Revascularized Giant Aneurysm of the Anterior Communicating Artery after Surgery and Embolization, Occluded by Placement of a Leo+Baby Intracranial Stent

A Case Report

M. DALL'OLIO¹, F. CALBUCCI², A. FIORAVANTI², C. BORTOLOTTI², L. CIRILLO¹, C. PRINCIOTTA¹, M. LEONARDI¹

¹Neuroradiology Department, IRCCS Neurological Sciences, Bellaria Hospital, University of Bologna; Bologna, Italy

²Neurosurgery Department, IRCCS Neurological Sciences, Bellaria Hospital, University of Bologna; Bologna, Italy

Key words: brain aneurysms, stent-assisted coiling

SUMMARY – Balt (Montmorency, France) recently manufactured the Leo+Baby dedicated intracranial stent for arteries with a calibre between 1.5 and 3.10 mm. We describe a patient with a partially thrombosed giant sacciform aneurysm of the anterior communicating artery treated without success by surgery and coil embolization subsequently occluded by placement of a Leo+Baby stent (Balt, Montmorency, France). A 56-year-old man presented with a giant aneurysm in the anterior communicating artery region. Following successive surgical intervention and embolization procedures the patient was referred to us with a revascularized aneurysm measuring 15×9×8 cm. To stabilize the endovascular occlusion a combined treatment was scheduled with coil embolization and stent deployment after dual antiplatelet therapy started five days before the interventional procedure. Treatment was undertaken two weeks later under general anaesthesia and total heparinization. A microcatheter was inserted into the aneurysmal sac and four metal coils were released for a total of 61cm obtaining almost complete occlusion of the aneurysm from the circulation. A Leo+Baby stent (2.5×18 mm) was subsequently deployed across the aneurysm neck. At follow-up angiography two months later the aneurysm appeared substantially excluded from the arterial circulation except for a small portion in the neck. Six months later, four months after suspending antiplatelet therapy, follow-up angiography disclosed the complete exclusion of the aneurysm from the circulation. Deployment of the new ministent through the same microcatheter used to release the coils made the interventional procedure simpler and faster.

Introduction

Giant aneurysms are defined as lesions with a maximum diameter greater than 2.5 cm, accounting for only about 5% of intracranial aneurysms¹. Classically, they are divided into sacciform and fusiform aneurysms depending on the presence of a well-defined neck. Giant intracranial aneurysms are mainly found in the largest circle of Willis arteries. The lesions present clinically with rupture resulting in sub-

arachnoid haemorrhage², or with neurological signs caused by mass effect, epileptic seizures, ischaemia due to embolus or occlusion of perforating arteries. Giant aneurysms may also be asymptomatic, disclosed by chance during neuroradiological investigation for other reasons.

Management of giant intracranial aneurysms is complex both by surgery and embolization. Whenever possible, the aim of treatment is occlusion of the parent artery. Alternatively, the aneurysm is excluded from the circulation by

surgical or endovascular means. The occlusion of giant sacciform aneurysms is seldom complete^{3,4}; it stabilizes any mass effect but may lead to subsequent revascularization. To make coil embolization more stable it is useful to position an intracranial stent in the parent artery in front of the aneurysm neck. The stent prevents protrusion of the coils outside the aneurysm thereby boosting complete exclusion of the lesion. The device also serves to promote endothelialisation of the neck and divert blood flow reducing the inflow⁵, a characteristic feature of flow-diverter stents designed to induce aneurysm thrombosis⁶⁻¹⁰. These new stents are an evolution of classic stents with a reduced mesh porosity resulting in higher coverage of the aneurysm wall. The braided mesh structure of Balt stents has become progressively denser from the Leo stent to the Leo+ and then the Silk stent. The Leo+ stent is an intermediate device with a high radial force making it easy to position. Its stent mesh is smaller than that of the Leo stent (from 1.9 F to 2.7 F) increasing the area of the aneurysm wall covered by the stent but still allowing the passage of a microcatheter through the mesh for coil embolization. However, the Leo+ cannot be used in arteries with a calibre smaller than 3.10 mm. Balt recently manufactured the Leo+Baby dedicated intracranial stent for arteries with a calibre between 1.5 and 3.10 mm.

We describe a male patient with a partially thrombosed giant sacciform aneurysm of the anterior communicating artery treated without success by surgery and coil embolization, subsequently completely occluded by placement of a Leo+Baby stent (Balt, Montmorency, France). To our knowledge, this is the first case report on this new type of stent.

Case Report

A 56-year-old man with a severely impaired sense of smell, right eye visual deficit and occasional headache underwent a brain MR scan elsewhere. The scan disclosed a giant aneurysm in the anterior communicating artery. The aneurysm was associated with bilateral frontal oedema and marked mass effect on the surrounding structures, namely compression of the frontal horns of the lateral ventricles and indentation of the corpus callosum (Figure 1A,B).

Transferred to the Neurosurgery Unit at Bellaria Hospital, cerebral angiography undertaken at the hospital's Neuroradiology Service

confirmed the giant aneurysm (maximum diameter 48 mm) in the anterior communicating artery. The aneurysm was partially thrombosed with a portion open to flow measuring 10 mm (Figure 2A,B). The lesion exerted a severe mass effect on the frontal brain tissue and frontal horns of the lateral ventricles.

The patient was referred for surgery to resect the aneurysm and resolve the mass effect. Due to the high risk of aneurysm rupture during surgery, the decision was taken with our neurosurgeon colleagues to perform preoperative partial embolization to reduce the risk of bleeding during surgery. The embolization procedure was completed leaving the proximal portion of the aneurysm patent to allow surgical clipping without coil obstruction (Figure 3).

On the following day the patient underwent surgery to exclude the circulation and remove the aneurysm. He was subsequently discharged in good clinical condition. One month later the patient was readmitted to a local hospital for mild subarachnoid haemorrhage and again transferred to the Neurosurgery Unit at Bellaria Hospital. Angiography performed by the Neuroradiology Service disclosed a newly vascularized aneurysmal sac measuring 16×9×8 mm. The sac's relatively narrow neck communicated with the anterior communicating artery (Figure 4). A second embolization procedure was undertaken inserting multiple coils (Penumbra Coil) for a total of 119 cm to enhance filling efficiency (Figure 5). The multiple surgical clips and coils in the aneurysm precluded follow-up CT angiography or MR angiography.

Four months later the patient underwent follow-up angiography disclosing a newly vascularized sac within the aneurysm measuring 15×9×8 cm (Figure 6). To stabilize the endovascular coil occlusion a combined treatment was planned with coil embolization and stent deployment following dual antiplatelet therapy to be started five days before the interventional procedure.

Two weeks later treatment was performed under general anaesthesia and total heparinization. A microcatheter was inserted into the aneurysmal sac and four metal coils were released for a total of 61cm obtaining almost complete occlusion of the aneurysm from the circulation. A Leo+Baby stent (2.5×18 mm) was subsequently deployed across the aneurysm neck (Figure 7A,B). Antiplatelet therapy was prescribed for the following four months. At follow-up angiography two months later the aneurysm appeared substantially excluded

Figure 1 MR scans. A) Axial T2, b) sagittal T1 with contrast administration: note the giant aneurysm of the anterior communicating artery with oedema in the frontal lobes and marked mass effect associated in particular with indentation on the corpus callosum.

Figure 2 Digital angiography. A) Antero-posterior view, B) oblique view: note the vascularized portion of the aneurysm.

from the arterial circulation except for a small portion in the neck. Six months later, four months after suspending antiplatelet therapy, follow-up angiography disclosed the complete exclusion of the aneurysm from the circulation (Figure 8A,B).

Discussion

We described a rare complex aneurysm requiring a multidisciplinary treatment approach involving surgical and endovascular expertise and the use of a new intracranial stent

Figure 3 Digital angiography oblique view: preoperative coil embolization. The aneurysm neck is intentionally left patent to allow insertion of surgical clips.

Figure 4 Digital angiography oblique view: 2 month follow-up after the procedure shows regrowth of the aneurysm sac.

Figure 5 Digital angiography oblique view: new embolization procedure with a coil system designed to enhance filling efficiency (Penumbra coil 400) and exclude the aneurysm sac from the circulation.

Figure 6 Digital angiography oblique view: 4 month follow-up after embolization shows the appearance of a newly vascularized aneurysmal sac.

(Leo+Baby, Balt, Montmorency, France) for definitive management.

Giant aneurysms (lesions with a maximum diameter greater than 2.5 cm) including sac-ciform and fusiform lesions account for only about 5% of intracranial aneurysms¹. Giant in-

tracranial aneurysms are mainly found in the carotid siphons or basilar trunk and in rare cases originate from the more peripheral arterial branches. The aneurysm in our patient originated from the anterior communicating artery in an asymmetrical stretch of A1, as

Figure 7 Digital angiography. A) Antero-posterior view, B) oblique view: new coil embolization of the aneurysm sac and deployment of a Leo+Baby (2.5x18mm) stent to cover the neck. At the end of the procedure part of the aneurysm neck remains vascularized.

Figure 8 Digital angiography. A) Oblique view, B) 3D reconstruction: final follow-up 6 months after the procedure shows complete exclusion of the aneurysm from the circulation.

often occurs, with hypoplasia of the right A1 portion, a dominant left A1 portion and blood flow into the aneurysm and into both A2 segments. The large size of the aneurysm (maximum diameter 48 mm) had a mass effect on the surrounding structures, namely the fron-

tal lobes anteriorly, the corpus callosum and frontal horns of the lateral ventricles. MR scan disclosed perilesional oedema in both frontal lobes. Clinical symptoms included impaired sense of smell, right eye visual defect, headache and personality change. In addition, pro-

Table 1 Pharmacological therapy administered before, during and after the embolization procedure.

THERAPY BEFORE TREATMENT		
→ For 5 days		
	Ticlopidine	250 mg × 2
	Aspirin	300 mg × 1
THERAPY DURING TREATMENT		
	Heparin	5000 UI
	Aspirin	500 mg
THERAPY AFTER TREATMENT		
→ For 2 days		
	Dalteparin	5000 UI × 1
	Ticlopidine	250 mg × 2
	Aspirin	300 mg × 1
→ For 28 days		
	Ticlopidine	250 mg × 2
	Aspirin	300 mg × 1
→ For 30 days		
	Ticlopidine	250 mg × 1
	Aspirin	300 mg × 1
→ For 30 days		
	Aspirin	300 mg × 1
→ For 30 days		
	Aspirin	100 mg × 1

longed compression of frontal cerebral tissue by aneurysms greater than 3.5 cm in diameter can lead to dementia¹¹. The aneurysm had to be resected not only to exclude the lesion from the circulation to avoid rupture resulting in cerebral bleeding, but also to resolve the mass effect. The difficulty in treating an aneurysm of this size surgically is the problem of identifying the neck and manipulating the aneurysm without causing rupture. For this reason, pre-operative embolization was carried out inserting GDC coils into the aneurysm to occlude the fundus and leave the proximal portion of the lesion patent to allow multiple surgical clips to be positioned for aneurysm occlusion. Aneu-

rysm resection was successful with no peri or postoperative complications. Subsequent progressive regrowth of the aneurysm with fissuration resulting in subarachnoid haemorrhage was probably caused by direct blood flow on the anterior communicating artery due to the asymmetry of the A1 segments and changes in the aneurysm wall. For this reason coil embolization procedures had proved ineffective and blood flow had to be diverted to reduce the blood supply to the coils and promote thrombosis within the aneurysm.

In addition to further coil embolization, it was decided to position a stent in the left anterior cerebral artery at the A1-A2 angle to cover the aneurysm neck. The use of stents in the treatment of intracranial aneurysms is an ongoing development. These devices are no longer used solely to prevent coil herniation from wide-necked aneurysms and boost endothelialisation of the neck itself, but also to divert blood flow and thereby reduce flow velocity in the aneurysmal sac. Balt recently developed the Leo+Baby nitinol intracranial stent with the same features as the Leo+ but with a mesh size of 0.9 mm dedicated to vessels with calibres between 1.5 and 3.1 mm. Such small arteries (minimum diameter 1.5 mm) can also accommodate flow-diverter stents¹²⁻¹⁴. However, we opted to use the Leo+Baby device for the following reasons:

1) The higher radial force of the Leo+Baby stent reduces the risk of stent stenosis resulting in artery thrombosis. In our patient, occlusion of the left A1, the main portion supplying the A2 segments, would have been dramatic. In addition, the stent's good radial force also allows optimum adherence of the stent mesh to the vessel wall and hence a greater flow-diverting effect.

2) The high curvature of the left anterior cerebral artery in the segment for stent deployment makes correct placement of flow-diverter stents difficult.

3) A coil microcatheter can be inserted in the aneurysm through the stent mesh for possible future embolization procedures.

4) The Leo+Baby stent can also divert blood flow, albeit to a lesser extent than flow-diverter devices.

5) The Leo+Baby stent is much less rigid than conventional intracranial devices thereby ensuring the least possible stress on the vessel wall.

The Leo+Baby stent was correctly deployed after additional coil embolization. A small re-

sidual aneurysm neck with marked contrast medium stagnation was disclosed at the end of the endovascular procedure. Antiplatelet and anticoagulant pharmacological therapy was administered before, during and after the embolization procedure (see Table 1). Two months after the last embolization and in the course of antiplatelet therapy, follow-up angiography disclosed a reduced vascularization of the aneurysm neck. Four months after suspension of antiplatelet therapy, cerebral angiography showed complete exclusion of the aneurysm from the circulation.

Conclusions

The Leo+Baby stent resolved the complex management of a giant intracranial aneurysm on the anterior communicating artery. No difficulty was encountered in device release despite the narrow curvature of the left anterior cerebral artery. Deployment of the new ministent through the same microcatheter used to release the coils made the interventional procedure simpler and faster. Last but not least, the Leo+Baby stent showed good flow-diverting capacity thereby promoting thrombosis within the aneurysm.

References

- Barrow DL, Alleyne C. Natural history of giant intracranial aneurysms and indications for intervention. *Clin Neurosurg.* 1995; 42: 214-244.
- Khurana VG, Piepgras DG, Whisnant JP. Ruptured giant intracranial aneurysms. Part I. A study of rebleeding. *J Neurosurg.* 1998; 88: 425-429.
- Gruber A, Killer M, Bavinszki G, et al. Clinical and angiographic results of endosaccular coiling treatment of giant e very large intracranial aneurysms: a 7-year, single-center experience. *Neurosurgery.* 1999; 45: 793-803.
- Ross IB, Weill A, Piotin M, et al. Endovascular treatment of distally located giant aneurysms. *Neurosurgery.* 2000; 47: 1147-1152.
- Leonardi M, Dall'Olio M, Cenni P, et al. Intracranial stenting in the treatment of wide-necked aneurysms. *Interv Neuroradiol.* 2007; 13 (1): 19-30.
- Leonardi M, Cirillo L, Toni F, et al. Treatment of intracranial aneurysms using flow-diverting silk stents (BALT): a single centre experience. *Interv Neuroradiol.* 2011; 17 (3): 306-315.
- Lylyk P, Miranda C, Ceratto R, et al. Curative endovascular reconstruction of cerebral aneurysms with the pipeline embolization device: the Buenos Aires experience. *Neurosurgery.* 2009; 64: 632-642.
- Szikora I, Berentei Z, Kulcsar Z, et al. Treatment of intracranial aneurysms by functional reconstruction of the parent artery: the Budapest experience with the pipeline embolization device. *Am J Neuroradiol.* 2010; 31: 1139-1147.
- Nelson PK, Lylyk P, Szikora I, et al. The pipeline embolization device for the intracranial treatment of aneurisms trial. *Am J Neuroradiol.* 2011; 32: 34-40.
- Cirillo L, Leonardi M, Dall'Olio M, et al. Complications in the treatment of intracranial aneurysms with silk stents: an analysis of 30 consecutive patients. *Interv Neuroradiol.* 2012; 18 (4): 413-425.
- Lownie SP, Drake CG, Peerless SJ, et al. Clinical presentation and management of giant anterior communicating artery region aneurysms. *J Neurosurg.* 2000; 92 (2): 267-277.
- Pistocchi S, Blanc R, Bartolini B, et al. Flow diverters at and beyond the level of the circle of Willis for the treatment of intracranial aneurysms. *Stroke.* 2012; 43: 1032-1038.
- Byrne JV, Beltechi R, Yarnold JA, et al. Early experience in the treatment of intra-cranial aneurysms by endovascular flow diversion: a multicentre prospective study. *PLoS One.* 2010; 5: e12492.
- Lubicz B, Collignon L, Raphaeli G, et al. Flow-diverter stent for the endovascular treatment of intracranial aneurysms: a prospective study in 29 patients with 34 aneurysms. *Stroke.* 2010; 41: 2247-2253.

C. Princiotta, MD
Department IRCCS Institute of Neurological Sciences
Bologna University
Neuroradiology Department Bellaria Hospital
Via Altura, 3
40139 Bologna, Italy
Tel.: 39/3387398092
E-mail: ciro.princiotta@gmail.com