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ORIGINAL RESEARCH

Procedural Morbidity and Mortality of Elective Coil Treatment of Unruptured Intracranial Aneurysms

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BACKGROUND AND PURPOSE: To report morbidity, mortality, and angiographic results of elective coiling of unruptured intracranial aneurysms.

METHODS: In a 10-year period, 176 unruptured aneurysms in 149 patients were electively treated with detachable coils. Seventy-nine aneurysms were additional to another ruptured aneurysm but were coiled more than 3 months after subarachnoid hemorrhage, 59 aneurysms were incidentally discovered, and 38 aneurysms presented with symptoms of mass effect. Mean size of the 176 unruptured aneurysms was 10.6 mm (median, 8 mm; range, 2–55 mm). One hundred thirteen aneurysms (64%) were small (<10 mm), 44 aneurysms (25%) were large (10–25 mm), and 19 aneurysms (11%) were giant (25–55 mm). Thirty wide-necked aneurysms (17%) were coiled with the aid of a supporting device.

RESULTS: Procedural mortality of coiling was 1.3% (2 of 149; 95% confidence interval [CI], 0.7–5.1%), and morbidity was 2.6% (4 of 149, 95% CI, 0.8–7.0%). The 4 patients with permanent morbidity were independent (GOS 4). Initial aneurysm occlusion was complete (100%) in 132 aneurysms, nearly complete (90%–98%) in 36 aneurysms, and incomplete (60%–85%) in 8 aneurysms. Six-month follow-up angiography was available in 132 patients with 154 coiled aneurysms (87.5%); partial reopening occurred in 25, mainly large and giant aneurysms (16.2%). Additional coiling was performed in 22 aneurysms and additional parent vessel occlusion in 1 aneurysm. There were no complications of additional treatments.

CONCLUSION: Elective coiling of unruptured intracranial aneurysms has low procedural mortality and morbidity. For the management of unruptured aneurysms, endovascular treatment should be considered.

Greater availability and improvement of neuroradiologic techniques have resulted in more frequent detection of unruptured aneurysms. Because prognosis of subarachnoid hemorrhage is still poor, preventive surgical or endovascular repair is increasingly considered as a therapeutic option. Management decisions require an accurate assessment of the risks of treatment options compared with the natural history of the aneurysm. The optimal management of unruptured intracranial aneurysms remains controversial[1-6] because of a lack of understanding of the natural history of intracranial aneurysms and the published results regarding procedural complications associated with neurosurgical and endovascular treatments. In this study, we report procedural complications of elective coiling of 176 consecutive unruptured aneurysms in 149 patients.

Patients and Methods

Patients and Aneurysms

Between January 1, 1995, and July 17, 2005, 906 aneurysms were selectively occluded with detachable coils. Of these 906 aneurysms, 687 had ruptured and 219 had not. Of the 219 unruptured aneurysms, 43 (in 42 patients) were treated in the same session as another recently ruptured aneurysm, and the remaining 176 aneurysms in 149 patients were treated electively. Of the 149 patients, 20 had more than 1 unruptured aneurysm coiled in a single session (17 patients with 2 unruptured aneurysms, 1 patient with 3 unruptured aneurysms, and 2 patients with 5 unruptured aneurysms).

Indication for coiling was assessed in a weekly joint meeting with neurosurgeons, neurologists, and neuroradiologists. In general, coiling was offered as a first treatment option in all large and giant aneurysms, all posterior circulation aneurysms, and all carotid artery aneurysms. Patients with aneurysms on the middle cerebral artery and anterior communicating artery were offered coiling when a defined neck was present.

The 149 patients with 176 electively coiled unruptured aneurysms are the subject of the present study. There were 132 women (88.6%) and 17 men (11.4%) with a mean age of 51.8 years (median, 52 years; range, 26–81 years). Forty-two patients (28%) were older than 60 years of age.

Of 176 aneurysms, 79 were additional to another ruptured aneurysm but were coiled more than 3 months after SAH. Fifty-nine aneurysms were incidentally discovered on imaging studies performed for clinical reasons unrelated to the presence of the aneurysm. Thirty-eight aneurysms presented with symptoms of mass effect: ophthalmoplegia, 18; visual disturbances, 6; brain stem compression, 4; hemiparesis, 3; frontal syndrome, 3; headache, 2; and trigeminal neuralgia, 2.

Fifty of 176 (28.4%) aneurysms were located in the posterior circulation: basilar tip, 31; posterior cerebral artery, 9; posterior inferior cerebellar artery, 5; and superior cerebellar artery, 5. One hundred twenty-six (71.6%) aneurysms were located in the anterior circulation: ophthalmic artery, 27; posterior communicating artery, 26; anterior communicating artery, 19; carotid tip, 17; middle cerebral artery, 12; cavernous sinus, 11; pericallosal artery, 6; carotid hypophyseal artery, 4; and anterior choroidal artery, 3.

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Characteristics of 6 patients with complications of coiling of unruptured aneurysms

Sex/Age (y)	Aneurysm Location and Size	Complication	Outcome at 6 Months
F/40	Left ophthalmic artery, 8 mm Left PcomA, 6 mm	Thrombo-embolic occlusion M2 branch	Apraxia right arm
F/43	Left choreoideal artery, 5 mm	Occlusion choreoideal artery	Discrete right hemiparesis
F/46	Left ophthalmic artery, 5 mm	Occlusion ophthalmic artery	Quadrant visual field deficit left eye
F/53	AcomA, 11 mm	Thrombo-embolic occlusion left A2, Heubner artery infarction	Paresis right leg
F/51	Basilar tip, 6 mm	Occlusion right posterior cerebral artery	Death
F/59	Basilar tip, 30 mm	Cerebellar hematoma by perforation of superior cerebellar artery branch by wire of supporting balloon	Death

Note:—PcomA indicates posterior communicating artery; AcomA, anterior communicating artery.

Mean size of the 176 unruptured aneurysms was 10.6 mm (median, 8 mm; range, 2–55 mm). One hundred thirteen aneurysms (64%) were small (<10 mm), 44 aneurysms (25%) were large (10–25 mm), and 19 aneurysms (11%) were giant (25–55 mm).

Coiling Procedure

Coiling of aneurysms was performed on a biplane angiographic unit (Integris BN 3000 Neuro, Philips Medical Systems, Best, the Netherlands) with the patient under general anesthesia and systemic heparinization. Heparin was continued intravenously or subcutaneously for 48 hours after the procedure, followed by low-dose oral aspirin for 3 months. Coiling was performed with Guglielmi Detachable Coils (GDC; Boston Scientific, Fremont, Calif) or TruFill DCS coils (Cordis, Miami Lakes, Fla). Some large aneurysms were coiled with very long mechanically detachable coils (Detach 18; Cook Inc, Copenhagen, Denmark). The aim of coiling was to pack the aneurysm as densely as possible, until not a single additional coil could be placed. Complications of coiling were recorded.

Initial angiographic results of coiling were classified as complete occlusion (100%), nearly complete occlusion (90%–100%), and incomplete occlusion (<90%).

Supporting Devices

Twenty-seven wide-necked aneurysms were coiled with a temporary supporting balloon (Sentry; Boston Scientific), 2 wide-necked aneurysms were coiled after placement of a permanent supporting device (TriSpan; Boston Scientific), and one wide-necked aneurysm was coiled after placement of a stent (Neuroform; Boston Scientific).

Clinical and Angiographic Follow-Up

Patients were scheduled for a follow-up visit in the outpatient clinic 6 weeks after coiling and for follow-up angiography after 6 months. On both occasions, neurologic status was evaluated. The effect of coiling on symptoms of mass effect was categorized as cured, improved, unchanged, or worsened. Results of follow-up angiography were classified in the same way as for initial angiographic results.

Results

Complications

Complications of coiling occurred in 6 patients, leading to death in 2 and permanent neurologic deficit in 4 (Table 1). Mortality of coiling was 1.3% (2 of 149; 95% confidence interval [CI], 0.7–5.1%) and morbidity was 2.6% (4 of 149; 95% CI, 0.8–7.0%). The 4 patients with permanent morbidity were independent (GOS 4).

Effect of Coiling on Symptoms of Mass Effect

Clinical follow-up was available in all 149 patients, including the 38 patients with aneurysms presenting with symptoms of mass effect. One of these 38 patients died immediately after coiling. Of the remaining 37 patients, the effect of coiling on symptoms of mass effect was as follows: cured, 13; improved, 14; unchanged, 7; and worsened, 3.

Angiographic Results, Follow-Up, and Additional Treatments

Initial aneurysm occlusion was complete (100%) in 132 aneurysms, nearly complete (90%–100%) in 36 aneurysms, and incomplete (<90%) in 8 aneurysms.

Six-month follow-up angiography was performed in 132 patients with 154 coiled aneurysms (87.5%). Follow-up angiography was not available in 17 patients with 22 coiled aneurysms. Seven patients with 11 aneurysms had died during the 6-month follow-up interval: 2 patients with 2 coiled aneurysms died of procedural complications of coiling; 2 patients with 2 coiled aneurysms died of pneumonia; 1 patient with 1 coiled aneurysm died of subarachnoid hemorrhage of another untreated aneurysm; 1 patient with 5 coiled aneurysms died of complications of surgery of an additional aneurysm; and 1 patient with 1 coiled aneurysm died of subarachnoid hemorrhage from the same aneurysm. Three patients with 4 coiled aneurysms refused follow-up angiography, and 7 patients with 7 coiled aneurysms are scheduled for follow-up angiography.

Partial reopening of the coiled aneurysm occurred in 25 of 154 aneurysms (16.2%) in 25 patients. Mean size of these reopened aneurysms was 22.6 mm (median, 20.5; range, 5–55 mm), and 16 of 25 (64%) reopened aneurysms were large or giant. Additional coiling was performed in 22 aneurysms and additional parent vessel occlusion in 1 aneurysm. Two partially reopened aneurysms were left untreated because the anatomy precluded additional coiling. There were no complications of additional treatments.

Discussion

We found that elective coiling of unruptured intracranial aneurysms is associated with low procedural morbidity and mortality in a large consecutive series of aneurysms with high proportions of large and giant size, location in the posterior circulation, and treatments with technically challenging neck supporting devices. The relatively high rate of 16% partial aneurysm reopening at 6-month follow-up requiring additional treatment is explained by the high proportion of large and giant aneurysms, because aneurysm size is the most important

predictor for coil compaction and aneurysm reopening over time.[7,8] Our results are in the same range as previously published reports on endovascular treatment; in a systematic review of 30 studies comprising 1397 unruptured aneurysms treated with detachable coils, mortality was 0.6% and morbidity was 7%.[9] Although direct comparison may not be valid because of differences in patient and aneurysm characteristics, procedural complications are also in the same range as for series of surgically treated unruptured aneurysms; in a 733-patient meta-analysis conducted by King et al,[10] mortality was 1.0% and morbidity was 4.1%. In a meta-analysis conducted by Raaymakers et al,[11] morbidity was 10.9% and mortality was 2.6% for surgically treated unruptured aneurysms in 2460 patients.

On the other hand, there is growing evidence that endovascular treatment carries lower risks than surgical treatment for unruptured aneurysms: in a direct comparison of surgical versus endovascular repair of unruptured aneurysms in 130 patients, Johnston et al[12] found that 25% of patients in the surgical group developed a change in Rankin Scale score of 2 or more versus 8% of endovascular patients. In another study,[13] 2069 patients were treated for unruptured aneurysms. Adverse outcomes were significantly more frequent in the 1699 patients treated with surgery (25%) than in the 317 patients treated with endovascular therapy (10%). Moreover, total length of hospital stay was longer and hospital charges were greater for surgical patients.

The natural history of unruptured intracranial aneurysms is still unclear and is influenced by many factors such as previous subarachnoid hemorrhage from another aneurysm, history of cigarette smoking, coexisting medical conditions, and aneurysm characteristics such as size, location, and morphology.[1,4,10,14] In the study by Wiebers et al,[1] 5-year cumulative rupture rates for patients who did not have a history of subarachnoid hemorrhage with aneurysms located in internal carotid artery, anterior communicating or anterior cerebral artery, or middle cerebral artery were 0%, 2.6%, 14.5%, and 40% for aneurysms less than 7 mm, 7–12 mm, 13–24 mm, and ≥25 mm, respectively, compared with rates of 2.5%, 14.5%, 18.4%, and 50%, respectively, for the same size categories involving posterior circulation and posterior communicating artery aneurysms. On the other hand, adverse outcomes after surgery or coiling of unruptured aneurysms were in the range of 25% and 10%, respectively.[1] These data have to be considered in balancing the risk of rupture against the risk of complications of elective treatment in patients presenting with unruptured aneurysms. In a study using life expectancy analysis based on International Study of Unruptured Intracranial Aneurysms data to determine the circumstances under which treatment of unruptured aneurysms might be beneficial,[15] life years are lost at all ages by treating incidental anterior circulation aneurysms smaller than 7 mm. For all other unruptured aneurysms, the number of life years saved by treatment is dependent on patient age at the time of treatment: 2–40 years are saved in patients aged 20 years, but benefits fall to zero in patients aged 45–70 years, depending on size and location of the aneurysm.

In our opinion, when treatment of an unruptured intracranial aneurysm is considered, coiling should be the first treatment option. When an aneurysm is unsuitable for coiling, surgical treatment may be considered as an alternative.

References

1. Wiebers DO, Whisnant JP, Huston J 3rd, et al. **International Study of Unruptured Intracranial Aneurysms Investigators. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment.** *Lancet* 2003;362:103–10
2. Anonymous. **Unruptured intracranial aneurysms–risk of rupture and risks of surgical intervention. International Study of Unruptured Intracranial Aneurysms Investigators** [published erratum appears in *N Engl J Med* 1999;340:744]. *N Engl J Med* 1998;339:1725–33
3. Morita A, Fujiwara S, Hashi K, et al. **Risk of rupture associated with intact cerebral aneurysms in the Japanese population: a systematic review of the literature from Japan.** *J Neurosurg* 2005;102:601–06
4. Juvela S. **Recommendations for the management of patients with unruptured intracranial aneurysms.** *Stroke* 2001;32:815
5. Tsutsumi K, Ueki K, Morita A, et al. **Risk of rupture from incidental cerebral aneurysms.** *J Neurosurg* 2000;93:550–53
6. Bederson J, Awad I, Wiebers D, et al. **Recommendations for the management of patients with unruptured intracranial aneurysms.** *Stroke* 2000;31:2742–50
7. Sluzewski M, van Rooij WJ, Rinkel GJ, et al. **Endovascular treatment of ruptured intracranial aneurysms with detachable coils: long term clinical and serial angiographic results.** *Radiology* 2003;227:720–24
8. Sluzewski M, van Rooij WJ, Slob MJ, et al. **Relation between aneurysm volume, packing, and compaction in 145 cerebral aneurysms treated with coils.** *Radiology* 2004;231:653–58
9. Lanterna LA, Tredici G, Dimitrov BD, et al. **Treatment of unruptured cerebral aneurysms by embolization with Guglielmi detachable coils: case-fatality, morbidity, and effectiveness in preventing bleeding–a systematic review of the literature.** *Neurosurgery* 2004;55:767–75
10. King JT, Berlin JA, Flamm ES. **Morbidity and mortality from elective surgery for asymptomatic, unruptured, intracranial aneurysms: a meta-analysis.** *J Neurosurg* 1994;81:837–42
11. Raaymakers T, Rinkel GJ, Limburg M, et al. **Mortality and morbidity of surgery for unruptured intracranial aneurysms.** *Stroke* 1998;29:1531–38
12. Johnston SC, Wilson C, Halbach V, et al. **Endovascular and surgical treatment of unruptured cerebral aneurysms: comparison of risks.** *Ann Neurol* 2000;4:11–19
13. Johnston SC, Zhao S, Dudley RA, et al. **Treatment of unruptured cerebral aneurysms in California.** *Stroke* 2001;32:597–605
14. Rinkel GJ, Djibuti M, van Gijn J. **Prevalence and risk of rupture of intracranial aneurysms: a systematic review.** *Stroke* 1998;29:251–56
15. Vindlacheruvu RR, Mendelow AD, Mitchell P. **Risk-benefit analysis of the treatment of unruptured intracranial aneurysms.** *J Neurol Neurosurg Psychiatry* 2005;76:234–39