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Retained Solitaire FR device after mechanical thrombectomy: Case review and management strategies

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Abstract:

Solitaire FR device is a Food and Drug Administration-approved device for mechanical thrombectomy. It has been tested in various clinical trials for its safety and efficacy. We report a case of inadvertent detachment of the Solitaire FR device at stent–stent wire interface while performing mechanical thrombectomy. We review a rare phenomenon of retained Solitaire FR stent retriever *in situ* and discuss technique of avoidance and its management.

Keywords:

Acute ischemic stroke, retained device, Solitaire, thrombectomy

Introduction

Mechanical thrombectomy has become standard of care for emergent large vessel occlusion.[1] Stentriever-based thrombectomy at our institution is performed with Solitaire FR (Medtronic) or Trevo (Stryker), both made from nitinol. Solitaire FR is available in diameters of 4–6 and lengths of 15–40 mm with parametric design,[2] closed cell and open end, mounted on nondetachable 0.016″ pusher wire. Trevo has tapered ends and hydrophilic coating, closed thought for delivering radial force, and mounted on 0.018″ pusher wire.[3] Both devices have demonstrated excellent safety profiles in large meta-analysis.[4] To the best of our knowledge, no device detachments have been reported to date for Solitaire FR.

Case Report

An elderly man was bought to the emergency room for sudden onset of the left hemiplegia and initial NIHSS of 22. Last seen normal by his family members was nearly 3 h from arrival to the emergency room. No tissue-type plasminogen activator was administered due to refusal from family. The initial computed tomography (CT) head revealed loss of gray-white differentiation in the right insular ribbon. CT angiogram revealed total occlusion in M1 segment of the right middle cerebral artery (MCA) and partially occlusive thrombus in A1 segment of right anterior cerebral artery. CT perfusion showed a penumbra in MCA territory. At 4 h from the last known well, he was taken to angiography suit for emergent thrombectomy. A 9F-Cello balloon guide catheter (Medtronic), 5F-Berenstein II catheter, and 0.035″ glide advantage wire (Terumo) were carefully navigated into right common carotid artery (CCA) under fluoroscopic guidance. 9F-cello was parked at the bifurcation of right CCA with its tip in the proximal portion of the right internal carotid artery (ICA). First images demonstrated proximal MCA occlusion [Figure 1a]. A Marksman microcatheter (Medtronic) over a Fathom 16 micro-wire (Boston Scientific) was navigated through the thrombus into inferior M2 branch of the right MCA. It proved to be difficult due to

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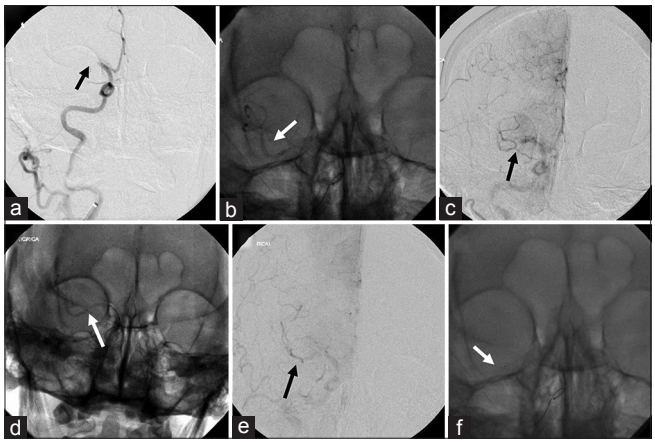

Figure 1: Thrombectomy findings: (a) Anterior-posterior internal carotid artery injection via the cello balloon guide reveals proximal M1 occlusion (arrow). (b) Fluoro puff at 3 min device up time reveals distal recanalization (arrow). (c) Postthrombectomy attempt one (device out) reveals slow distal flow through M2 and stenotic junction (arrow). (d) Second thrombectomy attempt fluoro puff with device up showing improved distal flow (arrow). (e) Final anterior-posterior internal carotid artery/common carotid artery injection showing slightly quicker anterograde flow through retained stent (arrow). (f) Retained device distal markers visible on anterior-posterior image near the arrow

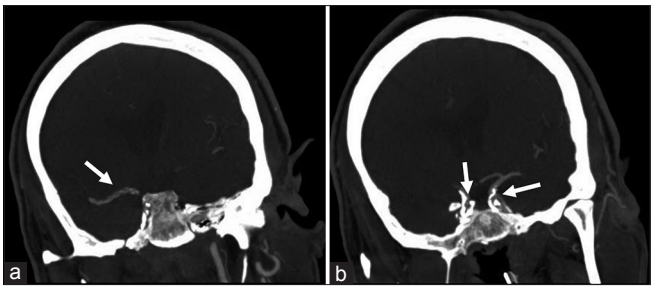

Figure 2: Postthrombectomy computed tomography angiography findings. (a) Coronal computed tomography angiography head, the arrow denotes small amount of M2 filling beyond the retained device. (b) Sagittal computed tomography angiography head, heavily calcified internal carotid artery is visible on bone windows (arrow)

severe intracranial atherosclerotic disease and extremely tortuous anatomy [Figure 2b]. A 4 mm × 40 mm Solitaire FR device (Medtronic) was then loaded and pushed to the end of the microcatheter beyond the thrombus. Deployment was performed with standard push-pull technique, with the Marksman microcatheter just distal to the proximal marker. After 4 min of delay, angiographic images with the device *in situ* demonstrated partial recanalization and delayed perfusion in the territory with small amount of retained thrombus in the proximal M2 segment of right MCA [Figure 1b]. The device was retrieved with slow gentle traction and 9F-Cello with balloon inflated under aspiration. The retrieval wire relayed every click from intracranial atherosclerosis. A red thrombus was visible on the retrieved device. Follow-up angiography showed thrombolysis in cerebral infarction 2a recanalization [Figure 1c]. The second pass was attempted given slow flow and distal M1 narrowing using the same device in similar fashion, using the same technique; however, this time, the device was placed slightly more distal than last time in the M2 division [Figure 1d]. While attempting retrieval of the device, after a slight movement during slow, gentle traction, resistance was completely lost as was any tension within the microcatheter on display. The pusher wire was removed, which was detached just proximal to the proximal marker. Stent retrieval with Amplatz gooseneck snares (EV3) was attempted. Despite being able to capture the device and bring the microcatheter over the proximal marker, no further re-sheathing or capture could be achieved after several attempts. Alligator snares were not available. The stent appeared firmly adhered to the intima of the vessel. At this time, decision was made to treat with aspirin and clopidogrel, and catheters were removed. The stent was left *in situ* spanning from ICA terminus to M1 segment of right MCA [Figure 1f]. The final angiographic images confirmed patency of right MCA and ICA with delayed but persistent flow [Figure 1e]. NIHSS after 24 h was 15. The postprocedure CT angiography head showed minimal patency of M1 segment [Figure 2a]. This event played an important role in family discussion. We explained the family about the described complication and the risk of right MCA stroke in event of a stent thrombosis. Unfortunately, the patient died of medical complications 7 days later.

Discussion

We found a few stentriever retainment reports during thrombectomy. In a case report of early unwanted detachment in the initial trials of Solitaire AB, the device detached and retained within the M1 segment in a patient undergoing thrombectomy who had tortuous anatomy and large thrombus burden.[5] Recanalization was achieved in this study utilizing intra-arterial urokinase. The Solitaire AB device differs from the Solitaire FR device in a way that the latter is nondetachable in design. Cobb *et al.* recently reported a retained Solitaire device during mechanical thrombectomy for tandem occlusion which became entangled and retained upon removal against a precise carotid stent, which was subsequently removed by staged carotid endarterectomy.[6] Of the five device detachments reported in a review table by Kwon *et al.*, Solitaire AB was utilized in four of them, and only one Solitaire FR device was used during the SWIFT trial. Solitaire AB has been known to break at the ball and socket joint at the stent–stent wire interface.[7] Castano *et al.* reported that six out of 262 cases of Solitaire device detachment (2.3%) classified into proximal to the marker versus distal. Retrieval was possible in the ¾th proximal disconnections. Symptomatic intracranial hemorrhage (33% vs. 4%) and poor outcomes were more likely associated with detached devices. The number of prior passes was found to be directly proportional

to the rate of detachment. Masoud *et al.* reported series of Solitaire detachments 7/1067 (<1%), and all of them were the first-generation devices. The Food and Drug Administration database review showed 82 detachment reports for the first-generation Solitaire devices, one report for the second-generation Solitaire devices, and seven reports for Trevo device.[8]

We believe that tortuous anatomy and severe intracranial atherosclerotic disease played a role in the malfunction of our device as the device was retrieved once without issue. There are no measures available to us at this time to quantify the risk of the stent retriever detachment based on tortuosity and atherosclerotic burden. Kang *et al.* verified that during their retained stent removal, the device was caught on severe calcified suprachoroidal ICA.[9] However, possible device malfunction cannot be ruled out as the detachment occurred exactly just distal to the proximal markers at the stent–stent wire ball and socket–joint interface. Had the stent sheared in half, the mechanism could be more anatomy related.

Management strategies include different snare techniques, either over a guidewire or a catheter with a gooseneck snare or an alligator snare. Stent removal techniques have been described by Parthasarathy *et al.* such as "deploy and engage," which involves deployment of another device into the proximal end of the first and subsequent stent removal by the "loop and snare" technique which involves passing a microcatheter or a guide wire through the device and looping it back to be snared everything as an entire unit.[10] Finally, if everything fails, dual antiplatelets or heparin drip may be considered. Surgical removal of a stent from the ICA terminus has been reported as well with an arteriotomy closure utilizing a clip/suture technique with flow preservation.[9] Any removal attempt in tortuous vessel anatomy carries the risk of vessel rupture, and surgical planning should include options to treat this complication.

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Conflicts of interest
There are no conflicts of interest.

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