Research Square

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Repeat Woven EndoBridge Implantation for Recurrent Intracranial Aneurysms: Experience From a Consecutive Single-Center Cohort

Taisuke Akimoto
Bicêtre Hospital
Cristian Mihalea
cristianmihalea@yahoo.com
Bicêtre Hospital
Fernanda Rodriguez Erazu
Bicêtre Hospital
Julia Juhasz
Bicêtre Hospital
Mohamed Ismail
Bicêtre Hospital
Dan Adrian Popica
Bicêtre Hospital
Daniel Claudiu Malita
Victor Babeș University of Medicine and Pharmacy Timișoara
Vanessa Chalumeau
Bicêtre Hospital
Léon Ikka
Bicêtre Hospital
Jildaz Caroff
Bicêtre Hospital
Laurent Spelle
Bicêtre Hospital
Jonathan Cortese
Bicêtre Hospital

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Abstract

Background

Retreatment after Woven EndoBridge (WEB) embolization is required in a subset of patients, yet the role of repeat WEB implantation remains poorly defined.

Objective

To evaluate the feasibility, safety, and angiographic characteristics of repeat WEB implantation for recurrent intracranial aneurysms.

Methods

We retrospectively reviewed a contemporary single-center cohort of 209 consecutive intracranial aneurysms treated with the WEB device between January 2020 and December 2024. Retreatment was defined as any additional endovascular or surgical procedure performed for aneurysm recurrence or incomplete occlusion during follow-up. Patients undergoing repeat WEB implantation were analyzed as a focused subgroup within this consecutive single-center cohort.

Results

Retreatment was required in 21 of 209 aneurysms (10.0%). Retreatment strategies included flow diversion (n = 14), coiling (n = 1), and repeat WEB implantation (n = 6; 2.9% of the total cohort). Recurrence mechanisms prompting repeat WEB included device compaction (n = 5) and combined growth and compaction (n = 1). Repeat WEB implantation was technically successful in all cases, with no procedure-related hemorrhagic or ischemic complications. One patient subsequently required flow diversion due to parent artery stenosis.

Conclusion

Repeat WEB implantation appears feasible and safe in carefully selected patients and may serve as a complementary or bridging retreatment strategy after initial WEB embolization.

Introduction

The Woven EndoBridge (WEB) device has become an established option for the treatment of wide-neck bifurcation intracranial aneurysms. Prospective trials and multicenter registries have demonstrated favorable safety profiles and durable aneurysm occlusion with WEB embolization in both ruptured and unruptured aneurysms.[1–6] Despite these encouraging results, aneurysm recurrence and the need for retreatment remain clinically relevant.

Reported retreatment rates after WEB embolization range from approximately 6% to 10%, with flow diversion, stent-assisted coiling, and microsurgical clipping representing the most frequently reported retreatment strategies.[7–10] In contrast, repeat WEB implantation has been only sporadically described, and its role as a distinct retreatment option remains insufficiently characterized.[10–13] Furthermore, predictors of successful long-term occlusion after repeat WEB implantation remain poorly defined. Variables such as aneurysm morphology, size and configuration of the recurrent cavity, deformation or compression pattern of the initial WEB device, and timing of recurrence have not been systematically analyzed in relation to outcomes of WEB-in-WEB retreatment.[13] Consequently, patient and aneurysm selection for repeat WEB implantation currently relies largely on individual operator judgment rather than evidence-based criteria.

The present study reports repeat WEB implantation for recurrent intracranial aneurysms as a focused subgroup analysis within a contemporary single-center consecutive cohort (2020–2024). Our aim was to describe recurrence mechanisms, procedural considerations, and short- to mid-term angiographic outcomes following repeat WEB treatment.

Materials and Methods

Study design and patient population

A prospectively maintained database of consecutive patients treated with the WEB device between January 2020 and December 2024 was reviewed for this study. A total of 209 intracranial aneurysms treated with the WEB device were included. Retreatment was defined as any additional endovascular or surgical procedure performed to address aneurysm recurrence or incomplete occlusion during the follow-up period. Repeat WEB implantation was defined as retreatment using an additional WEB device placed after the prior WEB treatment of the same aneurysm. The ethics committee of the CERIM (French Ethical Committee for Research in Medical Imaging) approved this study (CRM2402-394). The need for patients' informed consent was waived given the retrospective design of the study. Patients were informed they could oppose the use of their health-related data for research purposes.

Endovascular procedures and antiplatelet management

All procedures were performed under general anesthesia by experienced neurointerventionalists. Device type and size selection were based on aneurysm morphology and operator judgment using measurements from 3D rotational angiograms, generally following established oversizing principles.[14–16] The Sim&Size simulation software (SIM&CURE, Montpellier, France) was also used to help select the device size at the discretion of the operator. WEB devices were mostly delivered through VIA catheters (Microvention, CA, USA). Antiplatelet therapy was individualized according to rupture status and anticipated need for adjunctive or staged stent-based treatment. In ruptured aneurysms, no antiplatelet therapy (APT) was used prior to the treatment. In unruptured cases, patients received acetylsalicylic acid (ASA) (160 mg per day) and ticagrelor (90 mg twice a day) the day prior to WEB. Oral treatment was only continued in case of WEB protrusion (at the discretion of the operator) or in case of stent utilization. For either ruptured or unruptured aneurysms, treatment was performed under systemic heparinization (bolus of 50 IU/kg then 100 IU/kg/h IV) that was stopped at the end of the procedure.

Imaging follow-up and outcome assessment

Angiographic follow-up was performed using digital subtraction angiography (preferably) using high-resolution contrast-diluted Cone-beam CT with 20% iodine contrast agent and 80% saline solution (vasoCT; Philips Healthcare, Best, the Netherlands) and/or magnetic resonance angiography. Aneurysm occlusion was assessed using the WEB Occlusion Scale and, when available, the Bicêtre Occlusion Scale Score.[15–17] Recurrence mechanisms were classified as device compaction, aneurysm growth, or mixed. In this manuscript, the term *WEB compaction* was used to describe a previously reported shape modification of the WEB device[18, 19], associated with recurrence at the aneurysm neck or within the sac, in which the device is displaced toward the aneurysm dome. Clinical outcomes were assessed using the modified Rankin Scale (mRS).

Statistical analysis

Descriptive statistics were used to summarize the data. Categorical variables are presented as counts and percentages, and continuous variables are reported as means with standard deviations or medians with ranges, as appropriate.

Results

Among 209 WEB-treated aneurysms, retreatment was required in 21 cases (10.0%). Flow diversion was the most common retreatment strategy (n = 14; 6.7%), followed by coiling (n = 1; 0.5%) and repeat WEB implantation (n = 6; 2.9%).

In all six repeat WEB cases, device deployment was technically successful. Recurrence mechanisms prompting repeat WEB included device compaction (n = 5) and combined growth and compaction (n = 1). No procedure-related hemorrhagic or ischemic complications were observed. One patient presented a parent artery stenosis after repeat WEB implantation and subsequently underwent flow diversion. Detailed patient and aneurysm characteristics are summarized in Table 1. No new neurological deficit attributable to repeat WEB implantation was observed. One patient had a 90-day mRS score of 4 due to the initial bleeding episode, but retreatment with WEB did not result in a worsening of the mRS score. All other patients had an mRS score of 0.

Table 1
Characteristics of WEB on WEB patients

Case	Age	Sex	Location	Ruptured	Aneurysm size at initial treatment D × W × H(mm)† Neck width (mm)	Initial treatment WEB size	Time until retreatment (month)	Type of recurrence	Recurrent cavity size D × W × H(mm)† Neck width (mm)	Retreatment WEB size	Periproced complicati
1	63	Female	PCom	Yes	9.2X7.3X6.7 3.3	WEB SLS8-6.6	8	Compaction	5.2X5.1X7.2 3.7	WEB 7 – 4	No
2	35	Male	MCA	No	5.8X6.5X7.2 5.8	WEB SLS7-5.6	18	Compaction	3.8X3.6X3.7 3.8	WEB 4.5-3	Asymptom WEB protrusion after detachmer
3	53	Male	MCA	Yes	5.1X8.3X6.8 4.1	WEB 6 – 3	5	Aneurysm growth + compaction	3.5X2.6X3.9 3.5	WEB 4.5-2	No
4	39	Male	ACA	No	8.8X8.4X5.4 5.7	WEB 7 – 3	27	Compaction	3.9X5.7X5.3 5.8	WEB 5 – 2	No
5	41	Male	VA-PICA	Yes	11.3X6.6X5.2 3.5	WEB SLS7-5.6	5	Compaction	4.1X5.7X6.0 4.5	WEB 7 – 2	No
6	46	Female	MCA	No	4.0X4.4X4.3 4.4	WEB 5.5-2	8	Compaction	3.7X4.3X4.8 4.3	WEB 5 – 2	No

NA, follow-up angiographic occlusion assessment not available at the time of analysis.

†: Aneurysm dimensions are reported as three orthogonal diameters (mm) with neck width (mm), measured on 3D angiographic reconstructions.

‡: Final occlusion is reported as WEB Occlusion Scale (WOS) / Bicêtre Occlusion Scale Score (BOSS). Follow-up period after repeat WEB implantation (mont

*: Delayed asymptomatic WEB protrusion with parent artery stenosis, requiring retreatment with FD

Illustrative cases:

Case 1

A patient was treated for the recurrence of a right internal carotid artery–posterior communicating artery (ICA–PCom) aneurysm. The aneurysm was identified at presentation with aneurysmal subarachnoid hemorrhage associated with a right frontal intraparenchymal hematoma (Fig. 1A). The aneurysm measured 9.2 × 7.3 × 6.7 mm, with a neck width of 3.3 mm, at the time of initial treatment. Endovascular treatment with a WEB SLS 8–6.6 device (Woven EndoBridge, MicroVention–Terumo, Aliso Viejo, CA, USA) achieved satisfactory aneurysm occlusion based on the initial three-dimensional rotational angiographic workup (Fig. 1B), with post-deployment angiography demonstrating intra-aneurysmal flow disruption (Fig. 1C). The patient subsequently underwent surgical hematoma evacuation and decompressive craniectomy, followed by cranioplasty. At discharge from the intensive care unit, the patient's Glasgow Coma Scale score was 15, with bradyphrenia, hypotonia, and left hemiparesis; the 90-day modified Rankin Scale score was 4.

Six-month digital subtraction angiography demonstrated significant WEB compaction, with a residual aneurysm measuring 5.2 × 5.1 × 7.2 mm and a neck width of 3.7 mm, and retreatment was indicated. Recanalization was confirmed using working-projection angiography (Fig. 1D). Dual antiplatelet therapy with ticagrelor and aspirin was administered as premedication.

Retreatment was performed under general anesthesia with systemic heparinization. Using a standard triaxial system, a VIA 17 microcatheter (MicroVention–Terumo, Aliso Viejo, CA, USA) was navigated over a Synchro 14 microguidewire (Stryker Neurovascular, Fremont, CA, USA) to catheterize the proximal portion of the aneurysmal remnant. A 7 × 4 mm WEB device was deployed with satisfactory wall apposition and adequate neck coverage opposite the posterior communicating artery; notably, there was no right P1 segment. Post-deployment VasoCT confirmed appropriate positioning (Fig. 1F), and control angiography demonstrated no thrombus formation or distal embolic complications (Fig. 1E).

At the 1-year follow-up angiography, aneurysm occlusion was graded as BOSS 2 and WEB Occlusion Scale (WOS) C (Fig. 1G, H), without periprocedural or delayed complications. No recurrence or progression was observed on the 2-year follow-up MRI.

Case 4

A 39-year-old man presented with an unruptured anterior cerebral artery (ACA) aneurysm measuring 8.8 × 8.4 × 5.4 mm, with a 5.7-mm neck (Fig. 2A). Initial three-dimensional rotational angiography and working-projection DSA showed the aneurysm configuration and its relationship to an adjacent branch arising

near the aneurysm neck (Fig. 2A, B). Given the presence of this neck-adjacent branch, preservation of the vessel was a major consideration in treatment planning, and a slightly undersized WEB device was deliberately chosen. Endovascular treatment was performed with a 7 × 3 mm WEB device. Post-procedural CBCT confirmed satisfactory device position after treatment, and the procedure was completed without complication (Fig. 2C).

Follow-up angiography at 27 months demonstrated aneurysm recurrence due to WEB compaction, with a residual filling space measuring 3.9 × 5.7 × 5.3 mm and a neck width of 5.8 mm (Fig. 2D). Retreatment was undertaken using a 5 × 2 mm WEB device, with fusion imaging confirming device configuration and preservation of the branching vessel (Fig. 2E). At 9-month angiographic follow-up after retreatment, occlusion was classified as BOSS 2 and WOS C, with additional compaction of the second WEB device noted on DSA and CBCT (Fig. 2F, G). Despite this, the branch remained patent on follow-up DSA (Fig. 2F), and the patient remained clinically well with an mRS score of 0.

Case 5

A patient with a previously ruptured left posterior inferior cerebellar artery (PICA) aneurysm (Fisher grade 4, WFNS grade 2) had a favorable clinical outcome (modified Rankin Scale score 0). The initial presentation was documented using contrast-enhanced CT (Supplementary Fig. 1A). First treatment. Diagnostic digital subtraction angiography (DSA) of the left vertebral artery demonstrated a left PICA aneurysm (Supplementary Fig. 1B). The aneurysm was treated with a WEB device, and post-deployment DSA showed intra-aneurysmal flow disruption and preserved PICA patency (Supplementary Fig. 1C). Cone-beam CT (CBCT) confirmed the appropriate device positioning and expansion (Supplementary Fig. 1D). First retreatment (WEB-on-WEB) was performed. Follow-up DSA revealed aneurysm recurrence (Supplementary Fig. 1E). Retreatment was performed using the WEB-in-WEB technique, and CBCT confirmed the appropriate device configuration (Supplementary Fig. 1F). Second retreatment (WEB + FD). Subsequent imaging revealed a second recurrence on DSA (Supplementary Fig. 1G), which was further characterized by 3D rotational angiography (3DRA) (Supplementary Fig. 1H). A second retreatment was performed with combined WEB placement and flow diverter deployment, with CBCT confirming satisfactory device positioning (Supplementary Fig. 1I). Final DSA demonstrated adequate aneurysm occlusion with preserved PICA patency and no thromboembolic complications (Supplementary Fig. 1J). There were no specific complications, and the clinical course was favorable, with an mRS score of 0.

Discussion

In this single-center consecutive cohort of 209 aneurysms treated with the WEB device, repeat WEB implantation accounted for nearly one-quarter of the retreatment procedures following initial WEB embolization. Repeat WEB placement was technically feasible in all selected cases and was not associated with periprocedural hemorrhagic or ischemic complications. However, the angiographic durability after repeat WEB placement was heterogeneous, and additional retreatment was required in selected patients. These findings suggest that repeat WEB implantation is feasible and safe in carefully selected recurrent aneurysms, although long-term durability remains variable.

Prospective multicenter studies have established the safety and mid- to long-term efficacy of WEB for wide-neck bifurcation aneurysms, with durable occlusion at 3–5 years in WEBCAST, WEBCAST-2, the cumulative prospective series, and WEB-IT.[1–6] In parallel, data from CLARYS and subsequent analyses have supported the use of WEB in ruptured aneurysms, highlighting its antiplatelet-sparing profile.[7, 8]

Retreatment after initial WEB embolization remains necessary in approximately 7–10% of cases, most often using SAC, FD, or clipping.[9–12] Case reports and small series have demonstrated the feasibility of repeated—even triple—WEB implantation.[20–22] However, focused analyses isolating repeat WEB as a distinct retreatment strategy remain limited. Published WEB-on-WEB reports are summarized in Table 2. Consistent with prior literature, aneurysm recurrence after WEB treatment is most commonly attributed to device compaction, incomplete initial occlusion, or delayed morphological modification of the implanted device, rather than acute device failure.[10, 13, 23] Experimental and imaging studies have contributed to understanding occlusion grading and device–aneurysm interaction.[14–16]

Table 2
Published retreatment series and case reports involving WEB-on-WEB retreatment after initial WEB embolization

Study (Year)	Study design	Initial WEB cases (n)	Retreated cases (n)	Retreatment with WEB (WEB-on-WEB)	Other retreatment modalities	Complications specific to WEB-on-WEB	Occlusion specific to WEB-on-WEB
Kabbasch et al. (2019)	Single-center pilot series	122	15	1 case	Coiling; stent-assisted coiling; flow diversion; surgery	Not separately reported	Not quantified
Srinivasan et al. (2022)	Multicenter case series (13 centers)	342	30	1 case (additional WEB placement)	SAC (12), FD (7), coiling (2), PulseRider-assisted coiling (1), clipping (6), Hunterian ligation (1)	No major complications reported in cohort; WEB-on-WEB case not reported separately	6 month neckremnant (BOSS 2)
Caroff et al. (2023)	Multicenter retrospective (4 centers)	756	57	Second WEB placement: 5 cases (8.8%); 1 stent-assisted WEB reported	Flow diversion (~ 48%); stent-assisted coiling (~ 30%); coiling; surgery	Not separately reported for the WEB-on-WEB subgroup. (Overall retreatment: morbidity 5.3%, mortality 0%; thromboembolic events reported; no rebleeding during follow-up)	Not separately reported for the WEB-on-WEB subgroup Overall retreatment (follow-up 50/57): complete occlusion 56%; adequate occlusion 88%
Gawlitza et al. (2018)	Multicenter series	66	8	Reported (number not specified)	Coiling; stent-assisted coiling	Not separable as a WEB-on-WEB subgroup. (Overall series: permanent morbidity 5.9%; mortality 0%.)	Not reported as WEB-on-WEB subgroup. (Overall follow-up: complete 33.3%, neck remnant 40.0%, aneurysm remnant 26.7%.)
Withers (2025)	Case report	1	1	Yes (repeat WEB)	(subsequent Pipeline FD for incidental ICA aneurysm, not for basilar tip)	No complications reported.	Not quantified; described as satisfactory occlusion in the case report.
Hasebe (2025)	Case report	1	1	Yes (repeat WEB)	Flow diverter (FRED-X) deployed with semi-jail technique	No complications reported.	Complete occlusion at 4-month follow-up.
Present study	Single-center retrospective	209	21	6 cases (28.6%)*	FD (14), coiling (1)	No periprocedural complications; one case of asymptomatic delayed WEB protrusion with parent artery stenosis, retreated with FD	adequate occlusion (4/6, 66.7%)

*: Two cases also reported in this article (Caroff et al.2023)

In our cohort, recurrence was predominantly due to device compaction, with one case of combined aneurysm growth and compaction. This mechanism supports repeat intrasaccular treatment, particularly when the residual cavity remains accessible and branch geometry is preserved. In our practice, repeat WEB implantation was considered mainly for compaction-type recurrences with preserved bifurcation geometry, branch patency, and an accessible residual cavity for microcatheterization. In contrast, recurrence associated with significant neck enlargement, progressive branch incorporation, or unfavorable remodeling was more likely to prompt consideration of flow diversion or stent-assisted techniques.

Repeat WEB implantation may be particularly attractive in bifurcation anatomy, where branch preservation is critical and avoidance of permanent intraluminal implants is preferred. This consideration is especially relevant when dual antiplatelet therapy (DAPT) is undesirable, particularly in ruptured aneurysms or in patients with external ventricular drainage or recent intracranial hemorrhage.[7, 8, 24, 25]

The device-sizing strategy likely affects the durability of repeat WEB treatment. Previous studies have shown that slight width oversizing is associated with better occlusion. In contrast, irregular aneurysm morphology has been associated with residual filling or recurrence, and a recent systematic review and meta-analysis further supported the importance of baseline morphologic features in determining angiographic outcomes after WEB treatment.[17, 26] Furthermore, complete neck apposition of the device was also associated with improved occlusion rates during follow-up.[27] WEB treatment is also known to show gradual device deformation over time, including shape modification or compaction, and appropriate sizing is considered important for achieving stable neck coverage and durable occlusion.[17, 18] In the present series, four of the five WEB-on-WEB cases with angiographic follow-up showed compaction of the second WEB (Table 1). Although the number of cases is small, this finding suggests that repeat WEB treatment may remain prone to compaction in selected aneurysms. As shown in Case 4, when a branch arises near the aneurysm neck, device sizing may need to be more conservative to preserve the branch. In addition, the limited residual space after the first WEB may make it difficult to achieve sufficient oversizing of the second device. In such cases, the anatomical factors that likely contributed to the failure of durable occlusion after the first WEB may still be present at retreatment. Therefore, although WEB-

on-WEB can be a useful option in selected cases, careful consideration is needed when branch preservation or limited intrasaccular space prevents optimal sizing, because these aneurysms may remain at risk of recurrent compaction even after retreatment.

Our experience suggests that repeat WEB should be viewed not as an alternative to SAC or FD, but as a complementary option within a structured retreatment algorithm. In selected patients, repeat WEB can function as a bridging or staged strategy, with later conversion to flow diversion when warranted. In our series, one patient developed parent artery stenosis and subsequently underwent FD; this type of event is captured within the effectiveness endpoints of WEB-IT and reinforces the need for careful, longitudinal angiographic surveillance.[5, 6] Importantly, the existing literature does not allow firm conclusions regarding the comparative durability of repeat WEB versus SAC, FD, or microsurgical clipping. Most published data are retrospective, and repeat WEB typically represents only a small fraction of retreatment cases, which limits meaningful modality-specific comparisons.[10–12] Candidate selection for repeat WEB remains anatomy-driven because clear evidence-based criteria are lacking. The limited published experience suggests that WEB-on-WEB retreatment can be performed with an acceptable safety profile, but the available data remain too sparse for robust comparisons. Moreover, most studies do not report outcomes by retreatment modality, limiting comparisons of WEB-on-WEB with SAC, FD, or clipping.

Limitations

This study had several limitations. It is a retrospective, single-center study, and includes a limited number of repeat WEB cases. Imaging follow-up modalities and intervals were determined based on the evolving clinical practice over an extended study period. Device generation and operator experience changed over time, introducing potential heterogeneity. Furthermore, the absence of a direct comparator group (e.g., SAC or FD for recurrent aneurysms) precludes conclusions regarding relative efficacy. Therefore, our findings should be interpreted as hypothesis-generating.

Conclusions

Repeat WEB implantation appears to be feasible and safe in carefully selected recurrent aneurysms, particularly in compaction-type recurrences with preserved bifurcation anatomy. It may serve as an antiplatelet-sparing retreatment option within a broader retreatment algorithm before escalation to flow diversion in selected cases. However, angiographic durability was variable, and long-term imaging surveillance remains essential.

Declarations

Declaration of interest

The authors have no personal conflict of interest related to this study.

Competing Interests

J. Caroff has received honoraria from Balt, Cerenovus, and Medtronic for lectures. L. Spelle is a consultant for Microvention, Balt, Phenox, Stryker, and Medtronic; serves on the DSMB or Advisory Board for the CHOICE, INSPIRE, CLEVER, and COATING studies; and has received a grant/contract from Philips to his institution. J. Cortese has received research grants from Medtronic, Phenox, and Microvention, and honoraria for lectures from Balt. All other authors declare no competing interests.

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Author Contribution

T.A., C.M., J.Co., and L.S. contributed to the conception and design of the study and the interpretation of the data. C.M., F.R-E., J.Ju., M.I., D.A.P., D.C.M., V.C., I.L., J.Ca., and L.S. contributed to the acquisition and/or analysis of the data and critically revised the manuscript for important intellectual content. All authors drafted the work or revised it critically for significant intellectual content. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work, including its accuracy and integrity. T.A. and J.Co. are the guarantors.

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Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to patient privacy and institutional/ethical restrictions but are available from the corresponding author on reasonable request, subject to institutional and ethics committee approval.

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Figures

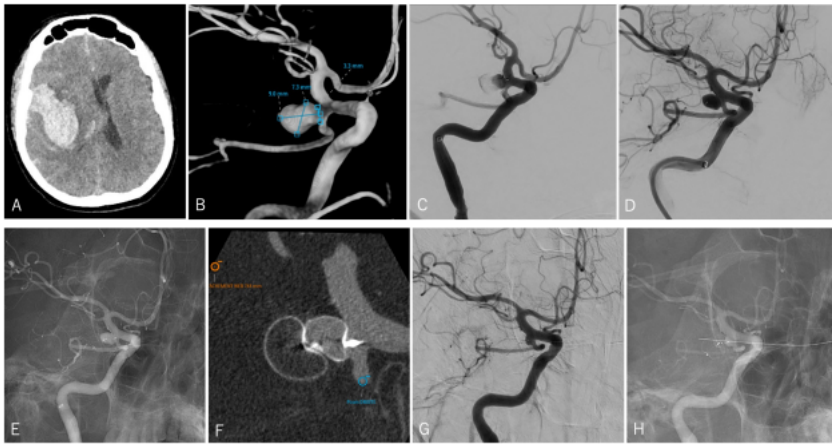


Figure 1

Serial imaging of a right ICA–posterior communicating artery aneurysm treated with WEB and subsequent retreatment.

(A) Admission non-contrast CT showing subarachnoid hemorrhage with a right frontal intraparenchymal hematoma.
(B) Three-dimensional rotational angiography at initial treatment.
(C) DSA after initial WEB deployment demonstrating intra-aneurysmal flow disruption.
(D) Working-projection DSA at follow-up demonstrating aneurysm recurrence due to WEB compaction.
(E) DSA after repeat WEB implantation.
(F) CBCT during retreatment confirming appropriate positioning and expansion of the second WEB device.
(G, H) One-year follow-up DSA demonstrating stable aneurysm occlusion.

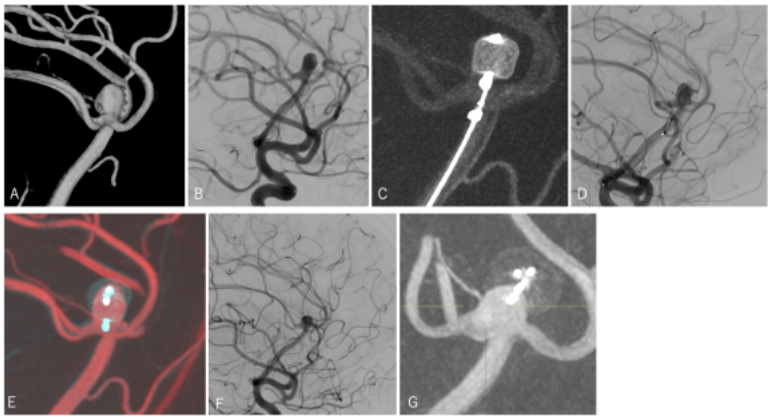


Figure 2

Serial imaging of an unruptured anterior cerebral artery (ACA) aneurysm treated with WEB and subsequent retreatment for recurrence.

(A) Initial three-dimensional rotational angiography demonstrating the aneurysm.
(B) Working-projection DSA before initial treatment showing the aneurysm neck and adjacent branching vessel.
(C) Post-procedural CBCT at initial treatment confirming device position.
(D) Follow-up DSA at 27 months demonstrating recurrence due to WEB compaction.
(E) Fusion image of CBCT and three-dimensional rotational angiography during repeat WEB treatment confirming device configuration and preservation of the branching vessel.
(F) Nine-month follow-up DSA after retreatment demonstrating BOSS 2 / WEB Occlusion Scale C occlusion with persistent branch patency.
(G) Follow-up CBCT at 9 months after retreatment showing compaction of the second WEB device.

Supplementary Files

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- floatimage3.jpeg