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Coiling of Truly Incidental Intracranial Aneurysms

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BACKGROUND AND PURPOSE: The purpose of this study is to report the morbidity, mortality, and angiographic results of coiling of asymptomatic incidental aneurysms and compare the characteristics of these aneurysms with other asymptomatic incidental aneurysms that were not treated.

PATIENTS AND METHODS: During a 10-year period, 97 patients without previous subarachnoid hemorrhage, presented with incidentally found intracranial aneurysms. In 48 patients, 58 aneurysms were coiled. The mean size of the 58 coiled incidental aneurysms was 10.9 mm (median, 9 mm; range, 3–40 mm). Twenty-six of 58 coiled aneurysms (44.8%) were ≥10 mm.

RESULTS: Permanent morbidity of coiling was 2.1% (1 of 48), mortality was 0%. Compared with untreated patients with incidental aneurysms, coiled patients were younger and more often had multiple aneurysms. Aneurysms of coiled patients more often had a small neck, were more often located on the carotid artery, and were less often located on the middle cerebral artery. Of 46 aneurysms with angiographic follow up, 45 were completely or near completely occluded. To obtain these results, 3 aneurysms were coiled more than once. Coiled incidental aneurysms did not rupture during a median follow-up period of 28.5 months. Mean hospital stay per patient was 2.5 days.

CONCLUSION: Coiling of incidental intracranial aneurysms has a low complication rate in selected aneurysms and patients. Coiling should be the first treatment option in incidental aneurysms suitable for this technique.

The widespread use of imaging of the brain with CT scanning and MR imaging enhances the chance of discovering an intracranial aneurysm unrelated to the presenting symptoms of the patient. Bleeding from an intracranial aneurysm may have devastating consequences, but the chance of rupture of an incidentally discovered aneurysm is generally low and is mainly dependent on size and location. In making the decision whether to treat an unruptured aneurysm, many factors have to be considered: location, size, and morphology of the aneurysm, patient age and life expectancy, and the skills and experience of the treating physician.

Unruptured aneurysms can be classified as symptomatic (by mass effect) or asymptomatic. Most asymptomatic unruptured aneurysms are additional aneurysms discovered in the diagnostic work-up of another ruptured aneurysm. Truly incidental aneurysms form a specific subset of unruptured aneurysms with a lower chance of rupture than additional or symptomatic unruptured aneurysms.[1-3]

Most reports about endovascular treatment of unruptured aneurysms contain data about all 3 types of unruptured aneurysms.[4-7] In this study, we report our experience during 10 years with coiling of 58 incidental aneurysms in 48 patients and compare patient and aneurysm characteristics with 53 incidental aneurysms in 41 patients who were not treated during the same period.

Patients and Methods

General

Between January 1995 and April 2005, 97 patients presented with incidentally found aneurysms. All patients were discussed in a multi-disciplinary working group consisting of 2 neurosurgeons, 2 neurol-

ogists, and 2 neuroradiologists. Asymptomatic aneurysms, diagnosed on imaging studies performed for symptoms unrelated to the presence of the aneurysm in patients without a history of subarachnoid hemorrhage, were classified as incidental. Imaging studies included CT scanning, MR imaging, and angiography performed for a variety of symptoms: headache, transient ischemic attacks, carotid artery stenosis, seizures, multiple sclerosis, tinnitus, dizziness, collapse, meningeoma, memory disturbances, suspected metastases, etc. In patients with an incidental aneurysm diagnosed on CT or MR imaging and for whom treatment was considered, a complete angiogram was performed; in the past 4 years, this included a 3D rotational angiogram. After completion of the angiographic imaging, the possibility of and need for treatment were discussed in the working group and the consensus opinion was discussed with the patient in the outpatient clinic. In general, coiling was the first treatment option for all aneurysms in the posterior circulation and for aneurysms with a well-defined neck in the anterior circulation. Surgery was considered in aneurysms not suitable for coiling or endovascular parent vessel occlusion, generally wide-necked aneurysms in the anterior circulation.

The working group tried to balance the benefit and risk of treatment against the presumed annual risk of bleeding from the aneurysm. Multiple patient and aneurysm factors were taken into consideration: patient age, general medical condition, comorbidity and wish for treatment, aneurysm size, location, anatomy, and presence of intraluminal thrombus or calcifications.

Patients

Of the 97 patients presenting with an incidental aneurysm, 56 (57.1%) were treated, 48 with coil embolization, 7 with surgical clipping, and one with parent vessel balloon occlusion. The 48 patients with incidental aneurysms that were coiled are the subject of the present study.

There were 38 women and 10 men with a mean age of 53.6 years (median age, 52 years; range, 26–75 years). Of the 48 patients, 19 (39.6%) had multiple incidental aneurysms for a total of 85 aneurysms: 8 patients had 2 aneurysms, 8 patients had 3 aneurysms, 2 patients had 4 aneurysms, and one patient had 8 aneurysms. Of these

85 aneurysms in 48 patients, 66 were treated, 58 with coil emboliza-tion and 8 with surgical clipping: 8 patients had 2 treated incidental aneurysms, 2 patients had 3 treated aneurysms, and one patient had 7 treated aneurysms. In 6 patients, 2 incidental aneurysms were coiled in the same session, and in one patient 4 aneurysms were coiled in the same session.

The mean size of the 58 coiled incidental aneurysms was 10.9 mm (median, 9 mm; range, 3–40 mm). Twenty-six of 58 coiled aneurysms (44.8%) were ≥10 mm. Locations were the ophthalmic artery (15), basilar tip (14), posterior communicating artery (8), anterior com-municating artery (6), middle cerebral artery (5), carotid tip (4), pos-terior cerebral artery (2), posterior inferior cerebellar artery (2), su-perior cerebellar artery (one), and basilar trunk (one).

During the same period, 184 other unruptured aneurysms were treated by endovascular means in our hospital: 97 were additional to another ruptured aneurysm, and 87 presented with symptoms of mass effect. Thus, the proportion of incidental aneurysms was 24% (58 of 242) of endovascularly treated unruptured aneurysms.

Coiling Procedure

Coiling of aneurysms was performed with the patient under gen-eral anesthesia and systemic heparinization. Heparin was continued intravenously or subcutaneously for 48 hours after the procedure, followed by low-dose aspirin for 3 months orally. Coiling was per-formed with Guglielmi detachable coils (Boston Scientific, Fremont, Calif) or TruFill DCS coils (Cordis, Miami, Fla). Some large aneu-rysms were coiled with very long mechanically detachable coils (De-tach 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. Wide-necked aneurysms were coiled with a tem-porary supporting balloon (Sentry; Boston Scientific) or after place-ment of a permanent supporting device (TriSpan or Neuroform stent; Boston Scientific). Complications of coiling were recorded.

Initial angiographic results of coiling were classified as complete occlusion (98%–100%), near-complete occlusion (90%–98%), or in-complete occlusion (<90%).

Duration of Hospital Stay

Patients with incidental aneurysms scheduled for coiling or addi-tional coiling were admitted in the neurosurgical ward in the morn-ing, coiling was performed in the afternoon, and discharge was the next afternoon in uncomplicated procedures. Duration of hospital stay was recorded in all patients.

Follow-Up

Patients with coiled incidental aneurysms were scheduled for an outpatient clinic visit at 6 weeks and a follow-up angiogram after 6 months. Results of angiographic follow-up were classified in the same way as the initial postembolization occlusion. Incomplete occlusion at any point in time was considered an indication for further therapy, unless clinical or anatomic factors dictated otherwise. Results and consequences of angiographic follow-up were discussed in the work-ing group. During the meeting, decisions were made for the need for additional treatment or extended angiographic follow-up. Patients with aneurysms with complete or near-complete occlusion at 6-month follow-up angiography were generally discarded from further angiographic follow-up. When additional treatment was performed, the result was evaluated in the weekly meeting and 6-month fol-low-up angiogram after additional treatment was scheduled.

In April 2005, a telephone survey was done by one of us (A.d.G.) for all treated patients with an outpatient clinic visit more than 6 months earlier. Patients or their next of kin were asked about general health, hospital admissions, and episodic headaches that might be contributing to subarachnoid hemorrhage.

Untreated Patients

Of the 97 patients with incidental aneurysms, 41 were not treated. The main reasons for not treating the 41 patients included unfavor-able aneurysm anatomy (wide neck) in 29, patient refusal in 3, near-complete thrombosis in 2, small aneurysm size (5 mm) in 2, advanced patient age in 2, failed surgical clipping in one, location in the cavern-ous sinus in one, and one 65-year-old man with a 30-mm basilar trunk dissecting aneurysm discovered on MR imaging performed for transient ischemic attacks in the right carotid artery territory who died of subarachnoid hemorrhage shortly before scheduled treatment.

There were 23 women and 18 men, with a mean age of 60.6 years (median age, 63 years; range, 46–74 years). Of the 41 patients, 7 (17%) had multiple aneurysms, for a total of 53 aneurysms: 4 patients had 2 aneurysms and 3 patients had 3 aneurysms. The mean size of the aneurysms was 9.2 mm (median, 8 mm; range, 3–30 mm). The loca-tions of 53 aneurysms were the middle cerebral artery (15), anterior communicating artery (9), basilar tip (9), cavernous sinus (5), poste-rior communicating artery (4), ophthalmic artery (3), superior cere-bellar artery (2), carotid tip (2), posterior cerebral artery (one), basilar trunk (one), pericallosal artery (one), and vertebral artery (one).

Comparison of Treated and Untreated Patients

For patients with coiled versus untreated incidental aneu-rysms, the following patient and aneurysm characteristics were compared: mean patient age, mean aneurysm size, proportion of wide-necked aneurysms, proportion of patients with multiple inci-dental aneurysms, and proportion of aneurysms located on anterior cerebral artery, middle cerebral artery, carotid artery, and vertebro-basilar artery.

Statistical analysis was performed by using a t test for comparison of means and a χ^2 test for comparison of proportions (MedCalc sta-tistical software, Mariakerke, Belgium).

Results

Comparison of Treated and Untreated Patients

In the Table, the characteristics of 48 patients with 58 inci-dental aneurysms that were coiled and of 41 patients with 53 incidental aneurysms that were not treated are summarized. Mean age of 53.7 years of 48 coiled patients was significantly lower than mean age of 60.6 years in 41 untreated patients. Mean aneurysm size did not differ for both groups. Eight of 58 coiled aneurysms (13.8%) had a wide neck versus 29 of 53 (54.7%) untreated aneurysms. This difference was statistically significant. Of the 48 coiled patients, 19 had multiple inciden-tal aneurysms (39.6%) versus 7 of 41 untreated patients (17.1%). This difference was also statistically significant. An-eurysms located in the carotid artery were significantly more often coiled, whereas aneurysms located in the middle cerebral artery were—to a statistically significant degree—more often left untreated.

Characteristics of 48 patients with 58 incidental aneurysms that were coiled and of 41 patients with 53 incidental aneurysms that were not treated

	48 Patients with 58 Coiled Aneurysms	41 Patients with 53 Untreated Aneurysms	P Value
Mean age	53.6 y	60.6 y	.0006
	(median 52, range 26–75)	(median 63, range 46–74)	
Multiple aneurysms	19/48 (39.6%)	7/41 (17%)	.035
Mean aneurysm size	10.9 mm	9.2 mm	.461
	(median 9, range 3–40)	(median 8, range 3–30)	
Aneurysms with wide neck	8/58 (13.8%)	29/53 (54.7%)	<.0001
Location on carotid artery	27/58 (47%)	13/53 (25%)	.010
Location on middle cerebral artery	5/58 (9%)	15/53 (29%)	.014
Location on anterior cerebral artery	6/58 (10%)	10/53 (19%)	.309
Location on posterior circulation	20/58 (34%)	14/53 (27%)	.472

Complications

One thromboembolic complication leading to permanent right-sided apraxia occurred in a 40-year-old woman during coiling of an 8 mm left carotid ophthalmic and a 6-mm left posterior communicating artery aneurysm in the same session. All other treatments were without complication. Permanent morbidity rate was 2.1% (1 of 48; 95% confidence interval [CI] 0.01%–12.03%). There was no mortality of treatment (0%; 97.5% CI 0%–7.4%).

Duration of Hospital Stay

Hospitalization was 2 days for 57 coiling procedures in 47 patients and 5 days for the one patient who suffered a thromboembolic complication. Mean hospital stay per patient, including additional coil treatments, was 2.5 days.

Clinical Follow-Up

All 48 coiled patients had clinical follow-up of a median 28.5 months (mean, 35.1 months; range, 2–112 months), totaling 1688 months (140.6 patient-years). A 68-year-old man died of pneumonia 6 months after coiling of a basilar tip aneurysm. A 70-year-old woman had mild aphasia after clipping of an additional incidental 15-mm left middle cerebral artery aneurysm. All other patients were alive and neurologically intact at the time of follow-up, and there were no hospital admissions or episodes of headache that could be attributed to subarachnoid hemorrhage.

Angiographic Results

Of the 58 aneurysms treated in 48 patients, 6 wide-necked aneurysms were coiled with the aid of a temporary supporting balloon and one with the aid of a stent. One 14-mm basilar tip aneurysm was initially coiled with the aid of a TriSpan supporting device and 6 months later was additionally coiled after placement of a stent. Initial postembolization occlusion in 58 coiled aneurysms was complete occlusion in 49, near-complete occlusion in 6, and incomplete occlusion in 3 aneurysms. Two of the 3 incompletely occluded aneurysms were additionally coiled, one 16-mm basilar tip aneurysm was additionally coiled with the aid of a stent, and one 26-mm partially thrombosed basilar tip aneurysm was additionally coiled 5 times during a 3-year period. One 10-mm ophthalmic aneurysm that was 80% occluded remained stable on follow-up and was not additionally treated.

Follow-up angiography at 6 months was performed in 42 patients with 46 coiled aneurysms (6 patients with 12 coiled aneurysms are scheduled for follow-up). One initial completely occluded 30-mm basilar tip aneurysm showed reopening and was additionally coiled for 4 times during a 2-year period to obtain a stable, almost-complete occlusion.

Discussion

In this study we found that coiling of incidental aneurysms has a low complication rate in selected patients and aneurysms. Selection was biased toward younger patients and aneurysms with well-defined necks. Aneurysms located on the carotid artery were treated significantly more often, and aneurysms on the middle cerebral artery were more often not treated. This may reflect the difference in morphology of aneurysms located at these sites: carotid artery aneurysms are usually sidewall aneurysms, whereas most middle cerebral artery aneurysms are located at bi- or trifurcations of arteries. Moreover, if carotid artery aneurysms are wide-necked, coiling with balloon protection of the carotid artery is relatively straightforward, whereas balloon protection in the middle cerebral artery aneurysms is hazardous. In the present study, none of coiled aneurysms ruptured during a median follow-up period of 28.5 months, but longer follow-up is necessary to establish the efficacy of coiling of incidental aneurysms.

Although selection was biased toward suitability of aneurysms for coiling, almost half of the coiled incidental aneurysms were ≥10 mm and in 9 procedures coiling was possible only with assistance of balloon protection of the parent artery or placement of a stent or TriSpan device. Despite these more challenging treatments, the complication rate was low.

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.[1-3,8-11] In the International Study of Unruptured Intracranial Aneurysms (ISUIA),[1] 5-year cumulative rupture rates for patients who did not have a history of subarachnoid hemorrhage with aneurysms located in the internal carotid artery, anterior communicating artery, anterior cerebral artery, and middle cerebral artery were 0%, 2.6%, 14.5%, and 40% for aneurysms <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 aneu-

rysms. On the other hand, adverse outcomes after surgery or coiling of unruptured aneurysms are in the range of 25% and 10%, respectively.[1,5,7] 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 ISUIA data to determine the circumstances under which treatment of unruptured aneurysms may be beneficial,[9] life years are lost at all ages by treating incidental anterior circulation aneurysms <7 mm. For all other unruptured aneurysms the number of life-years saved by treatment depends on patient age at the time of treatment: 2–40 years are saved in patients aged 20 years, but benefits fall to 0 in patients 45–70 years of age, depending on the size and location of the aneurysm.

Truly incidental aneurysms are considered to carry the lowest risk of rupture among unruptured aneurysms[1] and treatment of these aneurysms should therefore have the lowest possible risk of procedural complications. Endovascular coil treatment of unruptured aneurysms is generally associated with lower risks than surgical treatment.[2,4-7,12,13] Moreover, coiling of unruptured aneurysms is associated with significantly lower costs and shorter hospital stay.[5] Mean duration of hospital stay per patient was 2.5 days in our patients.

In our opinion, when treatment of an incidentally found 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. Long-term efficacy in preventing rupture of coiling of incidental aneurysms is not yet established; longer follow-up studies are needed.

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