Lateral Compression is the Strongest Independent Predictor of Aneurysm Occlusion After Endovascular Treatment of Intracranial Aneurysms With the Woven EndoBridge Device

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BACKGROUND AND OBJECTIVES: The effect of lateral compression (LC) of the Woven EndoBridge (WEB) device on intracranial aneurysm (IA) occlusion and retreatment has not been studied in depth. This study aims to determine the effect of LC on aneurysm occlusion and retreatment after endovascular treatment with WEB.

METHODS: We retrospectively reviewed IAs treated with WEB at our institution between February 5th, 2019, and March 31st, 2022. LC was determined in the immediate postdetachment angiogram by measuring the mean implanted WEB width at the equator in two orthogonal projections and subtracting it from the nominal WEB width. LC was then converted to the percentage of nominal WEB width (percent LC [%LC]). Independent predictors of complete and adequate aneurysm occlusion at follow-up and retreatment were determined using multivariate logistic regression analysis. Optimal %LC thresholds were determined using receiver operating characteristic analysis.

RESULTS: One hundred and fifty-five IAs were included, with a mean size of 6.4 mm, a mean neck of 3.6 mm, and a mean time to last follow-up of 15.5 months. At last follow-up, complete and adequate aneurysm occlusion was present in 98 (63.2%) and 139 (89.7%) IAs, respectively. Twelve IAs were retreated (7.7%). %LC was the strongest independent predictor of complete and adequate aneurysm occlusion at first and last follow-up and an independent predictor of aneurysm retreatment. Optimal %LC thresholds for complete and adequate aneurysm occlusion at first follow-up were >17.1% and >15.7%, respectively. Compared with IAs in which these thresholds were not attained, IAs in which these thresholds were attained had significantly higher rates of complete (31% vs 68%, *P*-value <.0001) and adequate occlusion (81% vs 96%, *P*-value .004) at first follow-up. The optimal %LC threshold for aneurysm retreatment was ≤15.6%. IAs with ≤15.6% LC had a significantly higher rate of retreatment (15%) than IAs with >15.6% LC (4%, *P*-value .025).

CONCLUSION: LC is the strongest independent predictor of aneurysm occlusion in IAs treated with WEB.

KEY WORDS: Aneurysm, Device, Outcome

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The Woven EndoBridge (WEB) device (MicroVention/Terumo) is a retrievable, nitinol-braided intrasaccular flow diverter (FD) for endovascular treatment of IAs that alters flow at the ostium of the aneurysm and serves as a scaffold for neointimal growth and healing. While several series have demonstrated adequate occlusion rates of over 80% with WEB, complete aneurysm occlusion rates are relatively low (50%-55%) and retreatment rates are relatively high (10%-15%).[1-11] Oversizing the WEB width at the time of treatment to laterally compress the WEB, thus leading to modification of the shape of the implanted WEB device, has been proposed as an important factor to increase its efficacy.[12-16] However, the effect of LC on aneurysm occlusion and retreatment rates has not been studied in depth.

ABBREVIATIONS: FD, flow diverter; **LC,** lateral compression; **MRA,** magnetic resonance angiogram; **WEB,** Woven EndoBridge; **WOS,** WEB occlusion scale.

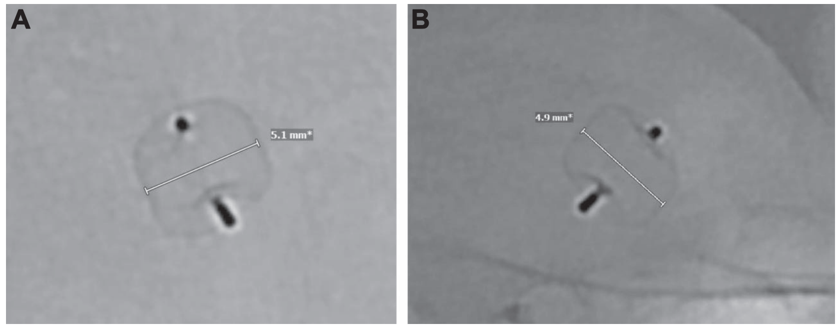

FIGURE 1. A *and* B, *LC calculation. Nominal WEB width: 6 mm. Mean implanted WEB width at the equator: (5.1 mm + 4.9 mm)/2 = 5 mm; LC: 6 mm − 5 mm = 1 mm; %LC: (1 mm/6 mm) × 100 = 16.7%. LC, lateral compression; WEB, Woven EndoBridge.*

The purpose of this study is to examine the effect of LC on aneurysm occlusion and retreatment in a large cohort of IAs treated with the WEB device.

METHODS

Study Design

After approval from our hospital's institutional review board, conducted in compliance with the health insurance portability and accountability act and following the strengthening the reporting of observational studies in epidemiology guidelines, a retrospective analysis of a prospectively collected institutional intracranial aneurysm (IA) database was performed for all patients who underwent endovascular treatment of IAs with the WEB device between February 4th, 2019, and March 31st, 2022. Informed consent was waived because this was a retrospective observational study. We collected baseline patient demographic data, aneurysm characteristics, procedural variables, LC at the time of treatment, aneurysm occlusion at first and last follow-up, and retreatment. We excluded cases in which (1) the WEB device was used to treat a recurrent or partially thrombosed IA, (2) adjunctive use of coils or an intravascular FD was employed, (3) a residual aneurysm sac was present in the immediate postdetachment angiogram (given the low likelihood of adequate occlusion at follow-up), (4) an angiographic follow-up of at least 3 months after treatment was not completed, or (5) the patient opted not to be included in any research study in routine admission paperwork. This IA cohort includes the use of the WEB device in off-label anatomic locations such as the posterior communicating, pericallosal, posterior inferior cerebellar, and superior cerebellar arteries.

Angiographic Imaging Review

Three neurointerventionalists reviewed the postdetachment angiographic images to determine the degree of LC at the time of treatment and the follow-up angiographic images to determine the degree of aneurysm

TABLE 1. Aneurysm and LC Characteristics by Nominal WEB Width

Nominal WEB width (mm)	N	Mean maximum aneurysm dimension (mm)	Mean aneurysm width (mm)	Mean LC (mm)	Median LC (mm)	Mean % LC	Median % LC
4	28	4.1	3.2	0.9	0.8	22.4	18.8
4.5	6	4.7	3.4	1	1.2	22.2	16.7
5	35	5.2	4.1	1	0.8	19.7	16
6	26	6.6	4.8	1.3	1.2	22.3	20
7	30	7.2	5.7	1.5	1.5	21.5	21.4
8	13	8.1	6.9	1.3	1.3	16.1	16.3
9	7	9.4	7.6	1.5	1.5	16.8	16.7
10	7	11.3	8.7	2.3	2.2	22.7	22
11	3	10.4	10.1	2	1.7	18.5	15.5

LC, lateral compression; %LC, percent LC; N, number; WEB, Woven EndoBridge.

TABLE 2. Independent Predictors of Aneurysm Occlusion and Retreatment After Endovascular Treatment With WEB

	Odds ratio	95% CI	*P* value[a]
Complete occlusion at first follow-up			
%LC	1.15	1.07–1.24	**.0001**
Sex	0.28	0.1–0.79	**.016**
Maximum aneurysm size	0.59	0.37–0.94	**.027**
Adequate occlusion at first follow-up			
%LC	1.15	1.04–1.27	**.0075**
Maximum aneurysm size	0.56	0.34–0.93	**.026**
Complete occlusion at last follow-up			
%LC	1.12	1.04–1.19	**.0012**
Sex	0.25	0.09–0.69	**.0072**
Ruptured presentation	0.25	0.08–0.75	**.0134**
Adequate occlusion at last follow-up			
%LC	1.17	1.05–1.3	**.0045**
Maximum aneurysm size	0.55	0.33–0.93	**.025**
Retreatment			
Ruptured presentation	9.42	1.66–53.5	**.0113**
%LC	0.88	0.79–0.99	**.0282**

%LC, percent lateral compression; WEB, Woven EndoBridge.
[a]Bold denotes statistical significance.

occlusion, with differences resolved by consensus. LC was determined by (1) measuring the mean implanted WEB width at the equator in two orthogonal projections, and (2) subtracting it from the nominal WEB width: LC = nominal WEB width – mean implanted WEB width at the equator (Figure 1). The LC was then converted to a percentage of the nominal WEB width: %LC = (LC/nominal WEB width) × 100 (Figure 1). The degree of aneurysm occlusion in the immediate postdetachment angiogram and at first and last angiographic follow-ups was determined according to the WEB occlusion scale (WOS).[17,18] Adequate occlusion was defined as complete occlusion or neck remnant.[7]

Dual Antiplatelet Therapy Regimen

Patients with unruptured IAs were premedicated with aspirin and a P2Y12 receptor antagonist, typically clopidogrel, 8 days before embolization, and platelet function testing was performed 1 day before the procedure using VerifyNow (Werfen), with a target P2Y12 reaction unit range of 30–180. After the procedure, daily aspirin was continued in all patients, whereas maintenance of P2Y12 receptor antagonist administration was at the discretion of the treating neurointerventionalist based on the degree of parent artery protrusion, with clopidogrel being discontinued by postoperative day 30 in most cases. If an intracranial stent was used as adjunctive therapy, clopidogrel was administered for at least 3 months. Patients with ruptured IAs were premedicated with a 325-mg aspirin dose 2 hours before embolization and maintained on 81-mg aspirin daily thereafter.

WEB Embolization Procedure

The WEB embolization procedure was performed under general anesthesia using transfemoral arterial access in a neuroangiography unit (Axiom Artis, Siemens). Intravenous heparin was administered to achieve an activated clotting time of 2-2.5 × baseline. A triaxial system comprising a 6Fr sheath (Benchmark or Neuron MAX, Penumbra), a 5Fr distal access catheter (SOFIA or SOFIA EX, MicroVention/Terumo), and a VIA microcatheter (MicroVention/Terumo) was used. The mean aneurysm width and minimum height in two orthogonal working projections were obtained, and a WEB device was selected, aiming to oversize the WEB width and undersize the WEB height. Then, using a digital roadmap, a 0.014-inch Synchro 14 microwire (Stryker) was used to advance the appropriate VIA microcatheter (17/21, 27 or 33) inside the aneurysm sac. The WEB device was then deployed in the aneurysm through the VIA, typically unsheathing the WEB until it formed "a flower" and then pushing the microwire to finish WEB deployment. A postdeployment angiogram was performed to determine the degree of WEB protrusion onto the parent artery, with occasional resheathing and redeployment as needed. The WEB device was subsequently detached. Final biplanar angiography was performed to document patency of the intracranial vasculature. Hemostasis was achieved with an Angio-Seal device (St. Jude Medical) or manual compression. Heparinization was not continued postprocedure.

Statistical Analysis

Statistical analysis was performed using the MedCalc 11.1 software package (MedCalc Software). Basic summary statistics for demographic variables, aneurysm characteristics, and clinical and angiographic outcomes were calculated. Multivariate logistic regression analyses were performed to identify independent predictors of complete and adequate aneurysm occlusion at first and last follow-ups and retreatment. Variables included in the multivariate logistic regression models were age, sex, hypertension, diabetes, smoking status (current/former/never), maximum aneurysm size, neck, dome-to-neck ratio, location (anterior communicating artery/middle cerebral artery/others), ruptured presentation, nominal WEB width, and %LC. For continuous variables identified to be independent predictors of aneurysm occlusion and retreatment in the logistic regression models, optimal thresholds were determined using receiver operating characteristic analyses. Then, univariate analyses with Fisher's exact test using these thresholds were performed for complete and adequate aneurysm occlusion at first and last follow-ups and retreatment. *P*-values of ≤.05 were considered statistically significant.

RESULTS

Patient Demographics, Aneurysm Characteristics, and Procedural Variables

Between February 4th, 2019, and March 31st, 2022, a total of 224 IAs were treated with the WEB device at our institution. The following IAs were excluded from this study: 16 recurrent IAs (7.1%), 3 partially thrombosed IAs (1.3%), 9 IAs treated with adjunctive use of coils (4%), 1 IA treated with adjunctive use of an intravascular FD (0.4%), 11 IAs with residual aneurysm sac in the immediate postdetachment angiogram (4.9%), 16 IAs without angiographic follow-up (7.6%, 12 in patients who expired from

TABLE 3. Optimal Thresholds for %LC and Maximum Aneurysm Size by ROC Analysis

	Optimal threshold	Sensitivity/specificity, %	AUC	95% CI	*P* value[a]
Complete occlusion at first follow-up					
%LC	>17.1%	73/64	0.7	0.63–0.78	**<.0001**
Maximum aneurysm size	≤6.4 mm	74/64	0.74	0.66–0.81	**<.0001**
Adequate occlusion at first follow-up					
%LC	>15.7%	66/73	0.72	0.64–0.79	**.0012**
Maximum aneurysm size	≤7.9 mm	84/53	0.7	0.62–0.77	**.013**
Complete occlusion at last follow-up					
%LC	>21.7%	48/81	0.67	0.59–0.75	**.0001**
Adequate occlusion at last follow-up					
%LC	>15.7%	67/75	0.74	0.66–0.81	**.0003**
Maximum aneurysm size	≤7.7 mm	81/56	0.71	0.63–0.78	**.0058**
Retreatment					
%LC	≤15.6%	67/68	0.69	0.61–0.76	**.015**

AUC, area under the curve; %LC, percent lateral compression; ROC, receiver operating characteristic.
[a]Bold denotes statistical significance.

complications of subarachnoid hemorrhage and 4 in patients lost to follow-up), and 13 IAs in patients who opted not to participate in any research study in routine admission paperwork (5.8%).

Hence, a total of 155 IAs in 145 patients met this study's inclusion criteria. The mean patient age was 61.5 years (median 62 years, range 12-83 years), 98 patients were female (68%), 96 had hypertension (66%), 27 diabetes (19%), 57 were current smokers (39%), 41 former smokers (28%), and 30 had a family history of IAs (21%). The mean maximum aneurysm size was 6.4 mm (median 6.1 mm, range 3.4-14 mm), the mean neck was 3.6 mm (median 3.3 mm, range 1.5-7.8 mm), and the mean dome-to-neck ratio was 1.5 (median 1.4, range 0.9-3.1). Forty-one IAs were acutely ruptured (26.5%). IA locations were 56 anterior communicating artery (36.1%), 44 middle cerebral artery (28.4%), 17 posterior communicating artery (11%), 14 internal carotid artery (9%), 13 basilar tip (8.4%), 4 superior cerebellar artery (2.6%), 3 pericallosal artery (1.9%), and 4 others (2.6%). Among the 126 4-7 mm WEB devices deployed, 79 were WEB 21s (62.7%) and 47 were WEB 17s (37.3%). One hundred and thirty-six WEBs were single layer (87.7%), and 19 were single layer spherical (12.3%). Adjunctive stents were used in 5 IAs (3.2%). The mean procedure time was 43.3 minutes (median 35 minutes, range 16-273 minutes). There were two intra-procedural aneurysm perforations (1.3%), one caused by the VIA and one by the WEB, none leading to a permanent deficit. There were 11 intraoperative or perioperative thromboembolic events (7.1%), one leading to a permanent disabling neurological deficit (0.6%). In the immediate postdetachment angiogram, 97 IAs were completely occluded (WOS A/B, 62.6%) and 58 had a neck remnant (WOS C, 37.4%). The mean LC was 1.3 mm (median 1.1 mm, range 0.1-3.5 mm), and the mean %LC was 20.7% (median 18.3%, range 1.7%-58%). Table 1 summarizes the IA and LC characteristics by nominal WEB width.

Angiographic Outcomes

The mean time from treatment to first angiographic follow-up was 7.1 months (median 6.3 months, range 3.5-28 months). First angiographic follow-up was catheter angiogram in 135 IAs (87.1%) and magnetic resonance angiogram (MRA) in 20 IAs (12.9%). At first follow-up, 80 IAs had complete occlusion (WOS A/B, 51.6%), 60 neck remnant (WOS C, 38.7%), and 15 residual aneurysm (WOS D, 9.7%). Compared with the immediate postdetachment angiogram, at first follow-up, the degree of aneurysm occlusion was better in 13 IAs (8.4%, all neck remnants to complete occlusions), stable in 103 IAs (66.5%, 67 complete occlusions and 36 neck remnants), and worse in 39 IAs (25.2%, 24 complete occlusions to neck remnants, 6 complete occlusions to residual aneurysms, and 9 neck remnants to residual aneurysms).

The mean time from treatment to last angiographic follow-up was 15.6 months (median 12.4 months, range 4-42.2 months). The last angiographic follow-up was MRA in 122 IAs (78.7%), catheter angiogram in 29 IAs (18.7%), and computed tomography angiogram in 4 IAs (2.6%). At last follow-up, 98 IAs had complete occlusion (63.2%), 41 had neck remnant (26.5%), and 16 had residual aneurysm (10.3%).

TABLE 4. Univariate Analysis of Independent Predictors of Aneurysm Occlusion and Retreatment After Endovascular Treatment With WEB

			Aneurysm occlusion at first follow-up			
	%LC ≤17.1%	**%LC >17.1%**	***P* value[a]**	**Maximum aneurysm size ≤6.4 mm**	**Maximum aneurysm size >6.4 mm**	***P* value[a]**
Complete occlusion, %	31	68	**<.0001**	69	30	**<.0001**
	%LC ≤15.7%	**%LC >15.7%**		**Maximum aneurysm size ≤7.9 mm**	**Maximum aneurysm size >7.9 mm**	
Adequate occlusion, %	81	96	**.004**	94	73	**.002**
			Aneurysm occlusion at last follow-up			
	%LC ≤21.7%	**%LC >21.7%**	***P* value[a]**	**Ruptured aneurysm**	**Unruptured aneurysm**	***P* value[a]**
Complete occlusion, %	53	81	**.0005**	51	68	.09
	%LC ≤15.7%	**%LC >15.7%**		**Maximum aneurysm size ≤7.7 mm**	**Maximum aneurysm size >7.7 mm**	
Adequate occlusion, %	79	96	**.0015**	94	74	**.0021**
			Aneurysm retreatment			
	%LC ≤15.6%	**%LC >15.6%**	***P* value[a]**	**Ruptured aneurysm**	**Unruptured aneurysm**	***P* value[a]**
Retreatment, %	15	4	**.025**	20	4	**.0028**

%LC, percent lateral compression; WEB, Woven EndoBridge.
[a]Bold denotes a statistically significant difference.

One hundred and thirteen IAs had more than one angiographic follow-up examination (72.9%) and the mean time interval from first to last follow-up was 12.2 months (median 8.1 months, range 4.2-36.1 months). Compared with the first follow-up, at last follow-up, 18 IAs had better occlusion (15.9%, all neck remnants to complete occlusion), 93 had stable occlusion (82.3%, 59 complete occlusions, 29 neck remnants and 5 residual aneurysms), and 2 had worse occlusion (1.8%, both neck remnant to residual aneurysm). All IAs with complete occlusion at first follow-up remained completely occluded at last follow-up.

Twelve IAs were retreated (7.7%): 6 with WEB (50%), 4 with coils (33%), and 2 with an intravascular FD (17%). There were no postoperative IA ruptures in our cohort.

Independent Predictors of Aneurysm Occlusion and Retreatment

Table 2 presents the independent predictors of aneurysm occlusion and retreatment in our cohort. %LC was the strongest independent predictor of complete and adequate aneurysm occlusion at first and last follow-up and an independent predictor of aneurysm retreatment. Patient sex, maximum aneurysm size, and ruptured presentation were additional independent predictors of aneurysm occlusion, whereas ruptured presentation was the strongest predictor of aneurysm retreatment in our cohort.

Table 3 presents the optimal thresholds for %LC and maximum aneurysm size for the prediction of aneurysm occlusion and retreatment using receiver operating characteristic analysis in our cohort. The optimal %LC and maximum aneurysm size thresholds for the prediction of complete aneurysm occlusion at first follow-up were >17.1% and ≤6.4 mm, respectively. The optimal %LC and maximum aneurysm size thresholds for the prediction of adequate aneurysm occlusion at first follow-up were >15.7% and ≤7.9 mm, respectively. The optimal %LC threshold for the prediction of aneurysm retreatment was ≤15.6%.

Table 4 presents the univariate analyses of the independent predictors of aneurysm occlusion and retreatment in our cohort. IAs with >17.1% LC had a significantly higher rate of complete aneurysm occlusion at first follow-up (68%) than those with ≤17.1% LC (31%, *P*-value <.0001, Figures 2 and 3). IAs with a maximum aneurysm size of ≤6.4 mm had a significantly higher rate of complete aneurysm occlusion at first follow-up (69%) than those with a maximum aneurysm size of >6.4 mm (30%, *P*-value <.0001). Ruptured aneurysms had a significantly higher rate of retreatment (20%) than unruptured aneurysms (4%, *P*-value .0028). IAs with ≤15.6% LC had a significantly higher rate of retreatment (15%) than those with >15.6% LC (4%, *P*-value .025). Of note, although sex was an independent predictor of complete aneurysm occlusion at first follow-up (54% in males vs 50% in females) and at last follow-up (70% in males vs 60% in females), these differences were not statistically significant in univariate analysis (*P*-values .73 and .29, respectively).

DISCUSSION

Our cohort's rates of complete (52%) and adequate (90%) aneurysm occlusion at first follow-up and retreatment (8%) are similar

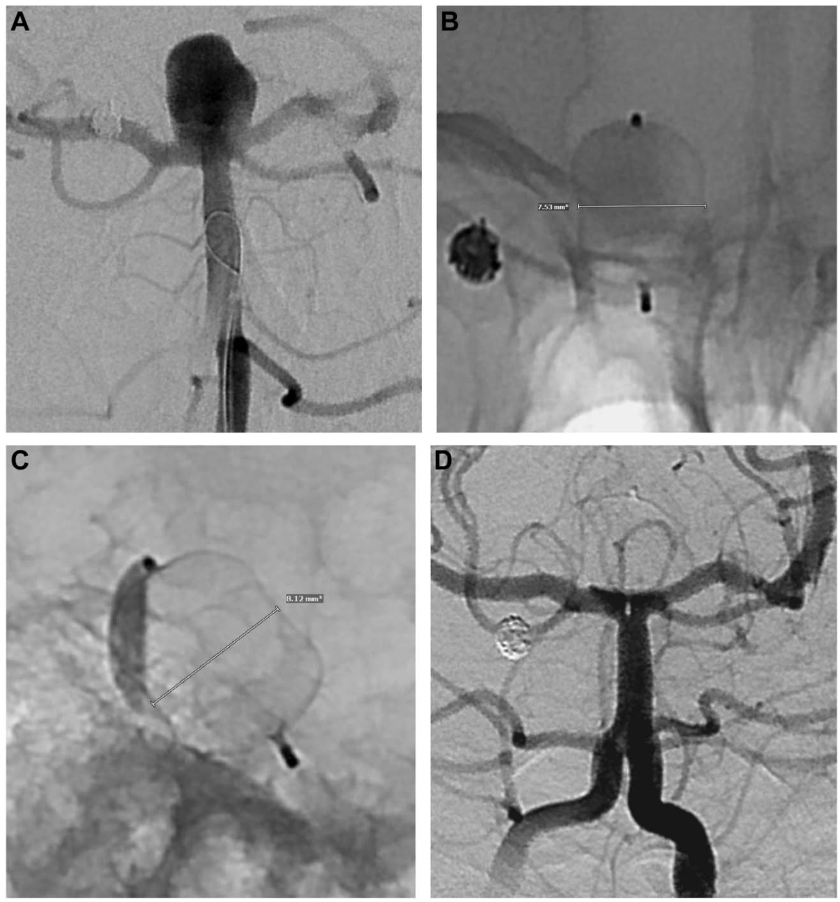

FIGURE 2. A, *Unruptured 10 mm basilar tip aneurysm.* B *and* C, *Nominal WEB width: 11 mm. Mean implanted WEB width at the equator: (7.5 mm + 8.1 mm)/2 = 7.8 mm; LC: 11 mm − 7.8 mm = 3.2 mm; %LC: (3.2 mm/11 mm) × 100 = 29.1%.* D, *Follow-up catheter angiogram demonstrates complete aneurysm occlusion. LC, lateral compression; WEB, Woven EndoBridge.*

to previously published multicenter WEB studies.[1-8] Similarly, our cohort's rates of intraoperative aneurysm perforation (1.3%) and a permanent disabling neurological deficit (0.6%) are also similar to previously published multicenter WEB studies,[1-8] thus corroborating the high safety profile of the WEB device in the "real-world" setting. Of note, we observed either stable or improved occlusion in subsequent follow-ups in most of the IAs with more than one angiographic follow-up in our cohort, which corroborates the long-term results of other multicenter WEB studies.[19-21] While some of the neck remnants at first follow-up that improved to complete occlusion at last follow-up in our cohort might have been due to the fact that first follow-ups were usually catheter angiograms and subsequent follow-ups were usually MRAs, aneurysm occlusion rates were at least stable and our study's angiographic follow-up algorithm reflects common clinical practice.

To our knowledge, this study constitutes the first in-depth analysis of the effect of LC on aneurysm occlusion and retreatment rates in IAs treated with the WEB device. In our cohort, %LC was the strongest independent predictor of complete and adequate aneurysm occlusion at first and last follow-ups, controlling for other important variables such as maximum aneurysm size, neck, ruptured presentation, and nominal WEB width. While, in general, the greater the %LC, the higher the likelihood of aneurysm occlusion and the lower the likelihood of retreatment, we found that when certain %LC thresholds were attained, complete and adequate aneurysm occlusion rates were significantly higher and retreatment rates were significantly lower. Of note, the %LC threshold for complete occlusion at first follow-up (>17.1%) was higher than the threshold for adequate occlusion (>15.7%), signaling that achieving greater LC increases the likelihood of complete aneurysm occlusion. The %LC thresholds identified in our cohort may provide clinically useful guidance to aid the operator in determining whether the implanted WEB device

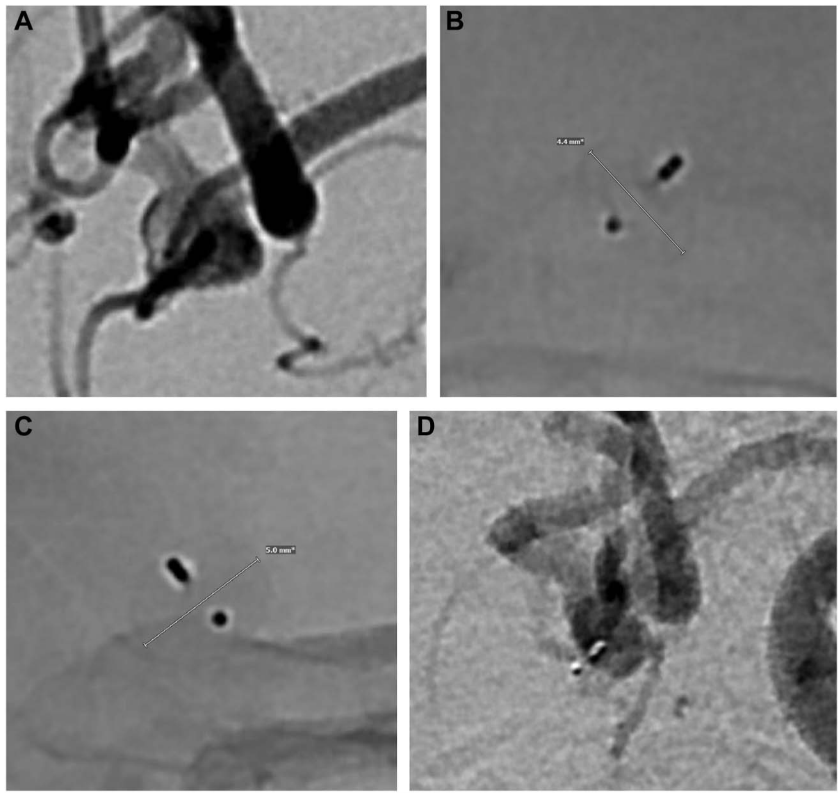

FIGURE 3. **A**, *Ruptured 4.6 mm anterior communicating artery aneurysm.* **B** *and* **C**, *Nominal WEB width: 5 mm. Mean implanted WEB width at the equator: (4.4 mm + 5 mm)/2 = 4.7 mm; LC: 5 mm − 4.7 mm = 0.3 mm; %LC: (0.3 mm/5 mm) × 100 = 6%.* **D**, *Follow-up catheter angiogram demonstrates aneurysm recurrence because of WEB compaction. The aneurysm was retreated with an additional WEB device. LC, lateral compression; WEB, Woven EndoBridge.*

has been sized appropriately, or if it should be changed for a wider and shorter device, when feasible. Nevertheless, future studies are needed to test the performance of these %LC thresholds in other data sets and compare them with other thresholds.

The effect of LC on aneurysm occlusion is explained by the increased contact of the WEB device mesh against the aneurysm wall when greater LC is attained, thus minimizing the likelihood of development of an endoleak around the WEB device and WEB compaction as the aneurysm thromboses and scars down. Measuring LC before detachment is now a routine part of our clinical practice, and we find that greater LC usually results in WEB shape modification with a boxier-shaped device when deployed (Figure 2), whereas a more flattened WEB shape with closer proximal and distal markers often indicates an unconstrained device with less LC (Figure 3). Appreciating this angiographic appearance can be useful in real-time clinical assessment.

Furthermore, we always select a wider and shorter WEB device whenever possible to maximize LC. If the sum of the width and height of two different WEBs yields the same number—meaning a similar amount of braid—and they can be delivered using the same size VIA microcatheter, we will always choose the WEB that has the wider width. Hence, rather than using a 4 mm × 3 mm WEB, we use a 5 mm × 2 mm WEB; rather than using a 5 mm × 3 mm WEB, we use a 6 mm × 2 mm WEB; and rather than using a 6 mm × 3 mm WEB, we use a 7 mm × 2 mm WEB. Any excess braid because of oversizing the width will be taken into the aneurysm dome in the space allowed by using the shorter device. Nevertheless, we are often limited in our WEB device selection by the lack of short devices for wider WEB widths because no 8 mm × 2 mm, 9 mm × 3 mm, 10 mm × 4 mm, or 11 mm × 5 mm WEB devices presently exist. Future development of shallow "pancake-like" intrasaccular FDs maximizing LC may attain higher complete aneurysm occlusion rates and cement intrasaccular flow diversion as a valuable endovascular IA treatment technique.

Maximum aneurysm size was an independent predictor of aneurysm occlusion in our cohort, with a significantly lower rate of complete aneurysm occlusion in IAs larger than 6.4 mm (30%). While the WEB device can achieve high rates of complete occlusion in small and medium IAs, when used to treat large IAs, operator and patient expectations should be set properly because there is a considerable likelihood of a neck remnant or residual aneurysm at follow-up. While most neck remnants in our cohort remained stable, long-term monitoring is needed to ensure that they do not enlarge or progress to aneurysm remnants requiring retreatment.[19] Prospective studies with long-term follow-up of neck remnants after WEB embolization are needed. Furthermore, future development of intrasaccular FDs with increased support or a larger structure centrally may provide higher complete aneurysm occlusion rates in large IAs.

Limitations

This study's limitations are its retrospective design, the relatively few large WEBs in our cohort, and the lack of uniform follow-up with catheter angiograms in all patients. Nevertheless, most of the patients had a catheter angiogram at first follow-up (87%), and this study's angiographic follow-up algorithm reflects common clinical practice. Furthermore, the exclusion of IAs treated with adjunctive coiling and flow diverters, as well as excluding those IAs with a residual aneurysm sac in the immediate postdetachment angiogram, might have introduced a selection bias in our patient cohort.

CONCLUSION

LC was the strongest independent predictor of aneurysm occlusion in our cohort of IAs treated with the WEB device. Determining the degree of LC before detachment may be an important step of the WEB embolization procedure, aiding the operator in determining whether the WEB device has been sized appropriately.

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Disclosures

Josser E. Delgado Almandoz serves as a consultant for MicroVention/Terumo, is a proctor for the WEB device, and an investor in Galaxy Therapeutics. Yasha Kayan and Alexander Z. Copelan serve as consultants for MicroVention/Terumo and are proctors for the WEB device. The other authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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COMMENTS

This article focuses on an important sizing nuance when treating intracranial aneurysms (IAs) with the Woven EndoBridge (WEB) device. The study retrospectively examined cases of IAs treated with the

WEB device and analyzed how lateral compression (LC) affected aneurysm occlusion and retreatment rates. The results, based on 155 ruptured and unruptured IAs, revealed that LC was the most significant independent predictor of complete and adequate aneurysm occlusion at initial and final follow-ups. The study identified optimal %LC thresholds for achieving complete and adequate occlusion, providing valuable guidance for device sizing. Furthermore, IAs meeting these thresholds had significantly higher occlusion rates and a reduced likelihood of retreatment.

The authors emphasize the importance of oversizing the width of the WEB device, even up to 2 mm, to achieve the desired LC. This recommendation aligns with the suggestions of other experienced centers.[1a-4a] They also discuss the limited availability of shorter and wider WEB devices, which presents an opportunity for the development of newer device sizes and other intrasaccular flow diverters with a "pancake-like" shape to further enhance LC and improve occlusion rates.

The authors acknowledge the limitations of their study, such as its retrospective design and potential selection bias. Prospective studies or registries with long-term follow-up are needed to validate these findings and explore the underlying mechanisms of the impact of LC on aneurysm occlusion.

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