Microguidewire Looping to Traverse Stented Parent Arteries of Intracranial Aneurysms

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Objective : Stents are widely used in coil embolization of intracranial aneurysms, but on occasion, a microcatheter must traverse a stented segment of artery (so-called trans-cell technique) to select an aneurysm, or double stenting may be necessary. In such situations, microguidewire passage and microcatheter delivery through a tortuous stented parent artery may pose a technical challenge. Described herein is a microguidewire looping technique to facilitate endovascular navigation in these circumstances.

Methods : To apply this technique, the microguidewire tip is looped before entering the stented parent artery and then advanced distally past the stented segment, with the loop intact. Rounding of the tip prevents interference from stent struts during passage. A microcatheter is subsequently passed into the stented artery for positioning near the neck of aneurysm, with microguidewire assistance. The aneurysm is then selected, steering the microcatheter tip (via inner microguidewire) into the dome.

Results : This technique proved successful during coil embolization of nine saccular intracranial aneurysms (internal carotid artery [ICA], 6; middle cerebral artery, 2; basilar tip, 1), performing eight trans-cell deliveries and one additional stenting. Selective endovascular embolization was enabled in all patients, resulting in excellent clinical and radiologic outcomes, with no morbidity or mortality directly attributable to microguidewire looping.

Conclusion : Microguidewire looping is a reasonable alternative if passage through a stented artery is not feasible by traditional means, especially at paraclinoid ICA sites.

Key Words : Aneurysm · Coil · Embolization · Microguidewire · Stent.

INTRODUCTION

Endovascular treatment of intracranial aneurysms has flourished in the aftermath of two pivotal studies: the International Subarachnoid Aneurysm Trial (ISAT) and the International Study of Unruptured Intracranial Aneurysms (ISUIA). Device improvements and advances in coiling techniques have now enabled treatment of lesions with complex configurations. Stenting (and various modifications thereof) has contributed greatly in this context, broadening the scope of endovascular treatment substantially. When inserting coil under stent protection, a jailed catheter
technique is generally applied first-line. However, should jailed technique fail or fall short in terms of coil compaction, passing a microcatheter through stent struts (so-called trans-cell technique) may be required to satisfactorily complete coil embolization. Additional stenting may also be needed in specific conditions, such as dissecting, fusiform, and blood-blister aneurysms, or as bail-outs solutions. Still, passage of both microguidewire and microcatheter through a stented parent artery is not easy, given the potential interference by stent struts, and it is particularly difficult in the tortuous carotid siphon. Recently, we devised a microguidewire looping method to easily traverse a stented parent artery. Feasibility and safety of this approach were explored in a limited group of patients, whose angiographic and clinical outcomes are detailed herein.

**MATERIALS AND METHODS**

**Study population**

Between January, 2013 and April, 2015, 982 aneurysms in 840 patients were subjected to endovascular coil embolization, including 249 instances (25.4%) of stent usage. Of these, 138 (55.4%) were amenable to jailed technique only, 35 (14.1%) required stenting upon completion of coil insertion (such as bail-out stenting), and 76 (30.5%) called for trans-cell technique (68 by traditional means). In 10 patients, more than two stents were deployed.

Microguidewire looping was applied in nine subjects (female, 8; male, 1; mean age, 61.9±5.9 years), largely due to failed or difficult traditional microguidewire advancement. One patient required additional stenting. All aneurysms were unruptured and broad necked, with depth-to-neck ratios <1.5 (mean, 0.9±0.2; range, 0.5–1.2) and small diameters (<10 mm). Therapeutic decisions relied on multidisciplinary deliberation by both neurosurgeons and nonsurgical neurointerventionists. Once the need for treatment and related risks were adequately explained, all patients granted informed consent. This study was approved by the Institutional Review Board of our institution. Clinical and radiographic features of the cohort are shown in Table 1.

**Therapeutic strategies**

Endovascular access by microguidewire looping was achieved step-wise as follows: 1) loop created in microguide-
wire tip; 2) advancement of looped microguidewire distally, across stented segment; 3) passage of microcatheter (microguidewire-assisted) close to aneurysm; 4) trans-cell navigation of microcatheter tip (via inner microguidewire) into dome of aneurysm. Schematic representation is depicted in Fig. 1.

The first step in this maneuver is looping the microguidewire tip. There are two ways to loop a distal microguidewire tip. First, the tip of microguidewire should be shaped with very small and tight angle. When this shaped microguidewire passes the petrovascular internal carotid artery (ICA) (Fig. 2A, B) or the proximal portion of a stent (Fig. 2C, D), a loop can be easily formed. Should this maneuver fail, entry into a small arterial branch, such as the meningohypophysial trunk, may be productive (Fig. 2E–G). Once created, the loop should be advanced distally, through the stented segment of parent artery. A rotational change in loop orientation may help surmount any stent interference. After positioning the microguidewire as needed, the microcatheter should follow. The aneurysm selection is achieved using inner microguidewire torque to navigate the microcatheter through the stent struts.

In advancing a microguidewire, the tip usually makes contact with arterial wall. Struts incompletely in apposition are thus likely to retard navigation, especially in lesions with tortuous parent arteries. Ordinarily, stent struts must be avoided to prevent microguidewire entanglement, but the rounded contour of a looped microguidewire facilitates passage, minimizing this risk. Nevertheless, this looping technique is only warranted if traditional methods are ineffective.

**Endovascular procedure**

The configuration of each aneurysm and its arterial grid were delineated using Allura Clarity (Philips Medical System, Best, The Netherlands) and Innova IGS 630 (General Electric, Wauwatosa, WI, USA) biplane systems, providing high-resolution 3D rotational angiography. The size of an aneurysm was defined as its broadest aspect in 3D configuration. Neck size and depth-to-neck ratio were measured on a working projection of digital subtraction angiography.

All procedures were performed under general anesthesia, administering antiplatelet medication in advance. In accord
with institutional protocol, patients were given dual antiplatelet pre-medication (clopidogrel and aspirin). In patients responding poorly to clopidogrel, based on VerifyNow P2Y12 assay (Accriva Diagnostics, San Diego, CA, USA), cilostazol was added. A bolus of heparin (3000 IU) was given after femoral arterial sheath placement, with hourly bolus doses (1000 IU each) thereafter. Activated clotting time was also monitored hourly. Maintenance antiplatelet medication was then advised, using dual agents for at least 3 months after the procedure and a single agent for at least 1 year.

Angiographic outcome and follow-up

Immediate angiographic results after coil embolization were interpreted by two experienced neurointerventionists (YDC and HSK), applying the 3-point Raymond scale as follows: complete occlusion (no residual filling of aneurysms by contrast medium), residual neck (limited residual contrast at base of aneurysm), or residual aneurysm (any opacification of the sac). Clinical outcomes were scored by Glasgow outcome scale (GOS) throughout the hospitalization period and at the last available clinical follow-up. In all patients, magnetic resonance angiography (MRA) with 3D reconstruction and/or plain radiography was recommended at 6, 12, 24, and 36 months after coil embolization. Conventional angiography was advised if aneurysmal recanalization was suspected by noninvasive evaluation, such as MRA or plain radiography, in order to decide if further treatment was necessary.

Anatomic follow-up results were also categorized by Raymond scale as follows: complete occlusion, minor recanalization, or major recanalization. Repeat embolization was advocated for patients showing major recanalization.

RESULTS

Our method of microguidewire looping, in conjunction with trans-cell technique (n=8) and in one additional bail-out stenting (due to coil protrusion), proved successful in nine subjects with saccular aneurysms of ICA (n=6), middle cerebral artery (MCA ; n=2), and basilar tip (n=1). The Enterprise™ stent (Codman Neuro, Raynham, MA, USA) was primarily used (n=7), followed by LVIS™ (MicroVention Inc, Tustin, CA, USA) and Neuroform™ (Stryker Neurovascular, Fre-
filler coil protruding into parent artery, additional stenting was required. Use of our microguidewire looping technique allowed passage of microdevices for stent delivery to MCA, and an additional stent was deployed. The aneurysm was satisfactorily occluded, without complication, and was unchanged 1 year later in follow-up angiography (Fig. 4).

DISCUSSION

Recent advancements in design and delivery of stents have ensured their use with ease and confidence\(^4\). Self-expanding stents that promote higher packing density, flow diversion, and endothelization at necks of aneurysms are gaining in popularity\(^2,13\). The actual course of a parent artery may be altered as well\(^6\). Even stent devices with low wall coverage divert flow in small aneurysms\(^15\), so enhanced wall coverage through smaller cell size may augment this effect, promoting a very high rate of occlusion. These effects favorably impact hemodynamic conditions near an aneurysm and help reduce recanalization rates.

In practice, a variety of stents are used for coil embolization of intracranial aneurysms, including open- and closed-cell designs, braided and laser-cut styles, and more. In general, a first-line approach for stent-assisted coil embolization is jailed technique, which alone is adequate for treating many lesions. In our series, use of jailed technique to complete coil embolization was applied in 55.4% of aneurysms involving stents. However, trans-cell technique is sometimes required if jailed technique should fail or fall short in the coiling process. It is well-known that stenting at sharply angled segments of parent arteries are troubled by incomplete apposition. This phenomenon is more pronounced in a closed-cell design, often manifested as kinking or folding\(^8\). Heller et al.\(^9\) reported double-barrel entanglement of intracranial stents resulting from undetected incomplete apposition of stent to vessel wall. In such circumstances, the technical demands of trans-cell technique or further stenting are high, especially in aneurysms near tortuous parent arteries (eg, paraclovoid ICA aneurysms).

Fig. 3. A : Angiographic image of distal ICA aneurysm. B : Frame coil formed and properly configuration by jailed method, after stent deployment. C : Unsuitably oriented jailed microcatheter withdrawn to proximal stent position, but traditional means fail to advance microguidewire. D : Microguidewire loop formed before proximal stent reached. E : Looping technique enables microguidewire advancement. F : Passage of microcatheter to point near aneurysm. G : Aneurysm selected via inner microguidewire torque. H : Additional coil insertion occludes aneurysm, with minimal residual filling. ICA : internal carotid artery.
with the passage of microdevices. Microguidewire looping is an effective alternative method for negotiating stented vessels if a traditional approach has failed. Rounding of the tip minimizes its capacity to snare an incompletely apposed strut.

In this series, looping was most often utilized for paraclinoid ICA aneurysms, which are more tortuous by nature. The obstacles to traditional wire torque were thus intensified. There was also a greater likelihood of incomplete stent apposition at this location. Hence, our novel technique may be of less value in MCA or basilar tip aneurysms, where parent arteries are relatively straight in course. Likewise, microguidewire looping is not appropriate for anterior cerebral or anterior communicating arteries, because the A1 segment is virtually inaccessible this way (Table 2). Furthermore, stent migration may result, particularly if the stent is a closed-cell design, although this was not a problem here. In ruptured aneurysms, migration of clot on stent might occur. In other settings, this approach may facilitate microdevice delivery into true distal lumen of a direct carotid-cavernous fistula or an acute dissection. According to Benndorf et al.\(^1\), microgu-

### Table 2. Traditional maneuvers (n=68) vs. microguidewire looping (n=8) during trans-cell coil embolization (n=76), shown by location (one double stenting excluded).

<table>
<thead>
<tr>
<th>Location (n=76)</th>
<th>Traditional maneuver (n=68)</th>
<th>Microguidewire looping (n=8)</th>
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<tbody>
<tr>
<td>ICA including PcomA (n=25)</td>
<td>20 (80)</td>
<td>5 (20)</td>
</tr>
<tr>
<td>MCA (n=14)</td>
<td>12 (86)</td>
<td>2 (14)</td>
</tr>
<tr>
<td>ACA including AcomA (n=18)</td>
<td>18 (100)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Posterior circulation (n=19)</td>
<td>18 (95)</td>
<td>1 (5)</td>
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idewire looping enabled breach of an occluded inferior petrosal sinus in the context of cavernous sinus dural arteriovenous fistula.

We do not advocate microguidewire looping as a first-line technique for negotiating stented arteries. If feasible by traditional means, this looping method is not needed. Although its use in disadvantaged situations may certainly be justified, the efficacy and safety of this approach must be confirmed in larger study populations.

**CONCLUSION**

Looping of a distal microguidewire tip is a viable option for accessing the distal reaches of stented parent arteries during trans-cell technique or if added stenting is required, but only if traditional methods have failed or are untenable. This technique is particularly suitable for paraclinoid ICA aneurysms.

**References**