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Endovascular occlusion of intracranial wide-necked aneurysms with stenting (Neuroform) and coiling: mid-term and long-term results

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Abstract
Introduction Coiling associated with placement of self-expandable intracranial stents has amplified the treatment of intracranial wide-necked aneurysms, but the durability of this treatment and the existence of delayed recurrence are not yet well known. The purpose of this report is to present our experience with the Neuroform Stent associated with coiling and to evaluate complications, effectiveness, and long-term results of this technique.
Methods A retrospective study of 42 patients with wide-necked cerebral aneurysms treated with the Neuroform Stent was performed. Mean aneurysm size was 11.3 mm. Mean neck size was 5.33 mm. All patients were treated with coiling and stenting. Clinical and angiographic follow-up was available in 38 patients (90.5%). The overall follow-up time ranged from 6 months to 5 years (mean, 42 months), but most of the patients (92%) had a follow-up period superior to 1 year.
Results Successful deployment of 41 stents (97%) was obtained. Permanent procedural morbidity was observed in only one patient (2.4%). Long-term complete aneurysmal occlusion was obtained in 27 patients (71%). Aneurysmal regrowth was observed in four patients (9.5%) on the first control angiogram. After the first control angiogram, no delayed recanalization or regrowth was observed. During the follow-up period, there were no hemorrhagic events, no delayed thrombosis, and no stent displacement.
Conclusion Our results demonstrate the effectiveness of the technique, a small rate of procedural complications, and long-term tolerance of the Neuroform Stent. Despite some evidence of early aneurysmal recurrence, long-term durability of stent-assisted aneurysm occlusion is stable after the first year.

Keywords Intracranial aneurysm · Endovascular · Guglielmi detachable coils · Neuroform · Stent

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Introduction

Endovascular treatment of intracranial aneurysms by endosaccular coiling has become an accepted alternative to surgical clipping, with lower morbidity and mortality rates in selected cases [1]. However, wide-necked aneurysms are difficult to treat because of their unfavorable geometry, which reduces the ability to achieve dense packing and exclusion of the aneurysm from the circulation. It has also been documented that aneurysms of large diameter and wide necks are also factors related to increased frequency of periprocedural complications as well as aneurysm recurrence [2, 3]. Despite significant advances in coil design [4, 5], as well as technical innovations such as the balloon remodeling technique [6], there remains a substantial number of aneurysms that cannot be treated successfully with coiling or that, when treated, recur at a high rate. The development of self-expandable intracranial stents has increased the options for the treatment of wide-necked aneurysms. Although many authors have demonstrated feasibility of the technique, which is associated with good clinical and anatomical results [7–15], the long-term

durability of the treatment and delayed aneurysm recurrence is not yet well-known. The present case series details our experience with the Neuroform Stent System [Boston Scientific Neurovascular, Fremont, CA] in the treatment of wide-neck aneurysms, with an emphasis on treatment durability at mid-term and long-term (more than 1 year) follow-up.

Patients and methods

Patients

Endovascular treatment is the first therapeutic option for both ruptured and unruptured intracranial aneurysms at our institution. We retrospectively analyzed the records of all patients with wide-necked cerebral aneurysms who received treatment or attempted treatment with stent-assisted coil embolization between 2003 and 2007. The analysis resulted in a series of 42 intracranial aneurysms (Table 1). There were 27 women and 15 men. Mean patient age was 54 years with a range from 30 to 81 years.

Twenty-eight aneurysms (66.6%) were located on the supraclinoidal internal carotid artery. Three cases involved the carotid cavernous artery (three cases), the middle cerebral artery (three cases), the anterior communicating artery (two cases), the vertebral artery (three cases), the basilar artery (two cases), and the posterior cerebral artery (one case).

All aneurysms had a large neck (>4 mm) and/or a dome to neck ratio ≤1.5. Mean neck size was 5.3 mm. Mean aneurysm size was 11.3 mm with a range from 3 to 35 mm. There were 31 unruptured aneurysms (74%) and 11 aneurysmal subarachnoid hemorrhages (SAH; 26%). Among the 31 unruptured aneurysms, 24 were incidental (one case was a recanalized aneurysm after an initial coiling), four cases presented with cranial nerve palsy, two with visual deficit, and one with a transitory ischemic event. In patients presenting with a SAH, the World Federation of Neurosurgical Societies scale was grade 1 in seven patients, grade 2 in one, grade 4 in two, and grade 5 in one. Five patients with SAH were treated with coiling and stenting at the acute period in one session. In two of these patients, stenting was not considered at the start of the procedure but was used as a rescue device due to protrusion of a coil in the parent artery. The other patients with SAH [6] were treated with coiling and stenting after coiling recurrence, several months after bleeding.

Procedure

In non-acutely ruptured aneurysms, pharmacological therapy included 100 mg aspirin per day and 75 mg of clopidogrel for 8 days before endovascular treatment followed by 6 months of clopidogrel and aspirin for 1 year post-treatment. In patients treated in the acute phase, aspirin (100 mg) was injected at the start of the procedure, and four clopidogrel pills were crushed and injected in the nasogastric tube during the procedure. After endovascular treatment, clopidogrel was administered for 6 months and aspirin for 1 year. All patients underwent endovascular treatment under general anesthesia. Heparin was titrated during the procedure to achieve an activated clotting time of 2–2.5 times that of baseline. In our series, stenting and coiling were performed in one session. The Neuroform Stent is a self-expanding, nitinol (nickeltitanium alloy) stent with a thermal memory. Our technique for stent-deployment has been described in detail in previous reports [10]. The Neuroform Stent was deployed across the neck of the aneurysm before coiling. At the beginning of our experience, coiling was performed with the microcatheter placed in the aneurysm through the mesh of the stent; later in our experience, we employed the "jailed catheter technique" in which the microcatheter is caged between the vessel wall and the stent. In 21 patients (50%), a remodeling balloon [HyperGlide; Micro Therapeutics, Irvine, CA] was placed within the stent during coils delivery (Table 1). This technique was used in order to avoid any coil protrusion into the parent artery through the stent struts, above all, when working views did not permit to differentiate accurately the aneurismal neck from the vessel. Balloon-in-stent technique was performed also to improve stability of the coiling microcatheter.

Clinical follow-up was collected at 3 and 6 months following endovascular treatment and every year thereafter. Outcomes were estimated by using the modified Rankin Scale score (mRS) for all the patients. Imaging follow-up included conventional angiography between the third and the sixth month, then at 1 and 3 years. Angiographic results were classified according to the simplified three-point Jean Raymond and Roy classification scale [16].

Statistical methods

Analyses of the data gathered from this study were primarily descriptive. Simple descriptive statistics (*n*, mean, percent), graphs, and patient listings were used to summarize the majority of the data.

Results

Stenting deployment

Forty-one of the 42 stents were easily delivered and deployed at the desired location, resulting in a deployment success rate of 97%. In one case (case n°28), the stent did

Table 1 Summary of patients data.

Case number	Age (year)/sex	Clinical presentation	Aneurysm type/ location	Size (dome/neck) (mm)	Balloon protection
1	56/F	Incidental	Supraclinoidal IC	(6/4)	No
2	56/F	Incidental	Supraclinoidal IC	(7/5)	No
3	65/M	SAH/WFNS 4	Supraclinoidal IC	(26/8)	Yes
4	30/M	SAH/WFNS 1	Acom	(3/2)	No
5	47/F	Incidental	Supraclinoidal IC	(12/6)	Yes
6	73/F	Incidental	Supraclinoidal IC	(7/4)	No
7	38/F	Incidental	Supraclinoidal IC	(8/4)	Yes
8	58/F	Incidental	Supraclinoidal IC	(6/4)	No
9	64/F	Incidental (recurrence after initial coiling)	Supraclinoidal IC	(20/6)	Yes
10	70/F	CN palsy	Supraclinoidal IC	(14/8)	No
11	51/F	Incidental	Supraclinoidal IC	(12/5)	Yes
12	47/F	Incidental	Supraclinoidal IC	(15/7)	Yes
13	51/F	Incidental	Supraclinoidal IC	(7/4)	No
14	38/F	Incidental	Ssupraclinoidal IC	(10/6)	Yes
15	57/F	Loss of vision on one eye	Supraclinoidal IC	(10/4)	No
16	36/F	CN palsy	Cavernous IC	(35/12)	Yes
17	68/F	CN palsy	Cavernous IC	(30/10)	No
18	71/F	Transient ischemic attack	Supraclinoidal IC	(16/6)	No
19	42/M	Incidental	PCA	(12/6)	Yes
20	51/M	SAH/WFNS 5 recurrence after initial coiling	BA	(14/6)	Yes
21	35/F	Incidental	Supraclinoidal IC	(7/4)	Yes
22	58/F	Loss of vision on one eye	Supraclinoidal IC	(14/7)	No
23	59/F	Incidental	Supraclinoidal IC	(5/5)	No
24	37/F	Incidental	Supraclinoidal IC	(5/5)	No
25	60/M	SAH/WFNS 1	BA	(4/4)	Yes
26	56/M	Incidental	VA	(18/6)	Yes
27	73/F	SAH/WFNS 2 recurrence after initial coiling	Supraclinoidal IC	(4/4)	No
28	34/F	Incidental	Supraclinoidal IC	(13/5)	Yes (failure of stenting)
29	50/M	SAH/WFNS1	MCA	(3/2)	No
30	55/M	SAH/WFNS 4 recurrence after initial coiling	Acom	(12/4)	Yes
31	45/F	Incidental	Supraclinoidal IC	(25/8)	Yes
32	45/M	SAH/ WFNS 1 recurrence after initial coiling	Supraclinoidal IC	(12/5)	No
33	57/M	Incidental	Supraclinoidal IC	(8/7)	Yes
34	81/M	SAH/WFNS 1	VA	(15/9)	Yes
35	54/M	Incidental	Supraclinoidal IC	(16/5)	No
36	62/F	Incidental	Supraclinoidal IC	(5/4)	No
37	54/M	incidental	Supraclinoidal IC	(5/4)	No
38	61/M	SAH/WFNS 1 recurrence after initial coiling	MCA	(3/3)	Yes
39	60/F	Incidental	VA	(12/4)	No
40	74/F	SAH/WFNS1	MCA	(5/4)	Yes
41	50/F	Incidental	supraclinoidal IC	(5/4)	No
42	50/M	CN palsy	cavernous IC	(7/4)	Yes

SAH subarachnoid hemorrhage, *WFNS* World Federation of Neurological Surgeons, *mRS* modified Rankin Scale, *CN* cranial nerve, *MCA* middle cerebral artery, *IC* internal carotid artery, *VA* vertebral artery, *BA* basilar artery, *Acom* anterior communicating artery, *ACA* anterior cerebral artery, *PCA* posterior cerebral artery

not reach the desired location due to severe tortuosity of the cervical internal carotid artery and spasm on the carotid artery and its intracranial branches. This patient was treated with the balloon remodeling method but presented with recanalization at the first control angiogram, for which a new attempt of stenting is being discussed.

Procedural complications

Two patients (4.8%) died from SAH complications unrelated to the endovascular procedure.

Nine procedural complications were observed (21.5%; Table 2). Asymptomatic complication occurred in one

Table 2 Data of patients with procedural morbidity and failure.

Case number	Age (year)/ sex	Clinical presentation	Aneurysm type/ location	Size (dome/ neck) (mm)	Procedural complication	Balloon protection	Follow-up time	Clinical follow-up (mRS)	Notes
2	56/F	Incidental	Supraclinoidal IC	(7/5)	Groin hematoma	No	4 years	0	
11	51/F	Incidental	Supraclinoidal IC	(12/5)	Post-op seizure	Yes	2 years	1	Transitory breakdown of the meningeal barrer
12	47/F	Incidental	Supraclinoidal IC	(15/7)	Transitory visual trouble due to occlusion in a branch of the retinal artery	Yes	1 year	0	
14	38/F	Incidental	Supraclinoidal IC	(10/6)	Transitory hemiparesis	Yes	2 years	0	
19	42/M	Incidental	PCA	(12/6)	Groin hematoma	Yes	3 years	0	
23	59/F	Incidental	Supraclinoidal IC	(5/5)	Stretched coil and thromboembolic complication	No	5 years	5	Infarction in the internal capsula
28	34/F	Incidental	Supraclinoidal IC	(13/5)	Stenting failed	Yes	Stenting failed	0	Treatment with remodeling technique
32	45/M	SAH/WFNS 1 recurrence after initial coiling	Supraclinoidal IC	(12/5)	Stretched coil without thromboembolic complication	No	5 years	0	
33	57/M	Incidental	Supraclinoidal IC	(8/7)	Post-op seizure	Yes	1 year	0	Transitory breakdown of the meningeal barrer
40	74/F	SAH/WFNS1	MCA	(5/4)	Asymptomatic thromboembolic complication	Yes	6 months	1	In stent thrombosis treated with success by thrombolysis

SAH subarachnoid hemorrhage, *WFNS* World Federation of Neurological Surgeons, *IC* intracranial carotid artery, *PCA* posterior cerebral artery, *MCA* middle cerebral artery, *mRS* modified Rankin Scale

patient: In this case (case 32), the last coil was broken during its delivery. This one was stretched then buried at the level of the fold of the groin, without complication.

Procedural morbidity was observed in eight cases (19%). Two patients presented comitial crisis after the procedure likely due to a transitory breakdown of the meningeal barrier and two others, a groin hematoma without false aneurysm. There were four symptomatic thromboembolic complications encountered (cases 12, 14, 23, and 40). Permanent procedural morbidity (2.4%) was observed in one patient (case 23): A coil was broken during its delivery, then gently stretched and buried at the level of the fold of the groin without dissection or thrombus formation on the control angiogram. At the end of the procedure, the patient presented a complete aphasia and hemiplegia. A computed tomography (CT) scan carried out 3 days later showed a small infarction located in the internal capsule. The patient never recovered and has a mRS 5, 5 years after the procedure.

Three patients presented a transitory event: The first patient (case 40) presented a complex middle cerebral aneurysm, which was treated with stenting and coiling in an acute setting of SAH. At the end of the anesthesia, the patient presented a focal neurological deficit and was fully anesthetized again. The control angiogram showed a non-occlusive thrombus formation in the stent, and an Eptifibatide bolus (180 μg/kg) was administered intra-arterially at the site of the thrombus. Complete angiographic clot lysis was seen without clot fragmentation and distal embolization, and the patient recovered with no post-procedural neurological deficit. The second one (case 12), treated for an incidental supraclinoidal aneurysm, presented a partial visual field loss after the procedure, and he recovered totally 12 h after. The third one (case 14), also embolized for an incidental aneurysm, developed a slight hemiparesis, which disappeared after the first night.

Follow-up

Clinical and angiographic follow-up was available in 38 patients (90.5%; Table 3). The overall follow-up time ranged from 6 months to 5 years (mean 42 months), but the majority of patients with follow-up available (92%) exceeded 1 year post-treatment.

During the follow-up period, no event of hemorrhage was observed. Among the 31 patients with unruptured aneurysms, 27 patients had a mRS of 0 (87%), two patients had a score of 1, one patient had a score of 2, and one patient had a score of 5. In this unruptured aneurysm group, 24 patients presented with an incidental aneurysm; 22 were classified mRS 0 (91.5%), one was mRS 1, and one was mRS 5. For the 11 patients who presented with SAH, six had a mRS 0, two had a mRS 6, one had mRS 2, one had mRS 3, and one had mRS 4.

Apart from three cases with only a 6-month angiographic follow-up available, angiographic follow-up was superior to 1 year for the remaining cases (92%). In all cases, angiographic follow-up revealed free flow within the stent and parent vessel without delayed thrombosis. No stent displacement, fracture, or torsion was observed during this period. One patient who had an angiographic follow-up of 6 months presented with moderate and asymptomatic stenosis of the stent. Long-term complete aneurysm occlusion was obtained in 27 patients (71%). Among these 27 patients, 14 of them were treated with a remodeling balloon placed in the stent during coiling and 13 without remodeling technique. Aneurysms that were completely occluded on the first angiographic control remained occluded during the following subsequent angiograms.

In six patients with a classified grade 2 neck remnant and in one patient with a classified grade 3 residual aneurysm, according to the simplified Raymond Classification Scale, results remained unchanged at follow-up.

After stenting, aneurysm regrowth was observed in four patients (9.5%; Table 4): There were three women and one man. Aneurysms were located on the supraclinoidal internal carotid artery in two cases, on the vertebral artery in one case, and on the cavernous segment of the carotid artery in the last case. Aneurysm size varied from 12 to 30 mm; neck size from 4 to 10 mm (neck ratios between 2 and 3). Balloon-in-stent-assisted embolization was used for none of these aneurysms. The final angiogram after stenting and coiling showed complete occlusion in two cases and partial occlusion in the other two cases (grade 2 in the simplified Raymond classification scale). For all these four patients, aneurysmal recanalization was demonstrated early during the first control angiogram. All the patients were treated endovascularly again, without procedural complication. In one patient (case 17), retreatment was performed using additional coils positioned through the stent; after the second embolization, the patient was classified as Grade 2 in the Raymond's classification, and the last control (4 years later) showed an unchanged aspect. A second stent was deployed within the previously positioned stent, after additional coiling in two patients (cases 39 and 35); immediate angiography showed a complete occlusion of the both lesions. The angiographic control carried out 6 months after the second procedure showed, in the first case (case 39), a complete occlusion and, in the second case (case 35), a new slight recurrence at the neck of the aneurysm. A sacrifice of the parent artery was carried out for the last patient (case 22), without any recurrence.

Discussion

The development of self-expandable intracranial stents has increased the options for treatment of wide-necked aneur-

Table 3 Clinical and angiographic follow-up.

Case number	Duration of the clinical follow-up	Clinical follow-up for patients who presented SAH (GOS)	Clinical follow-up (mRS)	Last post-operative angiographic control	Angiographic results at the last control (Raymond's classification)
1	4 years		0	3 years	1
2	4 years		0	3 years	2
4	5 years	1	0	3 years	1
5	5 years		0	3 years	1
6	4 years		0	3 years	1
7	5 years		0	3 years	1
8	2 years		0	1 year	1
9	4 years		0	3 years	1
10	3 years		0	3 years	1
11	2 years		1	1 year	2
12	1 year		0	1 year	1
13	3 years		0	3 years	1
14	2 years		0	1 year	1
15	3 years		1	3 years	2
16	5 years		2	3 years	3
17	5 years		0	5 years	3 (recanalization)
18	5 years		0	3 years	1
19	3 years		0	3 years	2
20	5 years	3	3	3 years	1
21	10 months		0	1 year	1
22	5 years		0	5 years	3 (recanalization)
24	2 years		0	1 year	1
25	5 years	1	0	3 years	2
26	3 years		0	3 years	1
27	5 years	1	1	3 years	1
29	5 years	1	0	3 years	1
30	5 years	3	4	3 years	1
31	2 years		0	1 year	1
32	5 years	1	0	3 years	1
33	1 year		0	1 year	1
35	1 year		0	1 year	3 (recanalization)
36	5 years		0	3 years	1
37	5 years		0	3 years	1
38	5 years	1	0	3 years	1
39	1 year		0	1 year	3 (recanalization)
40	6 months	2	1	6 months	2
41	1 year		0	6 months	1
42	6 months		0	6 months	1

GOS Glasgow Outcome Score, *SAH* subarachnoid hemorrhage; *mRS* modified Rankin Scale

ysms. In association with coiling, the application of a stent within the parent vessel has three main advantages: it enables dense aneurysm packing [17, 18], it induces significant intraaneurysmal flow modifications that may lead to spontaneous thrombosis [19, 20], and it may provide a framework for endothelial growth resulting in permanent separation of the aneurysm from the parent vessel lumen [21, 22].

As reported in other series, the use of the self-expandable Neuroform Stent [7, 10, 11, 15, 17, 22–26] resulted in successful navigation and deployment. The current Neuroform has been modified from earlier generations of the stent and significantly decreased the initial technical issues [14, 17].

With no mortality related to the technique and a permanent morbidity of 2.4%, the periprocedural complications observed in this current series are similar to those reported in recent published studies [15, 27, 28]. Among procedural events, thromboembolic complications are the most frequent and can be explained by the thrombogenicity of endovascular stents [8, 14, 15, 23, 29, 30] and the fact that more and more complex cases are being treated. Very

Table 4 Summary of patients with recanalized aneurysm after stenting.

Case number	Age (year)/ sex	Aneurysm type/location	Size (dome/ neck) (mm)	Balloon protection	Immediat angiographic results (Raymond's classification)	First angiographic control at 6 months (Raymond's classification)	Second intervention/ immediate angiographic results (Raymond's classification)	Last post-operative angiographic control (years)	Angiographic results at the last control (Raymond's classification)
17	68/F	Cavernous IC	(30/10)	No	2	3 (recanalization)	Coiling/2	5	2
22	58/F	Supraclinoidal IC	(14/7)	No	2	3 (recanalization)	Endovascular sacrifice of the IC	5	Endovascular sacrifice of the IC
35	54/M	Supraclinoidal IC	(16/5)	No	1	3 (recanalization)	Endovascular coiling and stent-within-stent/1	1	2
39	60/F	VA	(12/4)	No	1	3 (recanalization)	Endovascular coiling and stent-within-stent/1	1	1

CN cranial nerve, *IC* intracranial carotid artery, *VA* vertebral artery

interestingly, recent published reports of morbidity due to thromboembolic events after endovascular treatment of unruptured aneurysms with coils ranges from 9 to 10% [31, 32], which seems higher than the morbidity of procedures associating with combined coiling and stenting. This could be explained by the rigorous pre-, peri-, and post-procedural pharmacological regimen required for intracranial stenting.

Although antiplatelet therapy with clopidogrel and aspirin seems to be effective in preventing thromboembolic complications during intracranial stenting, this treatment does not completely eliminate thromboembolic events. Some of these complications could be due to some patients being non-responsive to antiplatelet therapy, especially clopidogrel, which is evident in 5% to 42% of patients [33–36]. Better understanding of clopidogrel resistance and systematic screening of "low" responders with verification of adequate platelet inhibition may decrease thromboembolic complications during stenting [30].

The long-term durability of the treatment and delayed aneurysm recurrence after stenting and coiling are not yet well known. After stenting, aneurysm recurrence was observed in 9.5% in our series; this compares favorably with the results presented by Murayama et al.[2] and Brilstra et al. [3], who reported a rate of 22% to 42% recanalization after endovascular occlusion with coils only in broad-neck aneurysms. Recanalization rates reported after stenting and coiling are variable in the literature: Biondi et al. [15] retreated five (11%) recanalized aneurysms in a series of 45 cases, Katsaridis et al. [37] reported no recurrence in all controlled patients, and Fiorella et al. [17] reported a 23% recanalization rate in a series including dissecting and fusiform aneurysms. In the recanalized cases from our series, technical strategy did not differ from the other procedure. Stenting was performed before coiling: in two cases, the microcatheter was introduced into the aneurysm through the struts of the stent; in the remaining cases, the microcatheter was placed into the aneurysm before stent deployment (jail technique). However, due to potential technical difficulties in placing a remodeling balloon into the stent after deployment, the balloon-in-stent-assist technique was not used and may have limited coil packing. Moreover, increasing vessel angulation may cause focal separation of the Neuroform crowns along the greater curvature of a curved artery and may decrease the scaffolding effect of the stent for aneurysms located in very angulated vessels. This has been described in other reports involving very tortuous cadaver intracranial arteries by Hsu et al. [38]. In all of our recanalized patients, the aneurysm was located within an angulated segment of the parent artery, and the ability of the stent to suitably bridge the aneurysm neck and constitute an ideal scaffolding for coils was likely affected.

In our series, any recurrence or regrowth was observed on the first control angiogram (between the third and the

sixth month post-procedure control). After this initial control, no angiographic change was observed: Completely occluded aneurysms remained completely occluded on subsequent angiograms. Furthermore, patients with an initial incomplete occlusion also remained stable. Therefore, apart from early recurrences, aneurysmal occlusion after stenting and coiling appears stable over time. This appears to be an improvement over results of coiling alone for which major recurrences may be observed more than 1 year after the intervention [39, 40].

Apart from in-stent stenosis, no long-term complications have been observed after stenting in our series: No bleeding or rebleeding, no thrombosis, displacement, fracture, or torsion was observed during the follow-up period. One patient presented with a moderate and asymptomatic stenosis of the stent. Severe in-stent stenosis was observed in two patients (3.8%) in the study of Fiorella et al. [17, 41] and in one patient in the series of Biondi et al. [15]. However, no in-stent stenosis was observed in other series using self-expandable stents [37, 42], even in the report from Turk et al. [43] where the Neuroform Stent was deployed in distal, small cerebral vessels. Although it represents a potentially devastating delayed complication, in-stent stenosis after stenting is likely rare. Its true incidence requires a larger volume of long-term follow-up data.

There were some limitations of our study. First, the data represent a single center experience and may not be generalizable to other centers for reasons of selection bias and level of experience of the interventional neuroradiologist. Finally, our study is not a randomized controlled trial.

Conclusion

Endovascular treatment of intracranial wide-necked aneurysms with stenting and coiling with the Neuroform Stent is effective. Long-term follow-up demonstrated good tolerance of the stent without delayed complication. Early recurrences are possible during the first year of follow-up but appear to remain stable during long-term follow-up. Further studies are needed to validate these results.

Conflict of interest statement We declare that we have no conflict of interest.

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