

# Endovascular Treatment of Recurrent Coiled Aneurysms: Assessment of Complications and Rebleeding during a Decade in a Single Center

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## Summary

Recurrence is the main drawback of aneurysmal coiling. Additional coiling must sometimes be considered in patients with reopened aneurysms and expose the patient to the risk of a new procedure. Our purpose was to assess the procedural complications of additional endovascular treatments in patients with previously coiled but recurrent aneurysms treated by two neurointerventionalists during a decade in a single center.

Between 1999 and 2009, 637 intracranial aneurysms were coiled and had a clinical and angiographic follow-up at our institution. Following the first embolization, 44 aneurysms were retreated with coils and 11 were retreated a second time. Retreatment was decided when a recurrence showed at angiographic follow-up. Early retreatments, performed in the first month after an incomplete or failed initial coiling, were excluded.

We retrospectively analysed the procedural complications, rebleeding, clinical and angiographic outcomes of the retreatments. No death or bleeding occurred in these 55 additional procedures. We had three periprocedural thromboembolic complications and the procedural permanent morbidity was 1.8%. Clinical and angiographic follow-ups ranged from six months to nine years (mean: 37 months, median: 36 months). Thirty-seven of the 44 retreated aneurysms (84%) showed a stable occlusion at follow-up. Seven showed a recurrence but were not retreated due to the stability of the packing.

No rebleeding was observed during the follow-up period. Our results show that endovascular treatment of recurrent aneurysms is associated with a low procedural risk.

## Introduction

Embolization has proven to be a safe and efficient treatment for intracranial aneurysms<sup>1-3</sup>, although recurrence remains a major concern of the endovascular treatment compared to clipping<sup>4-11</sup>. Recurrence may expose patients to bleeding or re-bleeding<sup>12</sup> and an additional procedure should be considered.

For this study, we retrospectively reviewed the retreatment cases done over the last ten years at our institution. We collected the procedure-related complications as well as recorded bleeding(s) or rebleeding(s) after retreatment.

## Material and Methods

### *Patients and Aneurysm Characteristics in the Studied Population*

Between July 1999 and June 2009, 760 patients bearing 840 aneurysms were admitted for endovascular treatment at our institution (330 aneurysms from 1999 to 2004 and 510 from 2005 to 2009). Mycotic, dissecting and inflammatory aneurysms were excluded from the study.

One hundred and six patients were lost at follow-up and 92 patients died from their initial haemorrhage. 562 patients (637 treated aneurysms) had a clinical and angiographic follow-up. Of the 637 aneurysms, 248 were treated between 1999 and 2004 (39%) and 389 between 2004 and 2009 (61%). Three hundred and sixty-five patients were women (65%) and 197 were men (35%); 64.5% (411) of the lesions were ruptured, 34.5% (219) were unruptured. In seven cases (1%), there was a doubt as to whether there was an initial haemorrhage.

Aneurysms were located as follows: 195 on the anterior communicating artery (30.6%), 226 (35.5%) on the internal carotid and among them 91 (14.4%) were at the origin of the posterior communicating artery, 131 on the middle cerebral artery (20.5%), 24 (3.8%) on the anterior cerebral artery, 61 (9.6%) on the posterior circulation (vertebral – 5, basilar trunk – 30, postero-inferior cerebellar – 18, posterior cerebral – 5, cerebellars other than PICA – 3).

16 (2.5%) were giant aneurysms, 125 (19.6%) had a diameter equal to or greater than 10 mm and 496 (77.9%) were smaller than 10 mm.

After coiling, occlusion of the aneurysms was classified according to the Roy et al. scale<sup>13</sup>. Post-treatment results showed a complete occlusion in 367 aneurysms and incomplete in 270 aneurysms (205 were classified as grade 2 and 65 as grade 3).

### Follow-up

The treated aneurysms were included in a routine follow-up program consisting of a medical consultation and angiography between the third and sixth months, between the 12<sup>th</sup> and the 18<sup>th</sup> month, and at five and ten years after the coiling procedure. If an aneurysm remnant or a change in treatment result was detected on any of the follow-up angiograms, additional angiograms were obtained at shorter intervals. Clinical and angiographic follow-up ranged from ten years to six months.

### *Patients and Recurrent Aneurysms Characteristics in the Retreated Population*

During the decade, 44 recurrent aneurysms (43 patients) were retreated once, and 11 of them required a third embolization session (total: 55 procedures). Subsequent treatments were performed if an anatomic change was

seen at angiography control. Aneurysms incompletely occluded after initial coiling and treated again the following month (7 procedures, 6 patients) were not considered as recurrent and were excluded from the study.

Recurrences occurred after initial simple coiling in 32 cases, and in 12 cases after coiling associated with adjunctive techniques: intracranial stent in two cases and remodelling balloon in ten cases. Of the 44 retreated recurrent aneurysms, eight were not ruptured (18%) and 36 (82%) had bled. Among the 43 patients, 23 (53.5%) were women and 20 (46.5%) were men. Age varied from 26 to 70 years; 35% (15) of the patients were smokers, 30% (13) had hypertension, and one patient had polycystic kidney disease. Four of the retreated aneurysms were giant (9%), 16 were large (36%) and 24 (54%) were less than 10 mm; 18 (41%) were located on the ACom, 16 (36%) were on the intracranial internal carotid and among them seven were located at the origin of the PCom, seven (16%) were on the MCA, three (7%) were located on the posterior circulation (1 on the intracranial vertebral artery, 1 on the basilar artery and 1 on the postero-inferior cerebellar artery).

The additional procedures consisted of coiling the remnants in 17 cases (31%). Coiling was associated with remodeling balloon in 24 cases (43.6%) and with stenting in 14 cases (25.4%).

Follow-up ranged from six months to nine years (mean: 37 months, median: 36 months). After retreatment, the patients entered the standard angiography follow-up program again. A treatment result was considered stable if two consecutive angiograms, within a minimum 12-month interval, were identical.

### Statistics

The factors predicting aneurysmal retreatment were assessed. Age ( $\geq 60$  vs  $< 60$ ), sex, aneurysm rupture, location of the aneurysm, and aneurysm size  $\geq 10$  mm were analyzed using the chi-squared test; p values  $< 0.05$  were considered to indicate a statistically significant difference.

### Results

#### *Patient and Recurrent Aneurysm Characteristics*

Over a period of ten years, 44 out of 637 aneurysms (6.9%) required a second or third endovascular procedure for late recurrence. Dur-

Table 1 Predictors of retreatment using the  $\mu^2$  test.

Variables		Patients (N°)	Retreated Patients (incidence%)	p value
Age	≥ 60 years	138	9 (6.5%)	p>0.9
	< 60 years	424	34 (8%)	
Sex	males	197	19 (9.6%)	p>0.5
	females	365	24 (6.6%)	
Variables		Aneurysms (N°)	Retreated aneurysms (incidence %)	p value
Initial presentation	Ruptured	411	36 (8.75%)	p<0.01
	Unruptured	219	8 (3.65%)	
Aneurysmal size	≥ 10 mm	141	21 (14.9%)	p<0.01
	< 10 mm	496	23 (4.6%)	
Aneurysmal location	AComA*	195	17 (8.7%)	p>0.3
	ICA*	226	17 (7.5%)	p>0.2
	MCA*	131	7 (5.5%)	p>0.2
	posterior circulation aneurysms*	61	3 (5%)	p>0.3

\* AComA: anterior communicating artery; ICA: internal carotid artery; MCA: middle cerebral artery; posterior circulation aneurysms: defined as posterior cerebral artery, vertebral artery, basilar artery, superior cerebellar artery, anterior inferior cerebellar artery, and posterior inferior cerebellar artery).

ing the first part of the study (1999-2004), 10% of the aneurysms (25) were retreated whereas 4.9% (19) were retreated between 2004 and 2009. The second treatment occurred between three and 99 months after the initial treatment (mean: 18.7 months). The delay between the second and third procedure ranged from nine to 62 months (mean: 26 months).

Retreatment was carried out in the ruptured aneurysmal group (9 %) more frequently than in the unruptured one (3.5%) ( $p<0.01$ ). Sex, age, and aneurysm locations of the aneurysm were not predictive factors of retreatment (Table 1). However, giant or large aneurysms were more often retreated than lesions smaller than 10 mm ( $p<0.01$ ).

#### Retreatment Indication

The decision to retreat was based on the modification of aneurysm occlusion at angiographic follow-up.

In 20 cases, the occlusion had moved from grade 1 to grade 2 or 3 of the Roy scale.

In 30, the remnant had changed from grade 2 to grade 3. In five cases with an initial grade 3, retreatment was performed for worsening of angiographic images. In no case was the retreatment consecutive to rebleeding.

#### Periprocedural Complications

No death or periprocedural bleeding occurred during the 55 retreatment procedures. We had three thromboembolic complications. The first patient presented with an ischemia (aphasia and hemiplegia) after the procedure. This patient, treated in 2004, progressively recovered over the following years and was assessed Modified Rankin grade 1 in 2010. The second patient presented with a post-procedural deficit which resolved on day 1. In the third case, thromboemboli occluded an anterior cerebral artery during the procedure. rtPA was injected *in situ* and the patient woke up with no neurologic deficit.

Until April 2003, the anticoagulation protocol consisted of an intravenous bolus of heparin (50 U/Kg) at the beginning of the procedure. The three thromboembolic complications occurred during this period. The other 41 lesions were retreated after April 2003 and, in addition to the IV bolus of heparin, patients received a daily dose of Clopidogrel (75 mg) and aspirin (75 mg) at least six days before the treatment. These patients continued to receive Clopidogrel and aspirin, two and six months after treatment.

We also have to report one technical complication. A coil was damaged and had to be

stretched and secured at the groin but there was no clinical consequence for the patient. Overall, the permanent morbidity rate related to the retreatment was 1.8%.

#### *Angiographic Results after Retreatment*

After retreatment of the 44 aneurysms (33 retreated once and 11 retreated a second time), post-embolization angiography showed complete occlusion in 25 cases, 19 aneurysms were classified in grade 2 of the Roy scale and 0 in grade 3.

#### *Outcome*

At follow-up, 37 lesions were stable and seven had moved from grade 1 to grade 2: four of them were followed up during more than 24 months and did not show any change; the three others were also stable but had a shorter follow up. There was no rebleeding during the follow-up period.

#### **Discussion**

At present, endovascular treatment with coils is associated with a low morbi-mortality rate and prescribed for most intracranial ruptured or unruptured intracranial aneurysms<sup>1,4,11,15-16</sup>. A randomized study comparing coiling to surgery in ruptured aneurysms demonstrated a better clinical outcome for the patients in the coiling arm<sup>2,17-18</sup>.

Even though unruptured aneurysm management is still debated, various studies have shown that the endovascular approach results in a lower morbi-mortality rate than surgery<sup>19-22</sup>. Nevertheless, coiling shows a higher recurrence and recanalization rate ranging from 4.5% to 33% in the literature<sup>4-11</sup>.

The natural history of remnants in aneurysms is often benign<sup>23</sup>, but the rebleeding rate is significantly higher for recurrent aneurysms than for stable aneurysms at angiographic follow-up<sup>2,12,15</sup>.

Post-coiling recurrences raise the problem of retreatment which can potentially reduce the risk of a new recanalization<sup>12</sup>. In our series, the retreatment was decided after a control angiogram showing either a major recurrence or an increase in the initial remnant aneurysm. To date, there are no objective criteria regarding the decision to retreat and Daugherty et al.<sup>24</sup>

recently showed substantial variability among experienced operators to indicate an aneurysmal retreatment for patients with angiographic recurrence after coiling. However, most authors propose to retreat remnants or recurrent aneurysms when the angiographic control shows a worsening<sup>1,7,15,25-26</sup>. Others have proposed, as the principal criteria, to retreat the recurrent aneurysms whose neck is not covered by coils greater than 2 mm<sup>27</sup>. Retreatment is also recommended for those aneurysms responsible for mass effect and recurrent clinical symptoms<sup>28</sup>. In general, symptom recurrence is associated with an angiographic recanalization.

Recently, Dorfer et al.<sup>29</sup> emphasized the importance of differentiating aneurysmal recurrence by compaction, whose treatment would be endovascular, and regrowth aneurysm, for which a surgical approach should be considered.

Our retreatment rate of 7.5% is comparable to the published results in the literature which range from 4.7% to 20.8%<sup>4-5,8,12,15,16,25,27,30,31,33</sup>.

Although the follow-up period was evidently shorter in the second period, the retreatment rate significantly decreased in the second part of our experience from 10.9% (27 aneurysms) to 5.6% (22 aneurysms). The learning curve and adjunctive techniques like remodeling balloons may have improved the results of the initial coiling as reported in the series of Ries et al. and Raymond et al.<sup>5,26</sup>.

The decision to retreat recurrences results from the comparison between the risk of conservative management and the risk of a new procedure. In our series, mortality was 0% and permanent morbidity was 1.8%. Except the series of Park et al.<sup>34</sup> reporting a morbidity of 10%, other series show a permanent complication rate of between 0% and 3%<sup>7,10,12,25,27,33,35-37</sup>. We did not observe any periprocedural bleeding in our series and we found only one case reported by Ries et al.<sup>27</sup> in the literature. Some authors explain that the coils deployed in the aneurysm sac<sup>12,33</sup> and the delay between the initial haemorrhage and the new treatment play a major role in reducing the periprocedural bleedings.

Our periprocedural complication rate is low and even lower than the rates usually reported during the initial treatment of ruptured aneurysms<sup>7,10,12,25,27,33,36-38</sup>. Our morbi-mortality also seems lower compared to the published results for asymptomatic aneurysms<sup>22</sup> – probably due to the fact we did not face periprocedural bleedings. It has to be noted that in our series 48% of

the retreated aneurysms were large aneurysms and the procedures were deemed difficult. The technical difficulty of retreatment procedures has also been described in the clipping of previously coiled aneurysms. In their publication on 43 recurrent previously coiled aneurysms, Waldron et al. (38) reported 43% of large and giant aneurysms and a permanent mortality and morbidity of 7% and 2%, respectively.

Complications in the endovascular retreatment of aneurysms are mostly thromboembolic<sup>7,10,12,25,27,33,36-37</sup>. In our study, thromboembolic complications were observed in the first part of our experience when the anticoagulation protocol only consisted of heparin. In the second part, no thromboembolic complication was noticed. Patients received aspirin and Clopidogrel. In the series of Park et al.<sup>34</sup>, thromboembolic complications were the cause of the 10% procedural morbidity but patients had received only heparin as in the first part of our study. If antiplatelets have not been statistically proven to be efficient in the treatment of ruptured aneurysms<sup>39</sup>, a double antiplatelet treatment may reduce the thromboembolic complications in the treatment of unruptured

aneurysms<sup>27,40</sup> and may be recommended during endovascular retreatments when the perioperative risk of thromboembolic complications is high.

Our study has some limitations: it is a monocentric and retrospective study with a high percentage (16%) of loss to follow-up. In addition there was no core laboratory for anatomic results evaluation.

## Conclusion

In our experience, the endovascular treatment of recurrent aneurysms has a low operating risk and allows a good occlusion of remnants in most cases. In our series, no bleeding was observed during the follow-up period. A longer follow-up on a larger scale is still necessary to confirm our conclusions.

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