Original research

WEB device for treatment of posterior communicating artery aneurysms

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ABSTRACT

Background Woven EndoBridge (WEB) device treatment of wide-neck bifurcation aneurysms has proved to be safe and effective, but the use of these devices in sidewall aneurysms has been reported only in a small number of case series.

Objective To report our results in a cohort of consecutive patients in whom a WEB device was used as first-line treatment for posterior communicating artery (PComA) aneurysms.

Methods We conducted a retrospective analysis of a prospectively maintained database of PComA aneurysms treated with a WEB device in our institution from June 1, 2012 to November 15, 2020. Clinical and radiological findings were evaluated at immediate and last follow-up.

Results A total of 219 aneurysms were treated with a WEB device, including 15 PComA aneurysms in 15 patients, 10 of which were ruptured. Aneurysms were wide necked, with a mean aspect ratio of 1.6 (range 0.7–3.0) and a mean neck size of 4.2 mm (range 2.6–7.4 mm). No intraoperative rupture occurred and only one thromboembolic event was noted. Among the group with at least a 3-month digital subtraction angiography (DSA) follow-up, complete and adequate occlusion were obtained in 54% and 72%, respectively (average follow-up 13 months). Re-treatment was needed for two initially ruptured aneurysms. No procedure-related morbidity or mortality was reported.

Conclusion This series suggests the high safety profile of WEB devices even when used in off-label indications. Treatment with these devices seems to be a valuable strategy for ruptured wide-neck PComA aneurysms, avoiding the need for antiplatelet medication. However, occlusion rates should be investigated in further larger studies.

INTRODUCTION

Intrasaccular flow disruption was introduced as an alternative approach to treating wide-neck bifurcation aneurysms, lesions that are challenging to treat endovascularly.[1] Among the existing flow disrupters, the Woven EndoBridge (WEB) device (MicroVention/Sequent Medical, Aliso Viejo, California, USA) has already been demonstrated to be safe and effective in treating lesions located in the middle cerebral artery, bifurcation of the internal carotid, basilar artery, and in the anterior communicating artery complex.[2–5]

The WEB device has been approved by the FDA (US Food and Drug Administration) for treatment of intracranial wide-neck bifurcation aneurysms, but some reports of off-label uses of the WEB device suggest that its initial indication could be extended while maintaining the safety and efficacy of the device.[6–8]

This paper reports clinical and anatomical results in a cohort of consecutive patients in whom the WEB device was used as a first-line strategy to treat posterior communicating artery (PComA) aneurysms.

METHODS

We retrospectively reviewed our prospectively maintained database for patients with aneurysms treated with a WEB device in our institution between June 1, 2012 and November 15, 2020. Among these, only lesions located in the communicating segment of the internal carotid artery, next to the origin of the PComA, were included. Every unruptured case was discussed in a local multidisciplinary meeting with neuroradiologists and neurosurgeons to determine the most appropriate strategy. In the cases reported here, the WEB device was mainly favored because of the presence of very-wide-neck lesions in order to avoid stenting requirement. The French Ethical Committee for Research in Medical Imaging (CERIM) approved this study (institutional review board number CRM-2101-127).

Treatment techniques

Treatment was performed under general anesthesia on a biplane or monoplane angiographic system (Azurion, Philips Healthcare, Best, the Netherlands). Patients with unruptured aneurysms were given dual antiplatelet therapy (acetylsalicylic acid 160 mg and ticagrelor 90 mg twice) 24 hours before the intervention. Antiplatelet therapy was not administered before or after treatment for patients with ruptured aneurysms. For every case, procedural heparin was given according to institutional protocol, without checking, as routine, the activated clotting time.

A three-dimensional rotational angiographic scan was systematically used to perform WEB sizing and selection.

Web sizing and postoperative medication

Dimensions of each aneurysm were obtained after three-dimensional rotational angiography. The

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height was determined on the working position and represents the distance from the neck to the dome, in a line perpendicular to the neck. The average width was obtained by measurements of two orthogonal widths of the aneurysm.

The width of the WEB devices was usually oversized to allow a good seal at the aneurysm neck.[9] In most cases operators tried to add at least 1 mm to the average aneurysm width. Prior to detachment, a control VasoCT (Philips Healthcare, Best, The Netherlands) scan was performed to evaluate WEB device positioning.[10] If needed, the device could then be repositioned or changed. Aspirin and ticagrelor prescriptions were discontinued after treatment in all cases.

Postoperative evaluation

Clinical evaluation was performed before and after procedures, as well as during hospitalization and in outpatient follow-up. The modified Rankin Scale (mRS) score was used as a reference for outcome assessment. Imaging follow-up was routinely scheduled at 3–6, 12, 18, and 24 months after treatment. The degree of aneurysm occlusion was measured by DSA, using the Bicêtre Occlusion Scale Score (BOSS)[11] as follows: 0=no residual flow inside the aneurysm or the WEB device; 0'=opacification of the proximal recess of the WEB device; 1=residual flow inside the WEB device; 2=neck remnant; 3=aneurysm remnant; and 1+3 = contrast agent media depicted inside and around the device.

In our study, scores of 0 and 0' were considered to indicate complete occlusion. Scores of 0, 0', and 2 were considered to indicate adequate occlusion. The other scores were considered to indicate incomplete occlusion.

RESULTS

Patient demographics

Between June 1, 2012 and November 15, 2020, 219 aneurysms were treated with a WEB device in our institution, including 15 PComA aneurysms in 15 patients. These were 10 female and five male patients, with ages ranging from 33 to 84 years (mean age 58 years). History of hypertension and dyslipidemia were found in six (40%) and five (33%) patients, respectively. Two (13%) patients were active smokers.

Among these aneurysms, 10 (67%) were ruptured and treated in the acute phase, in the first 24 hours after hemorrhage (table 1). None of the patients presented paralysis of the oculomotor nerve, either before or after the treatment of the aneurysm. The prehospitalization mRS score was 0 in all patients, except for one, who had past history of subarachnoid hemorrhage secondary to the rupture of another aneurysm.

Characteristics of aneurysms and treatment

The average maximum aneurysm diameter was 7.3 mm (size ranging from 4.3 to 11.4 mm), while mean aneurysm height and average width were 6.0 and 5.5 mm, respectively (table 2). In the present study, aneurysm conformation did not favor coiling in the majority of cases, with an aspect ratio (height/neck) smaller than 2 in 11 cases (73%). Mean aspect ratio was 1.6 (range 0.7–3.0), and mean neck size was 4.2 mm (range 2.6–7.4 mm). Adding to the technical difficulties, the PComA originated directly from the neck of the aneurysm (figure 1) in nine patients (60%). The PComA was larger than the ipsilateral P1 segment in nine patients (60%).

The average scopy duration for the embolization procedure was 30.2 min, ranging from 16 to 49 min, which also included the time taken to perform a complete diagnostic angiographic scan in 10 patients with subarachnoid hemorrhage.

Adverse events

In all cases, treatment with a WEB device was completed as planned. In one case, a balloon-assisted technique was performed to better position the WEB device.[12]

Only one procedure-related complication was observed; a thrombus formed at the level of the WEB device after detachment in one patient with subarachnoid hemorrhage. There was complete resolution of this thrombotic event with the use of a glycoprotein IIb/IIIa receptor antagonist without any clinical repercussion.

No intraoperative rupture occurred and no WEB-treated aneurysms presented with bleeding or rebleeding after embolization.

Table 1 Patient and clinical characteristics

Patient	Ruptured aneurysm	WFNS	Prehospitalization mRS score	mRS score at last follow-up	Procedure-related complications	Comments
1	Yes	1	0	**1**	No	
2	Yes	1	0	**0**	No	
3	Yes	5	0	**3**	No	ICH, hydrocephalus, and vasospasm related to SAH prior treatment
4	Yes	5	0	**3**	Yes (thrombus formation)	
5	Yes	4	0	**3**	No	
6	No	–	0	**0**	No	
7	No	–	0	**0**	No	
8	Yes	1	0	**0**	No	
9	No	–	2	**2**	No	Previous SAH from another aneurysm
10	Yes	4	0	**6**	No	Death from SAH complications
11	Yes	1	0	**0**	No	
12	No	–	0	**0**	No	
13	Yes	1	0	**0**	No	Vasospasm related to aneurysmatic SAH
14	No	–	0	**0**	No	
15	Yes	1	0	**0**	No	

WFNS, World Federation of Neurological Surgeons grading scale for subarachnoid hemorrhage; mRs, modified Rankin Scale; SAH, subarachnoid hemorrhage; ICH, intracranial hematoma.;

Table 2 Aneurysm and treatment data

Patient	Fetal pattern of PComA	PComA originates from the aneurysmal neck	Aneurysm height (mm)	Aneurysm mean width (mm)	Aspect ratio (height/neck)	Type of WEB	Follow-up time (months)	BOSS score	Degree of occlusion	Scopy duration (min)
1	Yes	Yes	9.3	6.0	2.6	SLS	20	0′	Complete	48
2	Yes	No	6.0	6.9	0.9	SL	21	2	Adequate	32
3	Yes	Yes	3.7	3.3	1.2	SL	39	0	Complete	49
4	Yes	Yes	8.4	10.0	1.7	SLS	5	2	Adequate	46
5	Yes	Yes	7.6	7.3	2.2	SLS	17	3	Incomplete	37
6	No	No	3.6	4.1	1.3	SL	7	0′	Complete	22
7	No	No	6.2	6.6	1.4	SL	*	*	*	16
8	Yes	Yes	8.4	5.4	3.0	SL	8	3	Incomplete	22
9	Yes	Yes	3.0	2,6	1.0	SL	12	0′	Complete	36
10	Yes	Yes	4.9	7.8	0.7	SL	*	*	*	29
11	Yes	No	5.1	2.7	2.0	SL	3	0	Complete	22
12	Yes	No	6.2	4.2	1.8	SLS	5	3	Incomplete	21
13	No	No	2.8	3.5	1.1	SL	3	0˜	Complete	29
14	Yes	Yes	8.7	8.4	1.6	SL	*	*	*	21
15	No	Yes	5.5	4.3	2.0	SLS	*	*	*	24

*Not available.
BOSS, Bicêtre Occlusion Scale Score; PComA, posterior communicating artery; WEB, Woven EndoBridge.

Clinical outcome

At the last follow-up, the mRS score was ≤2 in 11 patients (73%). For six patients, mRS worsened from the baseline score. All of these patients had been treated for ruptured aneurysms and this worsening was attributed to complications from subarachnoid hemorrhage, such as initial hemorrhage or vasospasm, the latter severely affecting two patients in our series (table 1). There were no transient or permanent complications related to the procedure.

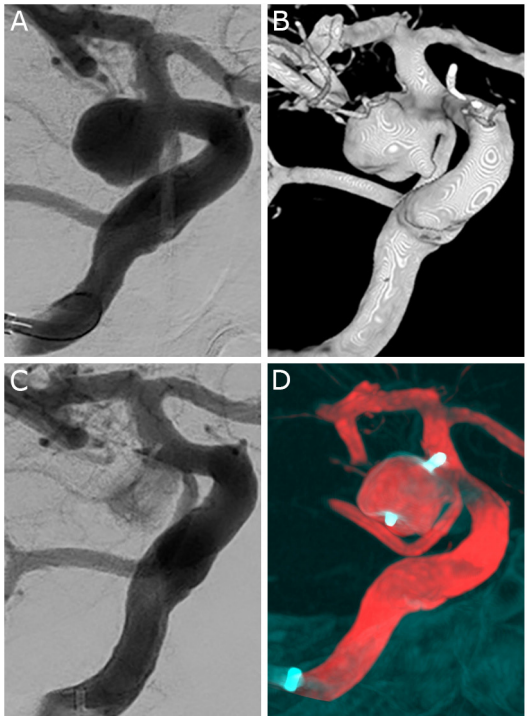

Figure 1 Illustrative case of an unruptured posterior communicating artery (PComA) aneurysm (A,B) treated with a Woven EndoBridge (WEB) device. (C) Significant stagnation of the contrast medium is depicted immediately after implant, and PComA patency is preserved. (D) Overlay of 3D rotational angiography and VasoCT after detachment.

Occlusion status

Four of the 15 patients were not followed up by imaging; in two patients, the treatment was performed after <6 months previously, one patient was living abroad and was lost to follow-up, and the fourth patient (who had received treatment for a ruptured aneurysm) died 3 months after treatment because of the severity of the initial hemorrhage.

The 11 remaining patients underwent at least one DSA scan, with a mean follow-up time of 13 months (ranging from 3 to 39 months). WEB device treatment was considered effective, with adequate occlusion in eight cases (73%), including complete occlusion in six (55%) (figure 2).

Three cases demonstrated recanalization with incomplete occlusion at follow-up. Two of these were subsequently subjected to further treatment, by means of flow diversion (table 2). These latter two were initially ruptured aneurysms.

DISCUSSION

PComA aneurysms

PComA aneurysms are predominant among all intracranial aneurysm locations.[13] PComA aneurysms can sometimes be challenging to treat endovascularly. Wide-neck lesions require the additional use of a stent to avoid coil protrusion into the internal carotid artery, but this strategy could fail to protect the PComA when it originates directly from the aneurysmal sac.[14]

Flow diverters can appear to be very appealing outside the hemorrhagic context[15]; however, their efficacy can be limited in cases of fetal PComA aneurysms.[16 17]

WEB devices for PComA aneurysms

In our study, WEB devices were mainly used in cases of wide-neck PComA aneurysms (mean neck size 4.2 mm). The CLARITY study determined that a higher rate of thromboembolic events occurred in patients with aneurysms with a neck >4 mm than in those with small-neck aneurysms (≤4 mm).[18] However, our study suggests, for PComA aneurysms, the previously reported high safety profile of WEB device treatment of bifurcation aneurysms.[19 20] Yet, no intraoperative rupture occurred and only one thromboembolic event

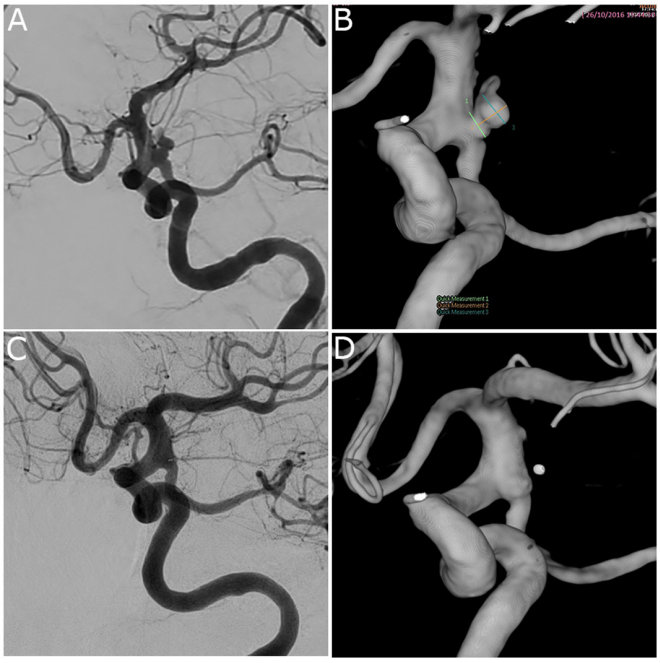

Figure 2 Illustrative case of a ruptured posterior communicating artery (PComA) aneurysm (A,B) measuring 3.3×3.7 cm, with a fetal PComA, treated with a Woven EndoBridge (WEB) device (WEB SL fourth generation, 5×3). (C,D) Complete aneurysm occlusion as well as the preservation of the fetal PComA is shown on control DSA after 39 months' follow-up.

occurred, which resolved with intra-arterial administration of a glycoprotein IIb/IIIa receptor antagonist.

It is also important to consider that PComA aneurysms treated endovascularly carry a high risk of major recanalization after coiling.[21] In addition, the CLARITY study reported worse angiographic outcomes in wide-neck aneurysms than in those with a neck size ≤4 mm.[22] Here, the angiographic efficacy of WEB device treatment of PComA aneurysms is similar to that reported in previous studies,[3] with 54% complete occlusion and 72% adequate occlusion achieved.

Ruptured aneurysms

An interesting characteristic of the WEB device is its potential for use in treating ruptured wide-neck aneurysms.[2 5 23] Indeed, in such situations, the use of stents—whether for stent-assisted coiling or flow diversion—is discouraged, in view of the need for double antiplatelet therapy. In this series, we used the WEB device in 10 patients with ruptured aneurysms; none were given aspirin or ticagrelor and no rebleeding occurred after treatment, suggesting its effectiveness in this subgroup of patients also.

Re-treatment

In our study, among 11 patients who had follow-up imaging two were re-treated. Both had aneurysms that were initially ruptured, and this incidence is not higher than that described by Campi *et al*[21]: (17.4%) in the endovascular group of the International Subarachnoid Aneurysm Trial (ISAT).

Unlike true bifurcation aneurysms, the PComA recurrences are most frequently suitable for treatment with flow-diverter stents.[24] Flow diverter stents were used to treat the two aneurysmal recurrences in our series, without any complications.

Recurrence prevention

To maximize their effect, proper selection of the size and shape of WEB devices is essential.[9] It is expected that oversizing the width might confer an increased mechanical resistance that could lead to a decreased rate of WEB shape modification during follow-up.[9 25 26] Good neck coverage also appears to be essential to optimize occlusion rates during follow-up.

Justification for WEB device treatment

Some of the aneurysms treated in this case series could have been treated with coiling and some would have required the additional use of a stent. Here, we had multiple rationales for using WEB devices: (1) faster treatments are known to be associated with fewer thromboembolic complications[27]; (2) we aimed to avoid postoperative antiplatelet therapy in all cases; (3) we hoped that treatment with WEB devices could achieve better angiographic results in these aneurysms that are at high risk of recurrence.

Our preliminary results are encouraging, but all those points are to be confirmed in a prospective controlled study.

Limitations

Our study has several limitations, mainly concerning its retrospective nature and the small number of patients. Also, more follow-up examinations are needed to assess the long-term stability of the angiographic results.

Owing to these limitations, further prospective multicenter studies with a larger patient sample will be required to draw definite conclusions. Nevertheless, we believe that this study focusing on aneurysms at the PComA location will provide valuable insights into the potential for WEB devices to be used in a wider range of aneurysmal locations.

CONCLUSIONS

This series suggests the high safety profile of WEB devices even when used in off-label indications. Treatment with WEB devices seems to to be a valuable strategy for ruptured wide-neck PComA aneurysms, avoiding the need for antiplatelet medication. However, occlusion rates should be investigated in further larger studies.

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