Endovascular Coiling of Aneurysm Remnants after Clipping in Patients with Follow-up

A Single Center Experience

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Summary

The vast majority of intracranial aneurysms can be obliterated completely with surgical clipping. However, postoperative remnants occur in about 4 to 8% of patients who undergo postoperative angiography.

Endovascular embolization has been successfully performed in patients with postoperative aneurysm remnant and it may represent a therapeutic alternative to surgical reintervention.

Twelve aneurysm remnants after surgical clipping were treated with endovascular embolization using GDC. All aneurysms were located in the anterior circulation. Our experience confirms the feasibility and relative safety of this treatment strategy that may be considered a valid alternative to reintervention.

Introduction

The goal of treatment in patients harbouring cerebral aneurysm is complete and permanent obliteration of the lesion thus excluding the entire aneurysm from the arterial circulation. The vast majority of intracranial aneurysms can be obliterated completely with surgical clipping. However, postoperative remnants occur in about 4 to 8% of patients who undergo postoperative angiography¹⁻³. These remnants are associated with a persistent risk of rebleeding that may result in serious and even fatal consequences⁴⁻⁷.

Furthermore postsurgical aneurysmal remnants may grow over time and produce symptoms by compressing neighboring structures. Over the past ten years technological progress has led to the development of endovascular strategies to treat cerebral aneurysms efficaciously, most notably using Guglielmi electrolytically detachable platinum coils (GDC). Endovascular embolization has been successfully performed in patients with postoperative aneurysm remnant and it may represent a therapeutic alternative to surgical reintervention⁸⁻¹². The latter is often technically difficult and associated with an increased rate of complications and the patient may refuse it. We report the cumulative experience in our center using GDCs for the treatment of residual aneurysm after incomplete or unsuccessful clipping in patients with angiographic follow-up.

Material and Methods

We reviewed the clinical charts of 12 patients (nine women, three men, aged 28-80 yrs, mean age: 55.5 yrs) with aneurysm remnant after surgical clipping treated consecutively by endovascular coiling at Careggi Hospital between 1995 and June 2003. All patients were referred for endovascular treatment by experienced cerebrovascular neurosurgeons at our institution according to the following criteria: presence of aneurysm remnant on postoperative angiogram,

progressive enlargement of the remnant on serial angiograms, new episode of subarachnoid haemorrhage (SAH). All surgical clippings were performed at our center. Clinical outcome was assessed at the time of clinical discharge using the modified Rankin scale (mRS). Severity of SAH was defined according to Hunt and Hess scale (HH).

Technique

All procedures were performed under general anesthesia in a neuroangiography suite equipped with digital subtraction angiography (DSA) and road-mapping capabilities. A baseline activated clotting time (ACT) was obtained and the patient was anticoagulated with intravenous heparin (5000IU bolus + 3000 IU/h infusion). A 6F sheath was placed in one or both femoral arteries and a 6F guiding catheter was advanced into the internal carotid artery providing arterial supply to the aneurysm remnant. Under roadmapping a microcatheter was advanced over a microguide into the aneurysm remnant. If the aneurysm remnant showed a wide neck a balloon-assisted remodelling technique (RT) was used. GDCs were then advanced through the microcatheter and deployed until the aneurysm remnant was deemed satisfactorily occluded. Then all devices were removed, anticoagulation was allowed to spontaneously reverse and femoral artery hemostasis was obtained with a vascular closure device. After an immediate postprocedural CT scan the patients were awakened and then admitted to neuro-intensive care for 24 to 48 hours unless they were recovering from a recent SAH.

Results

Twelve aneurysm remnants after surgical clipping were treated with endovascular embolization using GDC. A summary of clinical and radiological information is provided in tables I and II. All patients had initially presented with SAH: four patients were HH grade 1-2, six patients HH grade 3 and two patients HH grade 4. Ten patients were operated on within 72 hours and two patients within one week from onset of SAH.

All aneurysms were located in the anterior circulation: seven anterior communicating artery (acoma), three posterior communicating artery (pcoma), one middle cerebral artery (mca)

bifurcation and one carotid-ophthalmic (co) artery. At the time of surgery the aneurysm size was <5 mm in two patients, >5 and <10 mm in four patients and >10 mm in six patients (range 4.0-21.0 mm and mean 11.0 mm). In ten patients the postsurgical outcome was good (mRS: 0-1), in two patients it was complicated by permanent neurological deficit (mRS = 3 and 4 respectively).

The reason for referral for endovascular treatment was the presence of a residual aneurysm on routine postoperative angiograms in nine patients and recurrent SAH (1 HH5 and 2 HH3 grade) in three patients after eight, ten and 22 years respectively. Coiling was complete in nine patients and incomplete in one patient (neck remnant).

In two patients with a remnant of the anterior communicating artery embolization failed due to microcatheter instability in one and coil instability with onset of flow stagnation in the distal anterior cerebral artery before coil detachment in the other one harbouring contralateral A1 tract agenesis that prompted its retrieval. The latter patient was then successfully operated on. The other one refused the surgical reintervention and had an unchanged aneurysm remnant at four years angiographic follow-up. No ischemic complications occurred during or immediately after endovascular treatment. Perforation of a leptomeningeal vessel with the microguide during placement of the microballoon occurred in one patient treated with a RT.

The perforation resulted in a parenchymal haematoma and pseudoaneurysm surgically repaired. Follow-up angiography was obtained immediately after the procedure in all patients and at later times in seven patients (range 1-4 yrs) and demonstrated the stability of the aneurysm occlusion in all. Eight patients left the hospital without any functional impairment (mRS 0-1). Two patients had a slight or moderate disability (mRS:2-3) at the time of discharge and the patient with the haemorrhagic complication had a severe disability (mRS:4). One patient died in the hospital secondary to the effect of the SAH (mRS:6). Clinical follow-up after hospital discharge was available in all but one patient with a mean follow-up time of 22 months (range 3mo-4yrs). No cases of SAH or symptomatic aneurysmal regrowth were noted after endovascular treatment.

Figure 1 Consecutive angiographic examinations in a patient with multiple aneurysms and recurrent subarachnoid bleedings. A left internal unsubtracted carotidogram obtained in 1972 after an episode of acute SAH showed a ruptured aneurysm of the left mca bifurcation that was successfully operated on. Fourteen years later the patient experienced a subarachnoid rebleeding and a repeated angiography demonstrated two "de novo" aneurysms of the anterior communicating artery (B) and the right mca bifurcation (not shown) respectively. Both aneurysms were successfully operated on (C). In 1996 the patient was readmitted in bad clinical conditions (HH5) after a recurrent subarachnoid bleeding and the subsequent digital subtraction angiography showed a regrowth of the acoma aneurysm (D) that was treated with coiling (GDC) in the same session (E). The patient died 15 days later from the consequences of the last subarachnoid haemorrhage.

Figure 2 Endovascular coiling of an anterior communicating aneurysm after incomplete clipping. Diagnostic DSA (right carotidogram) in a patient with acute SAH showed a lobulated aneurysm of the acoma (A) that was incompletely clipped (B). The postsurgical aneurysmal residue was successfully treated by endovascular coiling as demonstrated by intraoperative roadmapping (C-D) and one year angiographic follow-up (E).

Discussion

In a recent analysis of six published series with postoperative DSA residual aneurysmal remnants were observed in 5.2% of patients¹³⁻¹⁶. Intra-operative DSA may reveal an incorrect clipping in 34% of cases especially in large – giant aneurysms. Unsuccessful clipping occurs most frequently in deep midline aneurysms of the posterior circulation, anterior communicating artery and para-ophthalmic aneurysms (8.2% vs 0.6% of aneurysms in other localizations)¹⁷.

Other factors favouring an unsuccessful clipping are a large neck, a large-giant sac, suboptimal aneurysm exposure, a large infundibular collateral artery originating from the aneurysm neck, intraoperative bleeding and slipping of the clip¹⁸. The potential of these remnants to grow and bleed is documented although data regarding their natural history are lacking. On the basis of their experience, Drake et Al⁵ advocated treatment of residual aneurysms. Feuerberg et Al⁶ calculated a 0.79% yearly risk in a period ranging from four to 13 years. In our series 27% of patients with an aneurysm

Table 1 Summary of clinical features with Hunt and Hess grade at presentation, preoperative aneurysm location and size, and postoperative course for each patient

# Patient Age/sex	Presentation	Location	Size (mm)	Postop. Course (mRS)	Notes
# 1 53/F	HH3	Acoma	15	1	
# 2 55/M	HH1	Right Carotid-ophthalmic	21	0	Transitory left hemiparesis
# 3 70/F	HH3	MCA bifurcation	8	0	
# 4 52/F	HH2	Acoma	7	0	
# 5 47/M	HH3	Acoma	7	0	Right Pcoma + syphon bifurcation aneurysms previously operated
# 6 28/M	HH4	Acoma	7	3	Left aca cortical infarctions
# 7 63/F	HH4	Pcoma	13	1	Left temporal lobe haematoma and pseudoaneurysm surgically removed
# 8 48/F	HH2	Right Pcoma	14	4	Vasospasm Left hemiparesis
# 9 54/F	HH3	Acoma	4	1	
# 10 45/F	HH3	Acoma	14	1	Mirror MCA aneurysms previously operated
# 11 80/F	HH3	Left Pcoma	18	0	
# 12 72/F	HH2	Acoma	4	0	
F: female, M: male, HH: Hunt and Hess, Acoma: anterior communicating artery, Pcoma: posterior communicating artery, MCA: middle cerebral artery.					

remnant presented a rebleeding with a time lag ranging from eight to 22 years (mean 13.3 yrs).

In one patient rebleeding occurred on an aneurysm considered completely clipped on the postoperative DSA that showed regrowth and in the other two patients the late rebleeding could not be linked to any change in the known

aneurysm remnant. The risk of late rebleeding (0.79% yearly) seems to be related to the morphology of the remnant as well as its size and location (terminal vs lateral) with respect to the parent vessel and direction of flow⁶.

The options that can be offered to a patient with a postsurgical aneurysm remnant are the

Table 2 Schematic representation of causes for referral, remnant size, technique, outcome at discharge from hospital, degree and stability of occlusion (follow-up) for each patient

# Patient Age/sex	Referral	Remnant size (mm)	Technique	Outcome	Degree of occlusion	Stability (FU)
# 1 53/F	Routine postop DSA	4	GDC	idem	100%	Unchanged 12 months
# 2 55/M	Routine postop DSA	10	GDC+RT	idem	100%	Unchanged 12 months
# 3 70/F	Rebleeding HH2	6	GDC	idem	100%	Unchanged 12 months
# 4 52/F	Routine postop DSA	7	GDC	idem	100%	Unchanged 12 months
# 5 47/M	Routine postop DSA	3	failure	idem	//	surgery
# 6 28/M	Routine postop DSA	8	GDC	idem	100%	NA
# 7 63/F	Routine postop DSA	15	GDC+RT	Worsened mRS 3	100%	NA
# 8 48/F	Routine postop DSA	7	GDC	Improved mRS 3	100%	Unchanged 4 years
# 9 54/F	Routine postop DSA	7	failure	0	//	Unchanged 12 months
# 10 45/F	Aneurysm regrowth Rebleeding HH5	18	GDC	Worsened mRS 6	95%	NA
# 11 80/F	Rebleeding HH3	10	GDC	idem	100%	NA
# 12 72/F	Routine postop DSA	7	GDC	idem	100%	Unchanged 12 months

F: female, M: male, GDC: Guglielmi Detachable Coils, RT: Remodeling Technique, NA: Not Available.

following: wait and see, reoperation, and coiling. Sato et al¹ advocated the wait and see policy based on the fact that six out of 11 remnants spontaneously thrombosed on follow-up angiography. However their follow-up period is short and it is known that aneurysm remnants can bleed several years after treatment. Moreover long-term follow-up revealed the possibility of “de novo” aneurysms at the site of the previous clipping. The latter seem to be caused by local damage of the clip on the arterial wall with disruption of the elastica interna and muscularis¹⁹.

The possibility to reoperate is dependent on the cause of failure of initial treatment, the

time elapsed and the complexity of the lesion. Sindou et al³ recently proposed a classification of postsurgical aneurysm remnants and the author suggested reoperation only in grade III (residual lobe of a multilobulated aneurysm) and grades IV-V (residual sac). Reintervention on a failed clipping implies some difficulties related to the time lag from the first operation, the presence of multiple clips, the vessel anatomy in relation to the aneurysm size and location⁷.

Drake reported a 7% morbidity and a 5.2% mortality rate in their series of reoperation. Nowadays coiling offers an interesting alternative option if the aneurysm remnant is at least as deep as it is wide and 2 mm in diameter and

if there are no anatomical constraints (vessel tortuosity, parent artery originating from the aneurysm remnant). Several cases and small series were reported²⁰ since Fraser described the successful coiling of a postsurgical aneurysm remnant²¹. Although indications for the endovascular treatment of aneurysm remnants are not well established, several authors agree on the need to treat bleeding recurrences, aneurysm remnants that show changes in morphology or size on consecutive follow-up DSA, those associated with mass effect or showing residual lobes (grade III) or medium to large residual sac (grades IV-V). There are insufficient data regarding the risks and efficacy of endovascular treatment of small aneurysm remnants.

Our series is characterized by a prevalence of medium size (5-10 mm) and anterior communicating artery (58%) aneurysm remnants. In such cases coiling was difficult due to the presence of clips, the need to preserve parent vessel patency especially in patients with A1 agenesis and the vascular anatomy of the anterior communicating complex. These difficulties influenced the endovascular treatment that failed in two cases due to instability of the microcatheter and coils. In both cases the presence of a large neck remnant, the clip and in one case also the small remnant size (3 mm) caused the remnant to assume a morphology unfavourable to coil containment (inclined roof). If such is the case the risk of coil migration or protrusion into the parent artery may be prevented with the remodeling technique described by J Moret.

In our series this technique was successfully employed in two cases with complete obliteration of the aneurysm remnant. However, in one case perforation of a leptomeningeal vessel by the microguide of the balloon caused a left temporal lobe haematoma that needed surgical drainage. This was our only intraprocedural complication (8%) in our small series. One patient died 15 days after the endovascular intervention from complications related to the severe subarachnoid haemorrhage and clinical conditions on admission (HH5). Her history was characterized by at least two recurrent consecutive subarachnoid bleedings fourteen and ten years apart respectively from de novo aneurysms successfully operated on. As regards the percentage of successful remnant occlusion (83%), our experience is somewhat

in agreement with that of Rabistein et al²² although his mean remnant size (6.4 mm) was slightly different from ours (8.5 mm). Although in our series most aneurysm remnants were distally located (66%) ischemic complications still occurred.

This may be in part the result of strictly observed anticoagulation protocols with pre, and post procedural ACT gauging. In our experience endovascular coiling of aneurysm remnant resulted stable and in any case a rebleeding occurred. Given the high haemorrhagic risk of unrecognized aneurysm remnant or de novo aneurysms there is a growing need to submit patients operated on to a follow-up DSA similar to what is happening for patients undergoing endovascular treatment. As endovascular techniques continue to evolve they offer an alternative to the treatment of cerebral aneurysms and their indications have recently expanded. Combined surgical and endovascular approaches can nowadays be proposed for the treatment of complex aneurysms, the order of the intervention depending on the particular characteristics of each patient. This is true in cases of aneurysm remnant when not only can endovascular embolization complete the occlusion of a partial surgical treatment but surgery can also be performed after unsuccessful endovascular coiling.

Conclusions

Our experience with GDC coiling of postoperative aneurysm remnants confirms the feasibility and relative safety of this treatment strategy that may be considered a valid alternative to reintervention. We observed no complications directly related to the procedure and we were able to completely occlude the lesion in most cases.

Patients had an excellent clinical outcome except those with complications from surgery or subarachnoid haemorrhage. Although these initial results are promising, reliable evaluation of efficacy will require a much longer follow-up because it is well known that rebleeding from a remnant may occur many years after treatment and that the recurrence rate after endovascular coiling may not be so low. Endovascular coiling should be regarded as a valid adjunctive tool for aneurysm remnants after incomplete surgical treatment.

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