Bailout Strategies for Abrupt Change in Woven Endobridge 17 Device Orientation After Detachments: Technical Note of 2 Anterior Communicating Artery Aneurysm Cases

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■ BACKGROUND: **Little information is available regarding technical challenges with the new lower profile Woven EndoBridge (WEB 17) system intended for smaller aneurysms.**

■ METHODS: **We report illustrative cases of technical complications encountered with 2 anterior communicating artery aneurysms treated by the WEB 17 system requiring rescue stenting in both cases, discussing technical nuances regarding potential reasons for the encountered failures along with management plan.**

■ RESULTS: **Over a span of 1 year (January 2021 to January 2022), 45 WEB embolization procedures were performed at 2 institutions. Two procedures were complicated by abrupt change in orientation of the WEB device immediately after detachment from the delivery wire. In the first case, abrupt angulation with subsequent migration and prolapse out of the aneurysm sac into the distal right anterior cerebral artery was encountered with unsuccessful retrieval despite multiple attempts using a variety of devices, eventually requiring rescue stenting. A similar sudden orientation change was noted in the second case with partial prolapse from the aneurysm sac similarly bailed out by intracranial stenting. Both patients recovered to pre-procedural baseline with no permanent deficits and eventually were discharged home.**

■ CONCLUSIONS: **Intrasaccular WEB 17 embolization may be technically challenging in smaller wide-necked aneurysms with acute aneurysm—parent artery angulation with abrupt changing of WEB device orientation after detachments with device migration and prolapse into the parent vessel requiring rescue stenting. Proper WEB 17 device sizing and vigilance in the transition phase between the end of deployment and detachment windows of the procedure are paramount to treatment success. Routine use of antiplatelets in cases of anatomical aneurysms that are anticipated to be challenging might be a useful strategy if bailout stenting is needed.**

INTRODUCTION

The Woven EndoBridge (WEB; MicroVention, Aliso Viejo, California, USA)device to treat wide-necked bifurcation aneurysms is the most commonly used intrasaccular device in Europe[1] and the first of its kind device to obtain U.S. Food and Drug Administration approval following the WEB-IT (WEB Intrasaccular Therapy) study in 2019.[2] Compared with its endoluminal counterparts, the WEB device is designed to be placed completely within the aneurysm sac, spanning the ostium and disrupting local intra-aneurysmal flow and ideally obviating mandated long-term dual antiplatelet therapy (DAPT). Multiple technical challenges have been reported during the WEB embolization process, including sizing failures and in some circumstances the need for multiple devices, particularly for anatomically complex lesions.[3,4] Moreover, the need for adjunctive bailout techniques, including balloon assistance and rescue stenting, was encountered in 5.4% of cases in a recent U.S. post-market experience.[4] Multiple iterations of the device have been introduced to the market with different technical modifications in each version, with the latest being the lower profile WEB 17 system available in smaller diameters (from

Key words
- Aneurysm
- Flow diversion
- WEB

Abbreviations and Acronyms
ACA: Anterior cerebral artery
ACOM: Anterior communicating artery
CT: Computed tomography
DAPT: Dual antiplatelet therapy
WEB: Woven EndoBridge
WEB-IT: WEB Intrasaccular Therapy

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3 × 2 mm) that is intended for use in smaller aneurysms.[5] As neurointerventionalists in the United States continue to gather experience with the WEB device, it has been reported that device delivery might be technically challenging, particularly in aneurysms with significant angulation between the parent artery and the long axis of the aneurysm. Moreover, the smaller delivery system might perform more favorably in smaller aneurysms compared with earlier device versions by providing robust support during deployment and detachment.[6] Herein, we report 2 cases of anterior communicating artery (ACOM) aneurysms with tortuous local anatomy treated by the WEB 17 device that were complicated by abrupt change of orientation after detachment of the device and prolapse outside the aneurysm sac and with distal migration in 1 case, with rescue stenting eventually required in both patients.

WEB Embolization Procedures Overview

Over a span of 1 year (January 2021 to January 2022), 45 WEB embolization procedures were performed at 2 institutions. The software routinely used for sizing and measurement (Syngo X Workplace VD20B; Siemens Medical Solutions USA, Inc., Malvern, Pennsylvania, USA) calculated aneurysm measurements in three-dimensional mode. This occurred concurrently with use of conventional two-dimensional angiography images to measure aneurysm neck and height. All these measurements ultimately were inputted in the pamphlets (catalogs) provided by MicroVention, which includes charts to match between the neck size and height with the recommended VIA microcatheter (MicroVention) and the appropriate device size. All procedures were performed with the presence of support from MicroVention representatives to help with technical device counseling if needed. The routine periprocedural DAPT adopted at both institutions included starting aspirin/clopidogrel (or ticagrelor based on platelet function tests) 1 week before treatment. In cases of uneventful procedures, the second agent was discontinued immediately, while aspirin was discontinued either immediately or within a few weeks at the latest, based on the operator's discretion.

CASE PRESENTATIONS

Case 1

A 70-year-old man with a past medical history of stroke with residual baseline left-sided weakness presented to an outside hospital for evaluation of new strokelike symptoms (concern for worsening of the left lower extremity weakness). The patient underwent a stroke work-up and computed tomography (CT) angiography, which demonstrated an irregular multilobulated 5.3 × 4 mm ACOM aneurysm. The patient was referred for endovascular treatment. After review of the relevant imaging, stand-alone coiling was deemed unsuitable, and the decision was made to proceed with WEB embolization (Figure 1A). A triaxial system was used with a 5-F SOFIA (MicroVention) intermediate catheter positioned at the distal left internal carotid artery and early proximal left A1, a Benchmark (Penumbra, Inc., Alameda, California, USA) catheter positioned at the distal left internal carotid artery, and a VIA 17 microcatheter placed within the dome of the aneurysm. Next, a WEB 17 device (4 × 4 mm) was deployed by a combination of unsheathing the device and microcatheter pushing into the fundus of the aneurysm (Figure 1B), with multiple runs demonstrating good positioning of the device inside the aneurysm sac (Figure 1C and D). Immediately on detachment of the device and its release from the delivery wire, the device abruptly angled and prolapsed

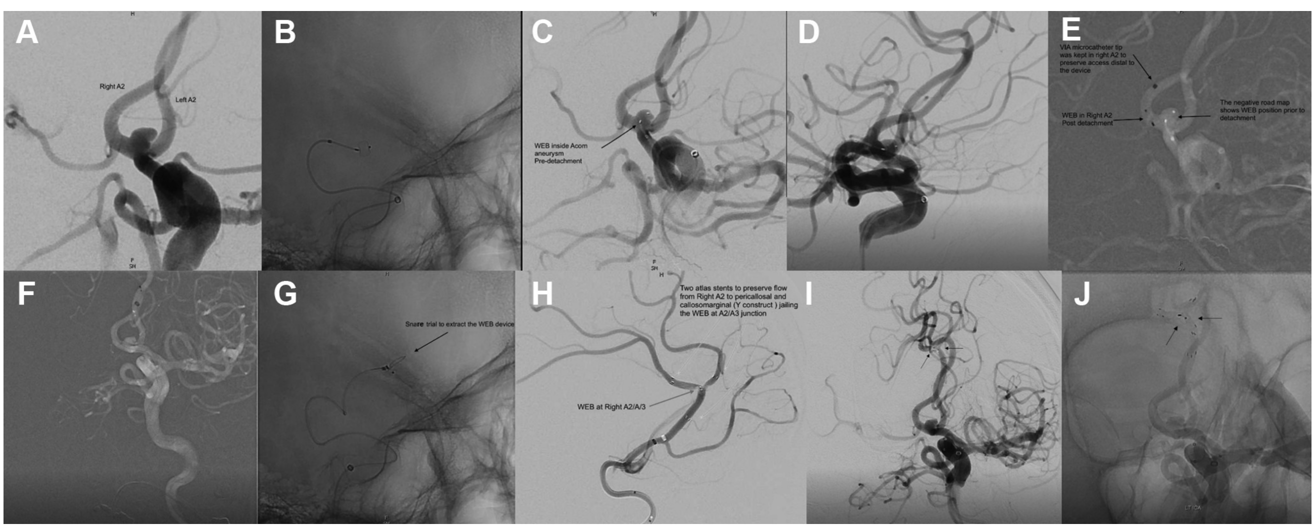

Figure 1. (**A**) Irregular multilobulated, superiorly projecting 4 × 4 mm anterior communicating artery aneurysm. (**B**) Native digital subtraction angiography showing WEB device before deployment. (**C** and **D**) End of deployment phase with lateral and anteroposterior runs showing adequate placement of the WEB 17 system inside the aneurysm sac. (**E** and **F**) After detachment, prolapse of the WEB device outside the aneurysm sac and migrating into the right A2. (**G**) Multiple unsuccessful attempts for removal of the device despite using a variety of devices, including a microsnare. (**H**–**J**) Deployment of Atlas stents in a telescoping Y-shaped construct to trap the WEB device at the level of the right pericallosal artery bifurcation with patent distal branches on final runs. WEB, Woven EndoBridge; Acom, anterior communicating artery.

from the sac, migrating into the right anterior cerebral artery (ACA), and moved further into the distal right ACA at the level of the pericallosal and callosomarginal bifurcation (Figure 1E and F). The groin sheath was exchanged for a 6-F BMX (Penumbra, Inc.) catheter that was positioned into the distal internal carotid artery. Next, the SOFIA aspiration catheter was brought up to the level of the device, with multiple unsuccessful attempts of retrieving the device using a microsnare, stent-retriever, balloon-assisted snaring, and direct aspiration (Figure 1G). The device could not be engaged, and the decision was made to stent the device in place at the level of the pericallosal artery bifurcation (Figure 1H and I).

The patient was given a loading dose of eptifibatide, and 2 Neuroform Atlas (Stryker Neurovascular, Fremont, California, USA) stents were deployed in a Y-construct (both 3 × 15 mm) within the callosomarginal and pericallosal arteries. Subsequent angiography demonstrated patent parent arteries with mild stenosis at the WEB device level secondary to being compressed to the ACA vessel wall by the Neuroform Atlas stent. After the procedure, the patient initially woke up with a left-sided hemiparesis (M3). CT scan of the head was negative for acute intracranial findings, and the patient's clinical examination gradually recovered to baseline on postprocedure day 1 after the patient received a moderate dose of vasopressors. Postprocedural CT angiography showed mild narrowing of the right ACA in the region of the stents, with no evidence of large vessel occlusion or high-grade stenosis otherwise. A few punctate acute-appearing infarctions were noted within the right frontal lobe in the right ACA territory on postoperative diffusion-weighted magnetic resonance imaging. The patient was continued on aspirin 325 mg/day and ticagrelor 90 mg twice daily and was eventually discharged to rehabilitation in stable baseline condition and ultimately to home.

Case 2

A 69-year-old man with a past medical history of an incidentally discovered ACOM aneurysm in the setting of a preoperative work-up for a recent left-sided carotid endarterectomy presented for elective management of the brain aneurysm. Other past medical history included hypertension, hyperlipidemia, smoking, unspecified hearing loss, and chronic obstructive pulmonary disease. The initial outpatient digital subtraction angiography showed a wide-necked irregular 4.5 × 3.9 mm ACOM aneurysm predominantly supplied from the left A1 ACA (Figure 2A), and the decision was made to proceed with elective endovascular treatment with the WEB system following discussion of the risks, benefits, and alternative options with the patient. Similar to case 1, a Benchmark catheter was used as a guide through a femoral approach, and a 5-F SOFIA catheter was selected as an intermediate catheter. A 4.5 × 2 mm WEB SLS device was chosen based on the 3.9-mm neck size and navigated through the VIA 17 catheter. The device was deployed under real-time fluoroscopy with postdeployment, predetachment runs showing cessation of flow into the aneurysm sac (Figure 2B).

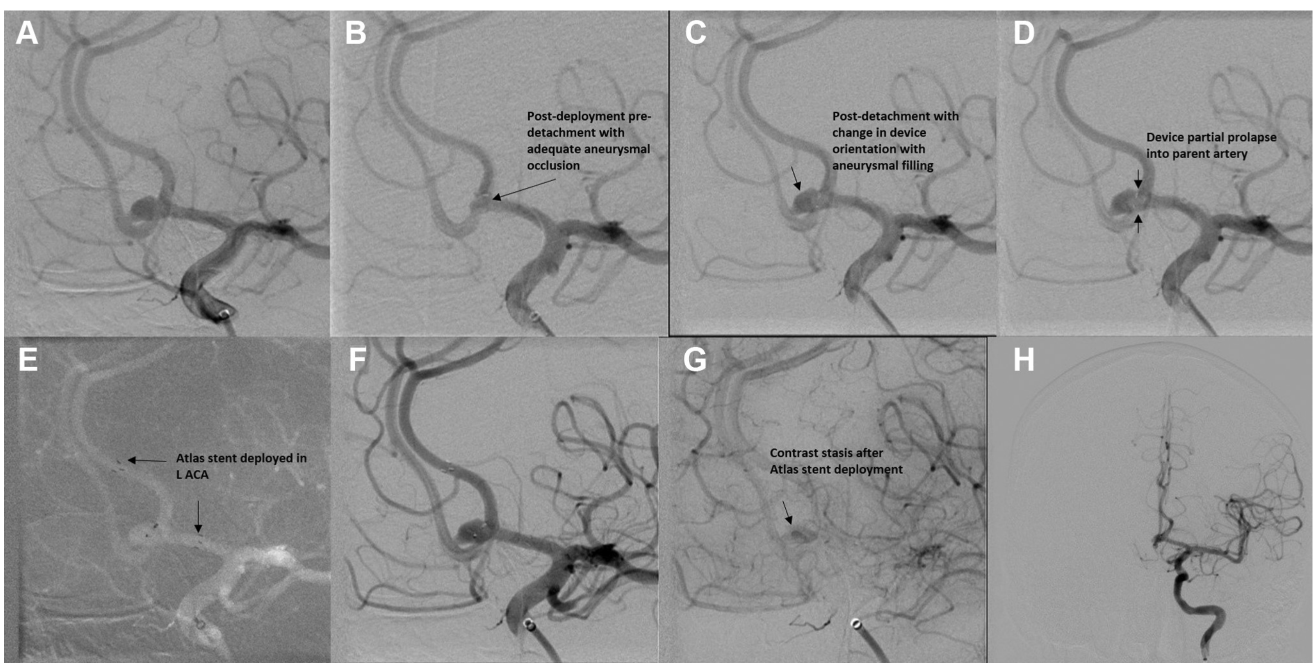

Figure 2. (**A**) Anterior communicating artery (4.5 × 3.9 mm) aneurysm predominantly supplied from the left A1. (**B**) End of deployment phase showing adequate placement of the WEB 17 system inside the aneurysm sac, sealing flow inside the sac with complete occlusion of the aneurysm. (**C** and **D**) After detachment, change of the device orientation inside the sac with resultant filling of the aneurysm (**C**) and further prolapse into the parent artery (**D**). (**E**–**H**) Neuroform Atlas stent placement within the ipsilateral anterior cerebral artery supporting the position of the WEB device inside the sac (**E** and **F**) with some degree of contrast stasis on run after deployment (**G**) and patent distal branches (**H**). WEB, Woven EndoBridge; L ACA, left anterior cerebral artery.

However, after device detachment, a sudden 90° change in the orientation of the deployed WEB device inside the aneurysm sac was noted (Figure 2C and D), resulting in subsequent filling of the aneurysm (owing to inadequate lateral compression of the device) and signs of partial prolapse into the parent artery. Given the instability of the device with partial floating within the aneurysm neck and parent artery (A1 segment) (Figure 2D), the decision was made to place an intracranial stent within the ipsilateral ACA to support the position of the WEB device (the patient had been started on DAPT 1 week before the procedure). The VIA 17 microcatheter was navigated over a Synchro[2] (Stryker Neurovascular) microwire into the A2 segment of the left ACA, and a 3 × 21 mm Neuroform Atlas stent was deployed within the left ACA spanning the A1 and A2 segments (Figure 2E and F). The stent pushed the WEB device back into the aneurysm, and angiography performed after WEB device and stent placement showed patency of the parent vessels with a mild degree of contrast stasis within the aneurysm sac (Figure 2G and H).

Given the noted stasis within the aneurysm, the decision was made not to proceed with additional coiling at this point and to decide on additional coiling during early follow-up. CT scan of the head performed after the procedure was negative for acute intracranial findings. The patient was monitored in the neuro-intensive care unit overnight and was discharged home in stable condition the next day.

DISCUSSION

Changes in WEB device orientation after detachment have been previously reported for the initial larger device and delivery system[4,6] with little emphasis on procedural details and clinical outcomes. This difficulty has yet to be described as a potential technical challenge after detachment in the new WEB 17 version of the device. We report 2 cases of ACOM aneurysms treated by the WEB 17 device complicated by abrupt change in orientation of the WEB device at the time of detachment from the delivery wire, with subsequent migration and prolapse out of the aneurysm sac into the distal parent vessel in 1 patient and requiring rescue stenting in both patients. The clinical sequelae of these procedures were limited, and both patients recovered to their clinical baseline. However, these 2 cases (of 45 cases, accounting for 4.5%, which is close to recently published reports[4]) demonstrate that the WEB 17 device can potentially change orientation during and/or after detachment, especially in small wide-necked aneurysms and in aneurysms with acute angulation between the parent artery and the axis of the aneurysm, when the device is not parallel to the delivery wire before release. In these situations, extra attention should be paid to the transition phase between end of deployment and detachment window of the procedure. These cases also suggest that retrieval of these devices via stent-retrievers or aspiration catheters might not always be feasible, and therefore careful vigilance to the dynamic risk/benefit profile of such interventions in these acute situations is required. It has been reported that microsnares might be useful in retrieving the device in cases of severe parent artery impingements[6]; however, this was not successful in the first case perhaps owing to distal migration.

The exact reasons of the technical failures in the 2 cases presented here are hard to discern with certainty; possibilities include sizing failure, which has been linked to orientation shifting after detachment resulting in parent artery impingement and/or inadequate sealing of the aneurysm neck with persistent filling.[6] The appropriate device size was selected based on aneurysm width and length on three-dimensional and two-dimensional angiographic measurements, with upsizing of the device width more than aneurysm width and similar decrease in its height compared to the aneurysm, to ensure adequate lateral compression as recommended in the device instructions for use.[6] Optimal sizing selection is a critical technical consideration in WEB device deployment, as oversizing is of paramount importance to ensure adequate anchoring of the device to the aneurysm wall, yet sizing failure remains one of the most consistent challenges reported in the literature with WEB embolization. An expert European group reported a sizing failure rate of 25% that has remained constant over 7 years of experience.[3] Moreover, the complex anatomical characteristics in terms of the small size, multilobulated nature of both aneurysms, and their acutely angulated orientation with the parent artery might be additional contributing factors.[6] Furthermore, unrecognized suboptimal intracranial navigation techniques might be a contributing factor; it has been reported that excessive forward or backward loading of intermediate catheters and microcatheters might lead to device displacement following its release from the delivery wire.[6] Therefore, extreme care was taken during the deployment phase to ensure adequate neutrality of the catheter position, yet suboptimal procedural technique cannot be ruled out entirely. Lastly, the angulation of the device to the delivery mechanism with undue load may be a contributing factor as well as the force of the detachment pushing the device.

Other reported technical challenges while using the WEB device include the need for adjunctive bailout strategies, including balloon assistance and rescue stenting. The 2 main reported reasons for aneurysm recurrence after initial WEB treatment are device migration (i.e., change of position inside aneurysm sac without change in aneurysm size) or device compaction (i.e., decrease in device height secondary to deepening of the device recesses at both ends leading to aneurysm filling).[7] However, these issues are noted on subsequent postprocedural follow-up; the acute shift in device orientation and distal migration after detachment has not been reported before in the literature. The use of DAPT with WEB procedures tends to differ between providers and might reflect the operators' uncertainty regarding technical procedural feasibility or anticipation for the need of adjunctive bailout strategies. Despite the lack of evidence to support routine use of DAPT and the unknown impact on clinical and radiographic outcomes, these 2 cases might suggest that a low threshold for DAPT initiation in cases of aneurysms that are anticipated to be challenging might be useful in case of technical device delivery failure and the use of an alternative treatment modality (e.g., stent-assisted coiling) or the need for bailout rescue stenting. However, larger studies are needed to further study this notion in detail.

CONCLUSIONS

Intrasaccular WEB 17 embolization may be technically challenging in smaller wide-necked aneurysms with acute aneurysm—parent artery angulation as highlighted in the 2 presented cases with abrupt changing of the WEB device orientation after detachments with device migration/prolapse into the parent vessel requiring rescue stenting. Besides proper sizing of the WEB 17 device, particular vigilance should be paid to the transition phase between the end of deployment and detachment windows of the procedure and the position of the device relative to the delivery mechanism. Routine use of antiplatelets in such cases of anatomical aneurysms that are anticipated to be challenging might be a useful strategy if bailout stenting is needed.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Mohamed M. Salem: Conceptualization, Methodology, Conceptualization, Literature review, Writing – original draft, Writing – review & editing. **Aryan Ali:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Howard A. Riina:** Conceptualization, Methodology, Writing – review & editing. **Jan-Karl Burkhardt:** Conceptualization, Methodology, Conceptualization, Writing – review & editing.

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