent's maximal expansion diameter. We describe here the novel use of the Solitaire electrolytically detachable slotted stent (Solitaire, ev3, Irvine, CA, USA) featuring large-sized cells to fashion a concentric "double waffle-cone" construct. This method enabled the doubling of the neck coverage to treat an ultra-wide necked middle cerebral aneurysm with obtusely oriented daughter branches. The technique relies on the intra-cell crossing of the first stent using the second stent delivery microcatheter and fine tuning the relative position with the aid of cross-sectional cone-beam computed tomographic angiography to achieve optimal coverage of the neck prior to detachment of the stents in position. A retrievable stent with large cells such as the Solitaire device is optimal for this application given the need for relative adjustment of the deployment before final stent release to avoid under- or over-penetration of the distal stent struts into the aneurysm dome. An additional advantage of this approach over the kissing-stent technique is the absence of intraluminal stent struts, which was confirmed here by down-the-barrel cross-sectional imaging. The double waffle-cone construct enabled the successful coiling of the aneurysm with no post-procedural ischemic events detected on diffusion-weighted MRI and with stable complete embolization and no residual filling or in-stent stenosis at 6 month follow-up.

1. Introduction

Wide-necked bifurcation aneurysms remain challenging for endovascular embolization as unassisted coiling risks coil mass herniation into the parent or daughter vessels. Stent supported coiling approaches include single-stent placement from the parent to one of the daughter vessels and Y-stenting with a stent in each daughter vessel with a common proximal concentric lumen [1]. Horizontal trans-circulation stenting relies on the presence of a prominent anterior or posterior communicating artery but is not relevant to end-territory lesions such as the middle cerebral artery bifurcation [2]. In cases of wide-necked lesions with daughter vessels at an angle not permitting microcatheter selection, the waffle-cone technique has been used to great effect to support the entire coil mass using a single stent deployed distally within the proximal dome and proximally in the parent vessel [3]. Nonetheless, ultra wide-necked bifurcation aneurysms are not amenable to any of these techniques. The maximal expansion diameter of available intracranial stents is 5 mm, so aneurysms with necks wider than this do not allow proper waffle-cone construction. Aneurysms in which the daughter branches originate at opposing ends of the proximal dome also have limitations for the waffle-cone method. We present here the novel use of the Solitaire (Solitaire, ev3, Irvine, CA, USA) electrolytically detachable slotted stent featuring large-sized cells to fashion a concentric coaxial double waffle-cone construct, to treat a 69-year-old woman with an ultra-wide necked middle cerebral artery aneurysm with obtusely oriented daughter branches. This technique was chosen after preoperative bench-top testing suggested clear-cut advantages in terms of intra-cell crossing, positional fine-tuning, lack of strut interlocking, and ability for complete capture before final electrolytically controlled detachment.

2. Technical consideration

A 69-year-old woman presented to the hospital for evaluation of a near-syncopal event. Computed tomography angiography

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revealed a large right middle cerebral artery bifurcation aneurysm along with severe bilateral vertebral artery origin stenosis. Cerebral angiography demonstrated an anteroinferiorly pointing saccular aneurysm at the bifurcation of the right middle cerebral artery measuring 8.2 mm deep by 7.4 mm wide, with a neck of 6.2 mm (Fig. 1). Surgical clipping was believed to carry a high risk because of concomitant vertebral artery stenosis and the patient's age. Endovascular embolization options were considered instead, including placing a stent from the inferior M2 segment to the M1 segment or using a kissing Y-stent construct to protect both M2 divisions. A single waffle-cone technique was unlikely to succeed given the width of the neck (Fig. 2A, "Waffle Cone"). We devised a novel double waffle-cone technique enabling protection of the origins of both M2 branches (Fig. 2A, "Double Waffle-Cone"). We considered constructing the waffle-cone with kissing stents, but felt that a coaxial, concentric arrangement would better limit metal in the vessel lumen (Fig. 2A, "Kissing Stent"). Bench-top planning was performed to assess feasibility (Fig. 2C, D). Cell-size analysis of the Solitaire stent, the Enterprise vascular reconstruction device (Codman Neurovascular, Raynham, MA, USA), and the Neuroform stent (Stryker Neurovascular, Fremont, CA, USA), revealed the Solitaire stent to have twice the cell area (Fig. 2B), providing the easiest intra-cell crossing by the second stent and the least limitation of second stent expansion. Additionally, the Solitaire device's 100% recoverability and electrolytically detachable design made it possible to readjust relative stent positioning before final deployment. The planned construct is detailed in sequential schematic form in Fig. 2E. The patient was started on aspirin 325 mg daily and clopidogrel (Plavix, Bristol-Myers Squibb, New York, NY, USA) 75 mg daily 6 days prior to the procedure. Platelet function tests obtained on the day of the procedure revealed optimally reduced platelet aggregation.

3. Technique

The procedure was performed under general anesthesia. An 8-French vascular sheath access was obtained in the right femoral artery and kept under continuous heparinized saline. A Guider Softip XF 7-French guide catheter (Boston Scientific, Natick, MA, USA) was loaded coaxially with a 5-French catheter and advanced to the proximal right internal carotid artery over a 0.035″ Glidewire (Terumo Interventional Systems, Tokyo, Japan). We attempted to deploy a stent spanning from the M1 to the inferior M2 using a Prowler Plus microcatheter (Codman Neurovascular) over a Synchro-2 Soft guide wire (Boston Scientific). Although it was possible to advance the wire from M1 into the distal portion of the inferior M2 division by deflection off the aneurysm dome, the microcatheter would not follow due to stenosis at the origin of the inferior M2 branch (Fig. 1D, arrow).

Instead, we proceeded with the plan to construct a double waffle-cone. We deployed a 4 mm × 20 mm Solitaire stent via a Prowler Plus Select microcatheter over a Synchro-2 Soft microwire using a push-pull technique with the distal end of the stent opening into the aneurysm and the proximal end in the M1 (Fig. 3A).

Next, another Prowler Plus Select microcatheter was advanced into the inferior aspect of the aneurysm, crossing a distal cell of the first stent (Fig. 3B). We deployed a 4 mm × 15 mm Solitaire stent with the distal end in the aneurysm and the proximal end in the M1 segment (Fig. 3C). Cone-beam computed tomographic

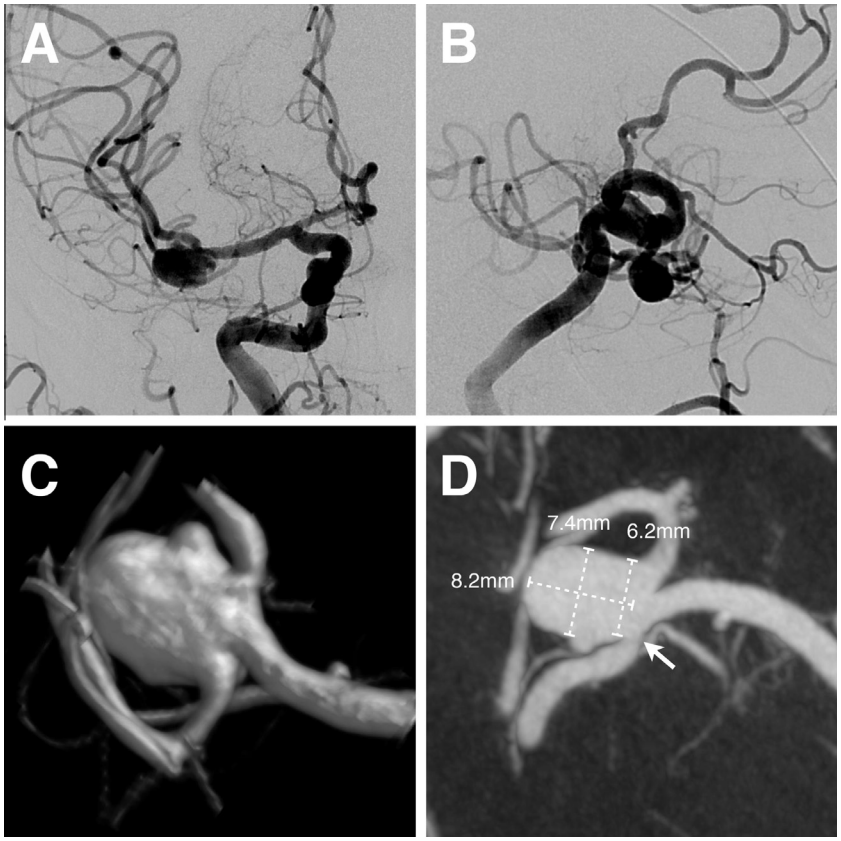

Fig. 1. (A, B) Right internal carotid artery injection digital subtraction angiography anteroposterior (A) and lateral-oblique (B) projections demonstrating a large middle cerebral artery bifurcation aneurysm. (C, D) Cone-beam computed tomography angiography three-dimensional (C) and axial (D) reconstructions demonstrating a wide neck and obtuse angles of the distal branches, with a stenotic area at the proximal segment of the inferior division (arrow).