Original research

Management of aneurysmal recurrence after Woven EndoBridge (WEB) treatment

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ABSTRACT

Background Around 10% of Woven EndoBridge device (WEB)-treated intracranial aneurysms will need retreatment, and it is generally believed to be more challenging than retreatment after an initial coiling. We aim to report retreatment strategies and outcomes after initial WEB embolizations.

Methods Databases from four treatment centers, containing consecutive aneurysms treated with a WEB between 2013 and 2022, were reviewed. Demographics, aneurysm characteristics, retreatment strategies and outcomes were collected and analyzed.

Results From a 756 WEB database, 57 aneurysms were included. The global retreatment rate was 7.5% (95% CI 5.6% to 9.4%). The retreatment rate was significantly higher in the ruptured compared with the unruptured population (13% vs 3.9%, respectively, P<0.0001). Aneurysms were retreated on average 21.2 months after the initial WEB treatment (range 4.8–70 months). Surgery was performed in 11% and endovascular treatment in 89% of cases, consisting of flow diversion (48%), stent-assisted coiling (30%), coiling (12%), and second WEB placement (10%). Imaging follow-up was available in 88% of all WEB retreatments (50/57) (average 17 months, 49% digital subtraction angiography), demonstrating complete occlusion in 56% and 'adequate' occlusion in 88%. Morbidity was 5.3% (95% CI 0% to 12.0%) and mortality 0%. No patient experienced rebleeding during the follow-up period.

Conclusion The retreatment rate after an initial WEB treatment seems to compare favorably with that of coiling. Endovascular treatment of recurrence following WEB implantation is feasible in most situations; it generally requires the use of a stent and leads to a high rate of satisfactory occlusion.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Approximatively 10% of Woven Endobridge device (WEB)-treated intracranial aneurysms will need retreatment.

WHAT THIS STUDY ADDS

⇒ From a 756 WEB database we report a 7.5% retreatment rate (13% and 3.9% for ruptured and unruptured aneurysms, respectively). The endovascular treatment of recurrence following WEB implantation is feasible in most cases with a 5.3% morbidity rate.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Intrasaccular device usage is increasing. The incidence and characteristics of intrasaccular remnants left by different devices share similarities. The results of this work should incite the conduct of prospective studies aimed at determining the best endovascular approach in such situations.

INTRODUCTION

The Woven EndoBridge (WEB) device (Microvention, CA) currently represents the most extensively studied intrasaccular device,[1 2] and has proven to be a very safe option to treat wide-necked bifurcation aneurysms.[3] Since its introduction, angiographic results have improved year on year, likely due to the sharing of operator experiences in device sizing,[4 5] and yet 5–12% of patients still require retreatment.[3 6–10]

Both open microsurgical[11] and endovascular[12] strategies have been reported as feasible options when retreatment is needed. Endovascular treatment (EVT) of aneurysm recurrence following initial WEB treatment does present certain specificities, however, including the obvious presence of the WEB and the fact that WEBs are generally used to treat wide-necked aneurysms. Retreatments in such cases may therefore be considered as more challenging than EVT after an initial coiling.

Few case series have been published,[6 11–13] with only partially available angiographic outcomes in most. The objective of this study is to report retreatment strategies and outcomes after initial WEB embolizations in four high volume interventional neuroradiology (INR) centers.

METHODS

Data collection

We retrospectively queried the prospectively acquired database of patients with aneurysms treated with WEB devices between 2013 and 2022 in four INR centers (all with >8 years of WEB experience).

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All the consecutive aneurysms that were retreated after the first 3 months of an initial WEB treatment were included.

Retreatment after initial WEB

The decision to retreat was made by multidisciplinary consensus; in all four centers, EVT was favored over surgery. The choice of INR strategy was case-dependent and based on aneurysm location, anatomy, and biometry.

Angiographic follow-up

Angiographic outcomes were analyzed by experienced interventional neuroradiologists and were based preferentially on digital subtraction angiography (DSA) using the Bicêtre Occlusion Scale Score (BOSS) six-point grading scale.[14] BOSS 0 and 0' were considered as complete occlusion.

Clinical follow-up

The modified Rankin score (mRS) was assessed before and immediately after retreatment as well as at last follow-up. Morbidity was defined as any permanent increase in the mRS score after retreatment.

Statistical analysis

Continuous variables are reported as mean±SD if normally distributed, or as median (IQR), while categorical variables are expressed as a frequency (%). A χ^2 test was used to evaluate qualitative factors. Confidence intervals (95% CI) were based on the Wald statistic. P values <0.05 were considered statistically significant. All statistical analyses were performed using R software (version 3.6.1).

RESULTS

Characteristics of patients and aneurysms

During the study period, a total of 756 aneurysms were treated with a WEB device in four centers, and 57 aneurysms were included for analysis due to the need for retreatment (7.5% retreatment rate) (table 1).

The population was 78% female and had an average age at first treatment of 54 years; 39% of aneurysms were initially ruptured.

Aneurysms were located mostly on the anterior communicating artery (ACom) (35%) or the middle cerebral artery (MCA) (33%), then also on the basilar artery (BA) (14%), the posterior communicating artery(11%), the anterior cerebral artery (4%), and other locations (3%).

Aneurysms were retreated on average 21.2 months after the initial WEB treatment (range 4.8–70 months).

Table 1 Characteristics of patients, aneurysms and retreatment with angiographic outcome

Baseline characteristics	All (n=57)
Age (years)	54±10.8
Female	36 (78)
Acutely ruptured	25 (40)
Aneurysm height (mm)	5.9±2.3
Aneurysm width (mm)	5.8±2.3
Aneurysm neck (mm)	4.5±1.7
Aspect ratio (height/neck)	1.4±0.6
Aneurysm location	
ACom	20 (35)
MCA	19 (33)
BA	8 (14)
PCom	6 (11)
ACA	2 (4)
Other	2 (4)
Retreatment type	
Surgery	6 (10.5)
Flow diverter stent	25 (43.9)
Stent-assisted coiling	10 (17.5)
Coiling	6 (10.5)
Y-stents assisted coiling	5 (8.8)
WEB	5 (8.8)
Angiographic outcomes	
DSA for last follow-up	28 (49)
Last imaging (month)	12 (5.7–18.6)
BOSS 0 or 0'	28 (56)
BOSS 1	2 (4)
BOSS 2	14 (28)
BOSS 3 or 3+1	6 (12)

Data are presented as a percentage (%) for qualitative variables and as mean±SD or median (IQR) for quantitative variables (according to their distribution).
ACA, anterior cerebral artery; ACom, anterior communicating artery; BA, basilar artery; BOSS, Bicêtre Occlusion Scale Score; DSA, digital subtraction angiography; MCA, middle cerebral artery; PCom, posterior communicating artery; WEB, Woven EndoBridge device.

Retreatments

Aneurysm retreatments were mainly due to aneurysm remnants and recurrences with BOSS 3 and BOSS 1+3 in 84% (48/57). The remaining aneurysms requiring retreatment presented with a BOSS score of 2 in 16% (9/57).

The global retreatment rate was 7.5% (57/756) (95% CI 5.6% to 9.4%). The retreatment rate was significantly higher in the ruptured population at 13% (95% CI 8.0% to 18%) versus 3.9% (95% CI 2.2% to 5.6%) in the unruptured population (P<0.0001).

In two patients EVT was attempted and deemed impossible; the patients were then referred for surgery. In total, surgery was performed in 11% (6/57) and EVT in 89% (51/57). EVT consisted of flow diverter stent (FDS) (48.0%), single stent-assisted coiling (19.6%), Y-configuration stent-assisted coiling (9.8%), coiling (11.8%), and second WEB placement (including a stent-assisted WEB in one case) (9.8%) (figure 1).

Two patients were retreated with coils and an FDS (for one of them the procedure was interrupted because of an adverse event during coiling and FDS was implanted in a third procedure); both were included in the FDS group.

Adverse events

During treatment

Three thromboembolic complications leading to ischemic stroke lesions occurred during aneurysm retreatments following initial WEB implantation. One patient presented an A1 occlusion during the coiling of an ACom aneurysm recurrence, with acute ischemic stroke in the recurrent artery of Heubner territory leading to memory disorder and an mRS score of 1 at follow-up. One patient treated with an FDS for an MCA recurrence presented a prolapse of the stent at the parent bifurcation level due to significant foreshortening after delivery. It

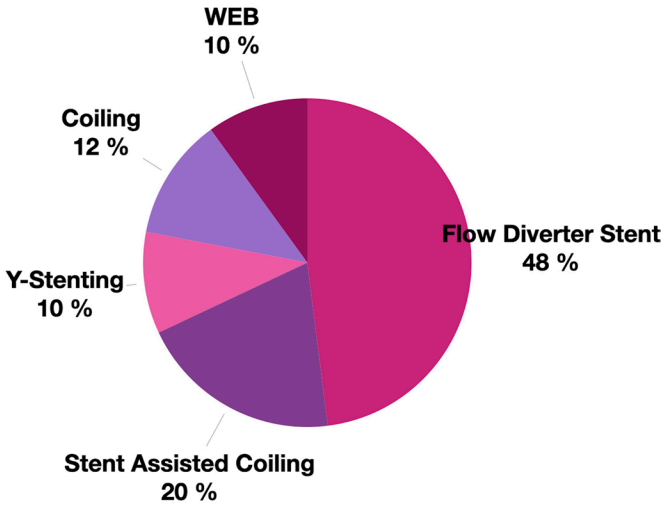

Figure 1 Endovascular strategies for retreatments following web implantation.

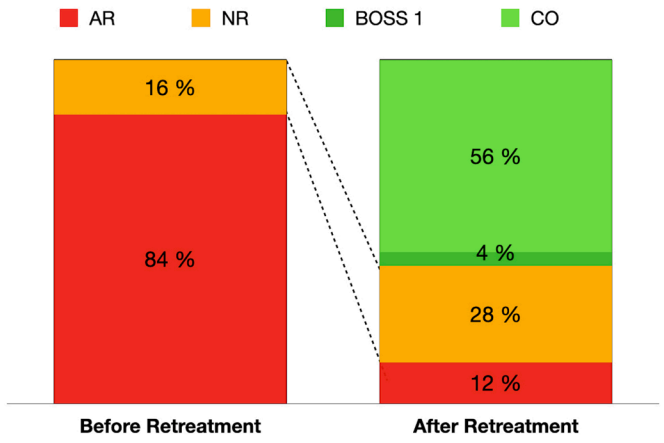

Figure 2 Angiographic outcomes after retreatment of WEB-treated aneurysm recurrence. AR, aneurysm remnant; BOSS 1, Bicêtre Occlusion Scale Score 1; CO, complete occlusion; NR, neck remnant; WEB, Woven Endobridge device.

was managed by the delivery of a non-FDS to the other branch (T configuration stenting); however, a frontal cortex ischemic lesion occurred. At follow-up the patient presented with mild hemiparesis and some speech disorder with an mRS score of 2. One patient experienced a thromboembolic complication during a coiling procedure that led to an incomplete treatment and an ischemic lesion. The patient then underwent a third procedure to deliver an FDS with no complications and the last mRS score was 1.

During four FDS procedures some thrombus formation was noted during operation that was completely resolved after the injection of a glycoprotein (GP) IIb/IIIa inhibitor, with no clinical impact.

Delayed complications

We observed two delayed complications. During retreatment for an ACom recurrence, one FDS was partially kinked on detachment with no flow impairment or symptoms. Follow-up DSA demonstrated asymptomatic FDS occlusion with contralateral flow compensation and complete resolution of the aneurysm recurrence.

One patient treated with an FDS for an MCA aneurysm experienced a small perforator infarction a few days after aspirin cessation (12 months after treatment), but had made a full recovery within 24 hours.

In the intention to use FDS procedures, the related permanent morbidity was 2/25 (8%) whereas it was 0% in the stent-assisted coiling group.

Permanent morbidity was 5.3% (3/57) (95% CI 0% to 12.0%) and mortality 0%. No patient experienced rebleeding during the follow-up period.

Angiographic outcome

Imaging follow-up was available in 88% of retreatments. Mean and median last angiographic follow-up were 16.9 and 12 months (range 2–68 months), respectively. The latest follow-up was performed by DSA in 49% of aneurysms. It demonstrated complete occlusion in 56% (28/50), an isolated WEB opacification (ie, BOSS 1) in 4% (2/50), a neck remnant in 28% (14/50), and an aneurysm remnant in 12% (6/50) (figure 2).

In the FDS (without coils) subgroup, DSA follow-up was available in 18 cases and demonstrated complete occlusion in nine (50%). In the stent+coils subgroup DSA follow-up was available in 12 cases and demonstrated complete occlusion in nine (75%). In the surgical subgroup, imaging follow-up was available in 5/6 cases among whom complete occlusion was achieved in 60% and remaining neck remnant in 40%.

DISCUSSION

WEB retreatments

Based on one of the largest practice databases (n=756), we have demonstrated that the retreatment rate after an initial WEB procedure was 7.5% (95% CI 5.6% to 9.4%). According to literature data, this appears slightly higher than retreatment rates associated with stent-assisted coiling and FDS (5%),[15] but lower than those associated with coiling (around 10%).[16 17]

In a smaller population but with 5 years of follow-up, Pierot *et al*[10] described an 11.7% retreatment rate with no observed difference dependent on aneurysm location, and with most procedures performed during the first 2 years post-treatment. In accordance with this, Cortese *et al*[5] demonstrated that recurrences mostly occur within the 17 months post-implantation, with a stable angiographic result after mid-term control.

Retreatment indications

The bleeding risk from recurrence following WEB implantation is challenging to assess, especially in aneurysms where the dome is well protected by the device, but blood is flowing into the neck region of the aneurysm. Also, the distinction between BOSS 2 and 3, differentiating a supposedly adequate from non-adequate occlusion, can be considered as open to interpretation.

In our series, the retreatment rates at each of the four treatment centers were 6.0%, 6.6%, 8.2%, and 9.5%, reflecting the variability in the risk assessment.

The retreatment rate was significantly higher in the ruptured versus the unruptured group (13% vs 3.9%, respectively, P<0.0001). However, since multiple analysis[5 18–20] found no statistical association between recurrence and ruptured aneurysm, we can hypothesize that operators were more prompt to treat initially ruptured recurrences, assuming a higher re-rupture risk. Similar observations have been made concerning aneurysms initially treated with coils in some series.[15]

Retreatment modality

A vast number of strategies are available including surgical and endovascular for the retreatment of aneurysm recurrence following WEB implantation. In our series the retreatments were mostly performed endovascularly; however, smaller case series have also reported clipping as a feasible option.[6 11] Retreatment involved microsurgery in six patients in our series, that achieved complete occlusion in 60% of the five patients with follow-up data.

Considering that the WEB device is dedicated to the treatment of wide neck bifurcation aneurysms, EVT of aneurysm recurrence following WEB implantation can appear challenging, especially when most cases present with shallow bifurcation lesions. This explains the requirement to use an intracranial stent in 78% of aneurysms treated in our series.

The morbidity rate (5.3%, 95% CI 0% to 12.0%) associated with the retreatment of a WEB-treated aneurysm appears slightly higher than that at initial treatment (0.7–4%),[21–23] but not when compared with the retreatment of an initially coiled aneurysm (2.7–7%).[24–26]

Retreatment efficacy

After retreatment, the rate of aneurysm remnants (BOSS 3) dropped from 85% to 12%, with 56% of complete occlusion (BOSS 0) at mid-term follow-up (average 17 months). Considering that half of the aneurysms were treated with an FDS (including 12 aneurysms with angiographic follow-up <12 months), complete occlusion rates might reasonably be expected to improve with a longer follow-up period; indeed, progressive and delayed occlusions are common when using this strategy in bifurcation locations.[27–29]

Limitations

We acknowledge several limitations. First, the retrospective nature of the analysis may have led to biases. Also, some angiographic follow-ups were missing but mostly because they were pending in recent treatments. Although we have explored a very large cohort of patients treated initially with WEB, the number of retreatments was limited and precludes any comparison between the different retreatment strategies. Finally, we also included the early experience of centers initially with first generation devices, before the oversizing dogma was established, and this might have influenced the results.

CONCLUSION

The retreatment rate after an initial WEB treatment seems to compare favorably with that of coiling, especially given the challenging nature of these aneurysms for the endovascular approach. EVT of aneurysm recurrence following WEB implantation generally requires the use of a stent, though is feasible in most situations, leading to a high rate of satisfactory occlusion.

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