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Woven EndoBridge Device Migration and Microsnare Retrieval Strategy: Single Institutional Case Reports with Technical Video Demonstration

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The Woven EndoBridge (WEB) (MicroVention/Terumo) device is a treatment option for wide-neck bifurcation aneurysms. An uncommon adverse effect is WEB device migration. While certain bailout strategies for WEB recovery have been described, there is still a paucity of information on optimal strategies to maximize both short and long-term post-operative outcomes. We add 2 cases at our institution to the existing literature of WEBectomy in the setting of complicated intracranial aneurysm treatment. We discuss the long-term imaging outcomes with additional fluoroscopy video demonstrating our technique. Our findings reflect a clear benefit for the use of the Amplatz Gooseneck^{TM} microsnare (Medtronic) device as a means of WEB recovery, coupled with potential stent-assisted WEB embolization to remove the aneurysm from the parent circulation, while minimizing recurrence and thromboembolic complications.

Key Words: Cerebral aneurysm; WEB; Woven endobridge; Microsnare

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INTRODUCTION

Approaches toward endovascular treatment of wide-neck bifurcation intracranial aneurysms have continued to evolve in recent years, arising from the difficulty in aneurysm occlusion while preserving flow through major arterial bifurcation points. Treatment with the intrasaccular Woven EndoBridge (WEB) (MicroVention/Terumo) device is an alternative to endovascular coiling that has demonstrated promise in the treatment of small- and medium-sized wide-neck bifurcation intracranial aneurysms. This device enables flow disruption, thrombosis, and neointimal tissue growth through a braided self-expanding mesh configuration of nitinol wires and a platinum core.[1] Compared to conventional treatment, WEB devices have comparable safety and cost-effectiveness relative to stent-assisted coiling, particularly in treating smaller aneurysms with lower dome width-to-height ratios.[2-4] One uncommon complication is device migration or mispositioning, which can have varying clinical consequences depending on the location of the aneurysm. We present 2 cases with images and video of WEB device deployment, migration, and successful retrieval to illustrate available options that can be taken into consideration for bailout strategies.

CASE REPORT

Case 1

A patient in their 70s with a history of stent-assisted coiling of a right carotid terminus aneurysm and an untreated unruptured basilar tip aneurysm was found to have growth of the basilar tip aneurysm from 2 mm to 4 mm over the course of 3 years. After discussion with the patient about the growth of the aneurysm, the decision was made to proceed with endovascular embolization.

The procedure plan included radial access. A short 6F Prelude radial sheath (Merit Medical Systems) was placed. A Benchmark guide catheter (Penumbra) was advanced into the right vertebral artery. A 5F Sofia EX (MicroVention) was then navigated into the distal vertebral artery for support. A diagnostic angiogram demonstrated a basilar apex aneurysm 4.7 mm in maximum diameter and 3.7 mm in height with a 4.4 mm neck (Fig. 1A). The aneurysm was accessed with a VIA 17 microcatheter (MicroVention), and a 5×2 mm WEB SL (MicroVention) device was deployed. Pre-deployment angiography showed excellent wall apposition (Fig. 1B). Initial post-deployment angiography demonstrated good WEB placement. Post-deployment on delayed angiography, the WEB device migrated outside of the aneurysm into the top of the basilar artery (Fig. 1C). A 4 mm 2.3F Amplatz Gooseneck^{TM} microsnare (Medtronic) was advanced through the guide catheter using the packaged catheter retrieval system. The microcatheter was advanced to snare the proximal detachment marker of the WEB and the entire device was retrieved into the benchmark guide sheath. The aneurysm was subsequently coiled *via* the balloon-remodeling technique using a Hyperform 4×15 mm balloon (Medtronic) and an SL 10 microcatheter (Fig. 1D). Post-embolization, there was no evidence of vessel injury, thrombotic events, or contrast extravasation. The patient recovered well without sequalae and was discharged from the hospital the next day (Supplementary Video 1).

Case 2

A patient in their 60s presented for elective endovascular embolization of an incidentally found unruptured anterior communicating (ACOM) artery aneurysm. The right femoral artery was accessed and a 4F Fubuki femoral sheath (Asahi Intecc) was inserted. The Fubuki guide sheath was navigated into the internal carotid artery (ICA). The diagnostic catheter was exchanged for a Navien guide catheter (Medtronic) which was navigated into the distal cavernous carotid. A VIA 21 microcatheter (MicroVention) was navigated over a Synchro2 microguidewire (Stryker) into the ACOM aneurysm. The aneurysm measured 5.1 mm in maximum diameter, 4.6 mm in height, and had a 4.8 mm neck (Fig. 2A). A 6×3 mm WEB was deployed into the aneurysm and removed given poor apposition. A 5×3 mm WEB device was deployed into the aneurysm but also subsequently removed given poor apposition. The 4F Fubuki sheath was then exchanged for a 5F Fubuki sheath. A Scepter XC 4×11 mm balloon microcatheter (MicroVention) over a Synchro 2 microguidewire was then navigated from across the ACOM complex into the contralateral A2 segment (Fig. 2B). A VIA-21 microcatheter over a Synchro2 microguidewire was navigated back into the aneu-

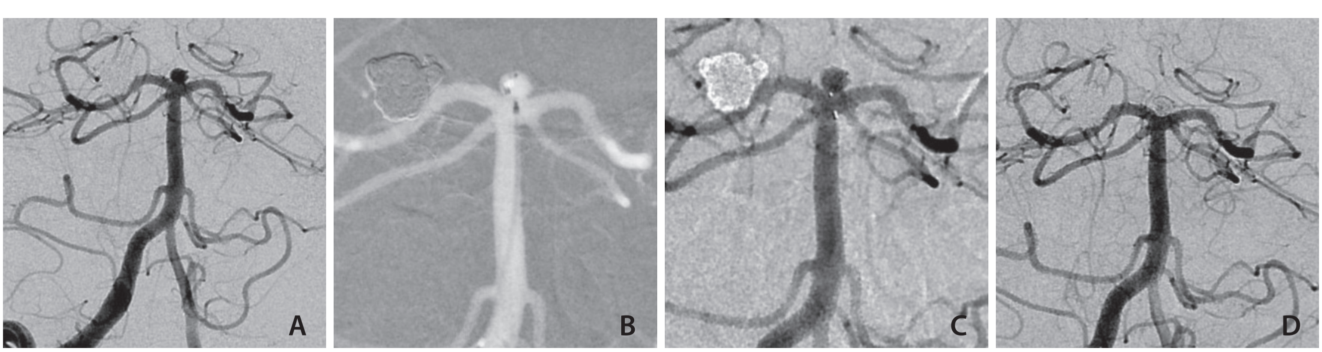

Fig. 1. Woven EndoBridge (WEB; MicroVention/Terumo) migration and retrieval from the basilar artery (case 1). (**A**) Pre-embolization right vertebral artery angiogram. (**B**) Pre-detachment of WEB device in position within the basilar tip aneurysm. (**C**) Post-detachment of the WEB device right vertebral artery angiogram displaying device migration inferiorly into the basilar artery. (**D**) Post-coiling right vertebral artery angiogram.

rysm. A 4×3 mm WEB device was deployed without issues. However, post-deployment angiography demonstrated that the WEB device migrated into the left anterior cerebral artery (ACA), which caused partial occlusion of the distal ACA (Fig. 2C, D). The WEB had rotated such that the distal marker was now facing the proximal vessel.

The left femoral artery was then punctured and a 4F Fubuki sheath was then navigated into the right ICA. The diagnostic catheter was then exchanged for a 058–105 cm Navien guide catheter which was navigated into the distal right cavernous segment of the ICA. Initially a Headway Duo microcatheter (MicroVention) was navigated past the flipped WEB and a 2.5 mm LVIS Jr. (MicroVention) was partially deployed to retrieve the WEB. Partial deployment of the LVIS Jr. failed to either compact the device or retrieve the device (Fig. 2E). A Headway-21 microcatheter was navigated just proximal to the WEB device and the marker was captured with a 2 mm Amplatz Gooseneck™ microsnare (Fig. 2F). The WEB device was successfully removed.

Because of the WEB migration, the interventional approach was modified to embolization with stent-assisted WEB embolization of the ACOM aneurysm. A 156 cm Headway Duo was navigated from the right ICA into the distal left A2 segment of the ACA. Then a VIA 21 microcatheter over a Synchro2 microguidewire was navigated into the aneurysm. An LVIS Jr. 2.5×23 mm stent was partially deployed from the left A2 segment across the ACOM complex to the right A1 segment of the ACA. A 4×3 mm WEB was deployed in the aneurysm. The remainder of the stent was deployed. Another LVIS Jr. 2.5×23 mm was deployed from the right A2 segment across the ACOM complex to the left A1 segment of ACA completing the X-stent-assisted WEB embolization of the aneurysm. The WEB device was detached. The patient was on dual antiplatelet therapy (DAPT) for the procedure given concern for possible structural stenting and continued post-procedure.

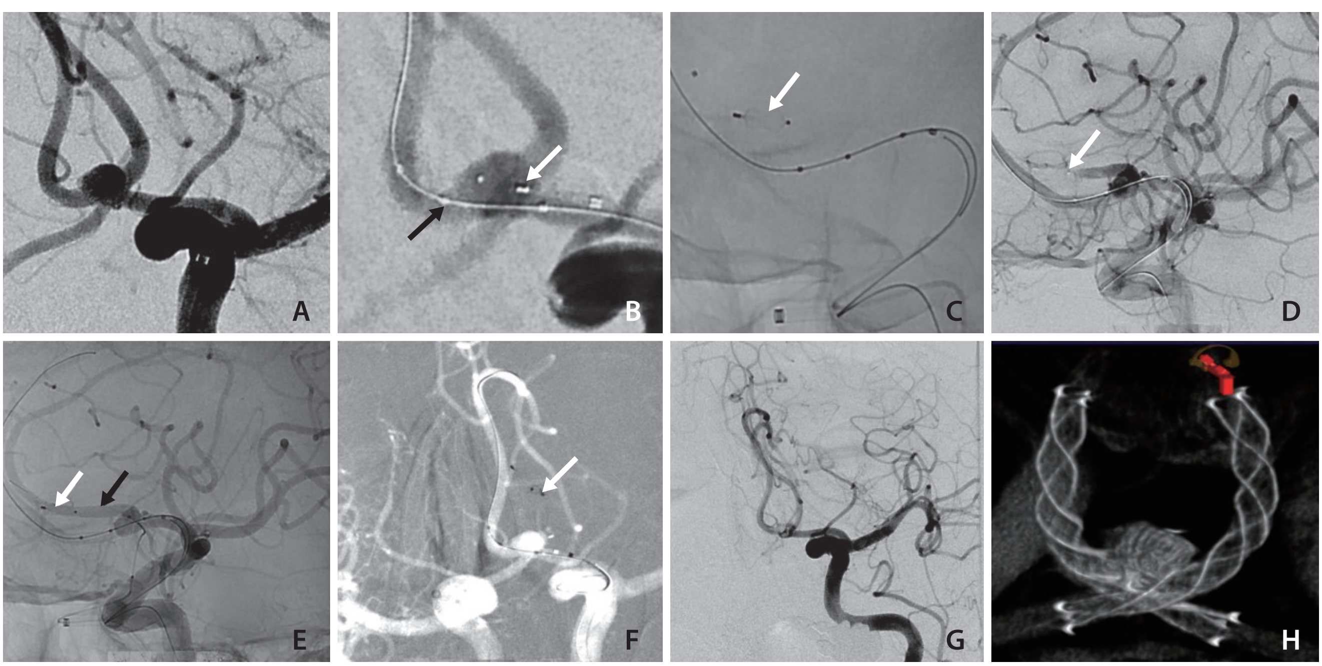

Fig. 2. Woven EndoBridge (WEB) (MicroVention/Terumo) migration from anterior communicating aneurysm (case 2). (**A**) Pre-embolization left internal carotid artery angiogram. (**B**) Pre-detachment of WEB device after deployment of the WEB with positioning using the Scepter XC balloon. Arrows marking the distal balloon marker (black arrow) as well as the proximal marker of the WEB (white arrow). (**C**) Unsubtracted view post-detachment of the WEB device displaying device migration into the left anterior cerebral artery (ACA) with an arrow identifying the WEB. (**D**) Lateral carotid angiogram with arrow demonstrating ACA occlusion after migration of the WEB. (**E**) Unsubtracted lateral carotid angiogram demonstrating partial unsheathing of the first LVIS Jr. in an attempt for WEB retrieval. Resolution of vessel occlusion after partial unsheathing of the LVIS Jr. Arrows marking the body of the WEB device (white arrow) and the proximal stent (black arrow). (**F**) Roadmap view after bilateral internal artery injection with the microsnare in place with plans to capture the distal device marker. Arrow pointing to the microsnare with the loop about to grab the distal WEB marker. (**G**) Post-procedure left internal carotid angiography, frontolateral view, demonstrating decreased aneurysm filling. (**H**) Post-procedure micro dyna computed tomography demonstrating LVIS Jr. X stenting with placement of the WEB device in the aneurysm.

DISCUSSION

WEB device use has shown excellent outcomes in the treatment of aneurysms at bifurcation junctions in the intracranial circulation.[2,4,5] However, device compaction, compression, and intra-aneurysmal thrombosis can cause aneurysmal recurrence.[6] A less common adverse outcome is intraoperative WEB device migration. The most common reasons for migration include under sizing the device or a lack of compression with the sidewall such that the aneurysm fundus is not filled sufficiently.[6]

Accurate sizing is vital for treatment success, as oversized WEB devices can invade the parent vessel and cause thromboembolism, while undersized devices may poorly cover the neck of the aneurysm and are an independent risk factor for incomplete aneurysm occlusion and device failure.[7,8] More specifically, the "+1/–1" rule has been reported in the literature, in which 1 mm is added to the width of the device and 1 mm is subtracted from the height to allow the device to compress against the wall in a radial direction when deployed.[6,9] For this reason, computational-based tools, such as volumetric image segmentation and cloud-based platforms have already been found to be superior to manual height-by-width measurements.[4,9] However, the clinical utility of these tools is still equivocal without sufficient prospective series and trials.

Case Review

While WEB migration can be caused by different procedural shortcomings, the migrations observed in both reported cases seemed likely due to incomplete detachment of the WEB device from the delivery system. In case 1, the aneurysm was 4.7×3.7 mm and we elected to use a 5×2 mm WEB. Pre-deployment, the device was positioned appropriately. On delayed angiography post-deployment, the device migrated outside the dome of the aneurysm. One possible explanation is that the incomplete detachment of the WEB device from the electrothermal delivery system resulted in proximal migration of the device upon retraction of the delivery wire.[6] It is difficult to predict these complications, as the angiography had shown appropriate placement and sufficient opposition of the device. Whereas in the past we preferred to oversize +1 mm in the lateral dimensions, we now tend to oversize even more in this dimension. This is to increase the radial force on the aneurysm wall and therefore prevent movement.[10] Given the issues experienced in case 1 with the WEB, we elected to resume treatment with standard stent-assisted coil embolization. Based on the aneurysm morphology, we resorted to coiling as we felt more confident to have success with this approach, rather than to re-attempt WEB embolization with a larger device.

Case 2 demonstrated successful WEB embolization in an ACOM artery aneurysm following failed WEB placement. The LVIS Jr. was chosen for the initial retrieval to allow for either stent tagging of the WEB with the opening of the parent vessel or for potential stent-retrieval after partial deployment. The LVIS Jr. was able to open a channel against the WEB device despite the outward radial force of the WEB; however, there was still significant remaining stenosis leading us to attempt further retrieval strategies. Partial deployment of the LVIS Jr. also failed to provide strong enough outward radial force to drag the WEB *via* stent-retrieval. The Amplatz Gooseneck™ microsnare device was successful in capturing the WEB. While it was first intended for use in the cardiovascular system, specifically for venous catheter repositioning and venipuncture procedure assistance, our case report substantiates its use in retrieving mispositioned WEB devices in bifurcated intracranial aneurysms.[11] Following the previous WEB position failure in this case, we elected to modify our approach and perform a stent-assisted WEB embolization. We obtained successful WEB placement with an "X" shaped support with LVIS Jr. stents across the ACOM artery. Post-embolization, there was no evidence of vessel injury, thrombotic events, or contrast extravasation. A 1-year follow-up angiogram demonstrated near complete occlusion of the ACOM artery aneurysm and no evidence of aneurysm recurrence or in-stent stenosis.

Of the few reported ACOM aneurysm WEBectomies, one case proposed that the acute angulation between the aneurysm and parent artery enabled a change in orientation that caused the migration.[12] For this referenced case, after multiple failures with strategies that included microsnare retrieval, stenting with a Neuroform Atlas™ (Stryker) device eventually succeeded, which also required careful consideration of DAPT treatment. There have been 2 reported usages of the Amplatz Gooseneck™ microsnare in WEBectomy; 1 for an aneurysm in the posterior cerebral circulation and 1 for an aneurysm of the internal carotid.[13,14] To our knowledge, the second case demonstrates the first published instance of microsnare WEB retrieval from a distal migration from the ACOM into the distal ACA. We propose that our case illustrates an equally viable method for use of a retrieval device in a difficult to access region of the anterior intracranial circulation.

Review of WEBectomy Strategies

There have been various reported methods of recovering misplaced WEB devices, and the unique aneurysm profile should dictate which method is chosen. Through animal studies, researchers have found effective rescue of smaller WEBs with reperfusion catheters and larger WEBs with both microsnare and Alligator devices.[15] Alligator retrieval devices (Chestnut Medical Technologies) were designed to retrieve coils placed in smaller aneurysms using jaws and a grasper feature that is no longer available to practitioners in the US. Currently, the available microsnare devices range in loop diameter from 2 mm to 7 mm with a snare length of either 175 or 200 cm. Mechanically, the microsnare is ideal in its conformation with a 90-degree loop, as well as a super elastic construction that minimizes shape deformation. Another feature of the biomechanics of the microsnare is that the device remains coaxial to the lumen, making device capture more feasible in a dynamic intraluminal environment.[16] Potential drawbacks to the microsnare include an inability to open the loop in very small vessels. Stent-assisted approaches require patients to be put on antiplatelet therapy to prevent thromboembolic complications and still leave a space occupying device in the parent vessel. The risk of rupture or thromboembolic complications must be considered, so opting for a conservative "watching" approach can be weighed. Aspiration catheters are an additional option to ingest migrated WEB devices, but this approach is challenging for distal vessels or when attempting to navigate past larger wide-necked aneurysms. Stent retrievers, such as the Solitaire™ Revascularization (Medtronic) device, are more commonly reported for bailout strategy, given the ability to provide adequate radial force and friction to pull the WEB back into the microcatheter.[16] However, a potential limitation has already been described with retrievers interacting with large white thrombi, and it can be extrapolated that similar challenges may exist with removing larger migrated WEB devices.[17]

Long-Term Follow-Up for Cases

There has not been well-documented follow-up on patients that underwent microsnare WEB retrieval to date. We report excellent outcomes at approximately 1 year following aneurysm treatment in both cases. In case 1, 1-year follow-up magnetic resonance angiography showed an occluded basilar tip aneurysm with a possible small neck residual, classifying as a class II outcome on the Raymond–Roy scale, which is an angiographic classification system for grading the occlusion status of treated cerebral aneurysms. In case 2, there was no evidence of vessel injury, thrombotic events, or contrast extravasation post-embolization (Fig. 2G, H). A 1-year follow-up angiogram demonstrated near complete occlusion of the ACOM artery aneurysm and a WEB Occlusion Scale 2 outcome.[18] There was no evidence of in-stent stenosis or long-term complications of the stent-assisted WEBectomy with Amplatz Gooseneck™ microsnare.

CONCLUSION

Various bailout strategies should be considered when attempting to recover a migrated WEB device, and operators should consider the size of the WEB device and the size and location of the aneurysm to maximize retrieval chance. The Amplatz Gooseneck™ microsnare can be successfully utilized in both the anterior and posterior intracranial circulation at acutely angled bifurcation points between the aneurysm and parent artery for WEBectomy. Outcomes regarding aneurysm recurrence and thromboembolic complications were promising in our case and in reported literature following microsnare retrieval of migrated WEB devices.

SUPPLEMENTARY MATERIALS

Supplementary materials related to this article can be found online at https://doi.org/10.5469/neuroint.2023.00136.

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Fund

None.

Ethics Statement

This report was written in concordance with Northwell Health Institutional Review Board (IRB no.22-047). Requirements for IRB approval and informed consent were waived. We de-identified all patient information to ensure anonymity.

Conflicts of Interest
The authors have no conflicts to disclose.

Author Contributions
Concept and design: BAS, TGW, and CW. Analysis and interpretation: BAS, TGW, and CW. Writing the article: BAS. Critical revision of the article: TGW, CW, and KS. Final approval of the article: HHW. Overall responsibility: HHW.

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REFERENCES

1. Heiferman DM, Peterson JC, Johnson KD, Nguyen VN, Dornbos D, Moore KA, et al. Woven EndoBridge embolized aneurysm clippings: 2-dimensional operative video. *Oper Neurosurg (Hagerstown)* 2021;21:E365
2. Pierot L, Moret J, Barreau X, Szikora I, Herbreteau D, Turjman F, et al. Aneurysm treatment with Woven EndoBridge in the cumulative population of 3 prospective, multicenter series: 2-year follow-up. *Neurosurgery* 2020;87:357-367
3. Rai AT, Turner RC, Brotman RG, Boo S. Comparison of operating room variables, radiation exposure and implant costs for WEB versus stent assisted coiling for treatment of wide neck bifurcation aneurysms. *Interv Neuroradiol* 2021;27:465-472
4. Dmytriw AA, Dibas M, Ghozy S, Adeeb N, Diestro JDB, Phan K, et al. The Woven EndoBridge (WEB) device for the treatment of intracranial aneurysms: ten years of lessons learned and adjustments in practice from the WorldWideWEB consortium. [published online ahead of print Sep 6, 2022] *Transl Stroke Res* 2022
5. Goertz L, Liebig T, Siebert E, Pflaeging M, Forbrig R, Pennig L, et al. Stent-assisted WEB embolization: aneurysm characteristics, outcome and case report of a WEB delivered through a stent. *Acta Neurochir (Wien)* 2022;164:2181-2190
6. Goyal N, Hoit D, DiNitto J, Elijovich L, Fiorella D, Pierot L, et al. How to WEB: a practical review of methodology for the use of the Woven EndoBridge. *J Neurointerv Surg* 2020;12:512-520
7. Cagnazzo F, Ahmed R, Zannoni R, Dargazanli C, Lefevre PH, Gascou G, et al. Predicting factors of angiographic aneurysm occlusion after treatment with the Woven EndoBridge device: a single-center experience with midterm follow-up. *AJNR Am J Neuroradiol* 2019;40:1773-1778
8. Fortunel A, Javed K, Holland R, Ahmad S, Haranhalli N, Altschul D. Impact of aneurysm diameter, angulation, and device sizing on complete occlusion rates using the Woven Endobridge (WEB) device: single center United States experience. [published online ahead of print Mar 7, 2022] *Interv Neuroradiol* 2022
9. Shah KA, White TG, Teron I, Link T, Dehdashti AR, Katz JM, et al. Volume-based sizing of the Woven EndoBridge (WEB) device: a preliminary assessment of a novel method for device size selection. *Interv Neuroradiol* 2021;27:473-480
10. Gravino G, Masri S, Chandran A, Puthuran M. Management of WEB device migration and mal-position in endovascular treatment of cerebral aneurysms. [published online ahead of print Aug 25, 2022] *Interv Neuroradiol* 2022
11. Nazarian GK, Myers TV, Bjarnason H, Stackhouse DJ, Dietz CA Jr, Hunter DW. Applications of the Amplatz snare device during interventional radiologic procedures. *AJR Am J Roentgenol* 1995;165:673-678
12. Salem MM, Ali A, Riina HA, Burkhardt JK. Bailout strategies for abrupt change in Woven Endobridge 17 device orientation after detachments: technical note of 2 anterior communicating artery aneurysm cases. *World Neurosurg* 2022;162:68-72
13. Radu RA, Gascou G, Derraz I, Cagnazzo F, Costalat V. Micro-snare retrieval as bail-out technique for a distally migrated WEB-device: a case report. [published online ahead of print Aug 4, 2022] *Interv Neuroradiol* 2022
14. Amuluru K, Al-Mufti F, Sahlein DH, Scott J, Denardo A. Adjustment of malpositioned Woven EndoBridge device using gooseneck snare: complication management technique. *Neurointervention* 2021;16:275-279
15. Simgen A, Kettner M, Dietrich P, Tomori T, Mühl-Benninghaus R, Bhogal P, et al. Different rescue approaches of migrated Woven Endobridge (WEB) devices: an animal study. *Clin Neuroradiol* 2021;31:431-438
16. Bañez RMF, Chong W. Retrieval of displaced Woven EndoBridge intrasaccular flow disruptor using solitaire platinum revascularization device. *Neurointervention* 2022;17:106-109
17. Machi P, Jourdan F, Ambard D, Reynaud C, Lobotesis K, Sanchez M, et al. Experimental evaluation of stent retrievers' mechanical properties and effectiveness. *J Neurointerv Surg* 2017;9:257-263
18. Caroff J, Mihalea C, Tuilier T, Barreau X, Cognard C, Desal H, et al. Occlusion assessment of intracranial aneurysms treated with the WEB device. *Neuroradiology* 2016;58:887-891