CASE REPORT

Solitaire salvage: a stent retriever-assisted catheter reduction technical report

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SUMMARY

The endovascular management of giant aneurysms often proves difficult with standard techniques. Obtaining distal access to allow catheter reduction is often key to approaching these aneurysms, but several anatomic challenges make this task unsafe and not feasible. Obtaining distal anchor points and performing catheter reduction maneuvers using adjunctive devices is not a novel concept, however using the Solitaire in order to do so may have some distinct advantages compared with previously described methods. Here we describe our novel Solitaire salvage technique, which allowed successful reduction of a looped catheter within an aneurysm in three cases. While this technique is expensive and therefore best performed after standard maneuvers have failed, in our experience it was effective, safe, and more efficient than other methods.

BACKGROUND

The endovascular treatment of large or wide-necked aneurysms often requires the placement of a neck remodeling device or flow-diverting stent. Multiple anatomic challenges make navigating a microcatheter through the aneurysm and back into the true lumen difficult, if not impossible. Complicated aneurysms often develop a kink or stenosis at the distal neck creating a ledge effect, preventing tracking of a microcatheter. These findings create a situation in which the microcatheter and wire can easily pass into the aneurysm but can only re-enter the true lumen of the distal neck with the catheter forming a complete 360° loop within

the aneurysm. The inability to reduce this loop creates a dangerous situation precluding stent placement. We describe three cases using a novel method of reducing a catheter loop within an aneurysm.

CASE PRESENTATION

Transfemoral access is obtained and the internal carotid artery (ICA) is selected with a diagnostic catheter and exchanged for a 90 cm NeuronMax that is advanced into the distal cervical ICA. A 0.058 inch/0.072 inch Navien catheter is advanced through the NeuronMax into the proximal cavernous-carotid over the Marksman catheter (figure 1). Assuming that the only way to access the outflow vessel is by forming a 360° loop in the aneurysm, we attempt initial distal access with a Marksman unless we have decided to Pipe-coil through the NeuronMax or if the Marksman is too stiff to circumnavigate the dome of the aneurysm. If access with a Marksman is unsuccessful, our preference of microcatheter in decreasing order is an XT-27, Velocity, or Echelon. Multiple attempts with simple coil reduction maneuvers should be made prior to using any distal anchoring technique.

If these attempts fail, the microcatheter and wire are advanced into a distal straight M1 segment. If access was obtained with a Marksman, XT-27, or Velocity microcatheter, a 4.0 mm×20 mm Solitaire device is advanced through the microcatheter and deployed in a straight segment of M1 (figure 2). If an Echelon was used, an exchange length 0.014 inch/300 cm Synchro is used to exchange for

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Figure 1 (A) Three-dimensional translucent road map view of the fusiform posterior carotid wall aneurysm demonstrating the tortuous acute angle needed to navigate distal to the aneurysm. (B) Three-dimensional colored shaded surface display illustrating the complex aneurysm morphology.

Figure 2 (A) 4 mm×20 mm Solitaire device at the distal tip of the XT-27 with the redundant microcatheter loop (red dash) outlining the aneurysm. (B) The Solitaire stent retriever is partially deployed to a length of approximately 10 mm and the distal stent tines are clearly visualized. (C) The XT-27 is dragged back slowly. (D) Half of the redundant loop has been reduced. (E) The entire redundancy has been removed and the Solitaire remains in position distally. (F) Native control run demonstrating the microcatheter pathway (red dash) in position along the internal carotid artery with no portion of the catheter buckling in the aneurysm.

Video 1 Live fluoroscopic images of the coil reduction maneuver using the Solitaire salvage technique. Ten millimeters of a 4×20 mm Solitaire is deployed through an XT-27 providing a distal anchoring point in the M2. The microcatheter loop within the aneurysm slowly on coils as traction is placed on the XT-27 any microcatheter system is dragged back. The reduction maneuver ultimately results in the microcatheter lying across the wide neck of the aneurysm.

Video 2 Follow-up angiography runs after the Solitaire salvage technique has been completed. The Solitaire device has been removed from the XT 27 and a 4.0×20 mm Pipeline embolization device has been placed across the wide-necked aneurysm in the usual fashion. Note there is been no iatrogenic injury to the distal intracranial vasculature where the Solitaire salvage technique had been performed in the M2 segment.

Figure 3 (A) Initial deployment of the Pipeline embolization device (PED) beginning at the internal carotid artery terminus with the PX Slim microcatheter in the aneurysm. (B) Post-PED deployment control run in the late arterial phase demonstrating the contrast stagnation with the aneurysm: the eclipse sign. The red circle with black arrowhead demonstrates the distal PED and the red circle with the black arrow shows the proximal PED position (C) Post-coil control run with no coil herniation, PED stenosis, or distal migration of the PED.

Figure 4 (A) Shaded surface three-dimensional reconstruction of the large posterior carotid wall aneurysm in patient 2. (B) Diagrammatic representation of the redundant microcatheter pathway (red dash) required to navigate distal to the aneurysm. (C) Control run demonstrating the reduced microcatheter pathway (red dash). (D) Post-Pipeline embolization device (PED) deployment and coiling (red dash) without coil herniation into the parent vessel or stenosis of the PED.

Table 1 Patient demographics and aneurysm characteristics for the three cases

Case	Aneurysm location	Anteroposterior (mm)	Lateral (mm)	Neck width (mm)	Vessel inflow diameter (mm)	Vessel outflow diameter (mm)	Age
1	Left supraclinoid	16	11	5.1	2.7	2.5	70s
2	Left communicating segment of ICA	11	11	6.2	3.7	2.9	70s
3	Ophthalmic	10	8	4.3	3.6	3.0	50s

ICA, internal carotid artery.

the largest catheter. Approximately 10 mm of the Solitaire device is unsheathed until acceptable wall apposition is achieved within a straight M1 segment and not around the ICA terminus. With the Solitaire acting as a distal anchor, the microcatheter is retracted slowly (videos 1 and 2). The microcatheter loop within the aneurysm uncoils forming a straight conformation across the aneurysm neck. This distal anchoring point enables advancement of the base catheters, thus increasing the proximal stability of the system. The Solitaire is removed and a 4 mm×20 mm Pipeline embolization device (PED) is deployed (figures 3 and 4).

If the Solitaire was deployed through a Velocity microcatheter, the catheter is exchanged for a Marksman or XT-27 over an exchange length 0.014 inch wire. Typically, we jail a catheter within the aneurysm for coiling. We favor placing the coiling catheter after the reduction maneuver in order to avoid interference.

The characteristics of the aneurysms, PEDs, Solitaire devices, and coils used in each case together with follow-up information are shown in tables 1 and 2.

DISCUSSION

The reduction of a catheter loop is completed without the use of adjunctive devices by rapidly pulling a coiled microcatheter back. If this simple technique fails, there are a variety of ways to reduce a coiled microcatheter. Obtaining distal anchor points and performing catheter reduction maneuvers using adjunctive devices is not a novel concept, however using the Solitaire may have distinct advantages compared with previously described methods.¹

In 2010 Snyder *et al*² described the use of a balloon to perform an anchoring technique in a giant ICA aneurysm. This technique uses a balloon inflated in the distal parent vessel to act as a fixation point while the proximal microcatheter is reduced.

In 2011 Hui *et al*³ published their experience using the Merci clot retriever to obtain distal access during stroke interventions. A Merci retriever was deployed in the M1 segment while tension on the retriever was applied, permitting access past the ophthalmic artery origin and into the target vessel for clot aspiration.

Fargen *et al*⁴ in 2012 described a stent anchor technique for the coiling of a giant middle cerebral artery aneurysm. They obtained distal access by encircling the aneurysm, then partially deploying an Enterprise neck remodeling device to obtain a distal anchor. The microcatheter containing the stent was placed under traction to reduce the loop within the aneurysm. With a separate coiling catheter jailed within the aneurysm, the remainder of the stent was deployed across the aneurysm neck followed by coiling.

In 2013 Kono *et al*⁵ described a variation of the balloon anchoring technique where they inflated a balloon within a giant aneurysm. The balloon was then dragged to plug the aneurysm at its neck, thus allowing a microcatheter to be easily navigated into the distal circulation, permitting stent-assisted coiling.

The balloon anchoring technique requires inflation of the balloon in the distal microvasculature, both occluding the artery and placing vessels at risk for rupture. The Solitaire salvage technique is considerably faster as there is no balloon preparation required.

Table 2 Characteristics of Pipeline embolization devices (PEDs), Solitaire devices, and coils used with follow-up information for each case

Case	PED size (mm)	Microcatheter used to deploy PED	No of PEDs used	Solitaire size (mm)	Microcatheter used to deploy Solitaire	Coils used	Raymond grade	Complications	Angiographic follow-up
1	4×18	XT-27 Stryker 0.027 inch	1	4×20	Penumbra Velocity 0.025 inch	(1) PC400, 12 mm×45 cm soft	3r	None	3 mm residual at 9 months
2	4×20	XT-27 Stryker 0.027 inch	1	4×20	XT-27 Stryker 0.027 inch	(1) eV3, 10×30 cm axium (1) eV3, 9×30 cm axium (1) eV3, 8×30 cm helical	2r	None	2 mm neck residual at 5 months
3	(1) 3.35×25 (1) 4.5×20	Marksman Covidien 0.027 inch	2	4×20	Marksman Covidien 0.027 inch	(1) eV3, 4 mm×10 cm axium (1) eV3, 4 mm×8 cm axium (1) eV3, 3 mm×6 cm axium	1r	CC fistula	N/A

CC, carotid-cavernous.

Krischek *et al* in 2011 demonstrated that the Solitaire device had superior radial force compared with other intracranial stents.⁶ Additionally, the Solitaire device demonstrated the greatest wall apposition compared with other intracranial stents and was graded the highest on ease of deployment. These properties make the Solitaire an ideal choice for a distal anchor point when catheter reduction is needed. We only advocate using this technique after all standard maneuvers fail. To justify this expense, we believe this technique is safer and carries a higher success rate than alternative methods. Finally, there may be concern about placing this device in a normal artery, which could cause dissection, spasm, or delayed stenosis. However, we have follow-up angiography showing no evidence of vessel injury where the device was anchored.

Learning points

- ▶ Wide-necked aneurysms can be technically challenging lesions requiring the use of adjunctive devices in order to be treated safely.
- ▶ When routine methods of treatment for wide-necked aneurysms have been exhausted, the Solitaire salvage technique is a safe and feasible option.
- ▶ Although coil reduction maneuvers have been described with other devices, our method uses a distal anchor point with more radial force than previously described techniques.

The treatment of large and giant aneurysms is technically challenging and is made more difficult when distal access cannot be obtained without traversing the aneurysm. The partial deployment of any fully retrievable stent permits an equivalent—if not superior—anchor point for catheter straightening compared with previously described techniques. The Solitaire salvage technique is a safe, quick, and effective method to reduce a catheter looped within an aneurysm and facilitates advancing distal access catheters or deploying intracranial stents.

Contributors All authors contributed equally to publication of this manuscript.

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