Microsurgical Clipping for Recurrent Aneurysms After Initial Endovascular Coil Embolization

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Key words
- Aneurysm recurrence
- Endovascular coiling
- Intracranial aneurysms
- Microsurgical clipping
- Neurosurgery

Abbreviations and Acronyms
Acom: Anterior communicating artery
CARAT: Cerebral Aneurysm Rerupture After Treatment
DSA: Digital subtraction angiography
ICA: Internal carotid artery
ICG-VA: Indocyanine green video angiography
ISAT: The International Subarachnoid Aneurysm Trial
OA-PICA: Occipital artery to posterior inferior cerebellar artery
PAO: Parent artery occlusion
Pcom: Posterior communicating artery
PICA: Posterior inferior cerebellar artery
SAH: Subarachnoid hemorrhage

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OBJECTIVE: **Surgical treatment for recurrent lesions of embolized aneurysms is difficult and challenging for many neurosurgeons because intra-aneurysmal coil masses are sometimes scarred to the wall of the aneurysm or adherent to adjacent vital structures. To assess the efficacy and safety of surgical treatment without coil removal for recurrent aneurysms after previous coil embolization, we retrospectively studied clinical results, angiographic results, and complications in patients treated with additional microsurgical clipping.**

METHODS: **From April 2003 to April 2013, 7 patients with recurrent previous embolized aneurysms underwent microsurgical treatment.**

RESULTS: **This series included 1 man and 6 women receiving endovascular coiling as the first-line treatment. One patient's aneurysm was unruptured, whereas the other 6 were ruptured. The aneurysm locations were posterior communicating ($n = 3$), anterior communicating ($n = 2$), ophthalmic ($n = 1$), and posterior inferior cerebellar ($n = 1$). The initial sizes ranged from 3–11.5 mm in diameter (mean, 6.6 mm), and the aspect ratios were 1.2 to 3.4 (mean, 1.9). In these aneurysms, the initial coiling result was complete occlusion in 5 patients, and neck remnants in 2 patients. The mechanism underlying aneurysm recurrence was coil compaction in 3 aneurysms, aneurysm regrowth in 3 aneurysms, and fundal migration in 1 aneurysm. The median recurrence latency was 28.8 months (range, 0.7–115 months). Microsurgical clippings without coil removal were used in 6 patients; a parent artery occlusion under bypass protection was done in 1 case with a posterior inferior cerebellar aneurysm. Fenestrated clips in combination with another type of clip were successfully used for 4 of 6 patients who were treated with direct neck clipping. No postoperative morbidity was observed, and postoperative imaging studies revealed complete occlusion of the aneurysms in all cases. There were no recurrences of aneurysms during the follow-up period (mean, 44.7 months; range, 0.5–118 months).**

CONCLUSIONS: **The microsurgical clipping without coil removal for recurrent lesions of embolized aneurysms is effective and safe when it is technically feasible. The tandem clipping in combination with a fenestrated clip is a crucial method for direct neck clipping without coil removal for previously coiled recurrent aneurysms. For unclippable lesions, a parent artery occlusion under bypass protection should be taken into consideration.**

INTRODUCTION

Endovascular treatment of intracranial aneurysms has been widely accepted as an established treatment for aneurysmal subarachnoid hemorrhage (SAH) (20, 24). Although the International Subarachnoid Aneurysm Trial (ISAT) data proved the initial clinical advantage of endovascular treatment of ruptured aneurysms, coil instability necessitating aneurysm retreatment remains a major shortcoming of endovascular treatment (23, 28). In patients in whom relevant aneurysm recurrences are documented on imaging follow-up, both endovascular and surgical techniques can be used.

To assess the efficacy and safety of surgical treatment for recurrent aneurysms after previous embolization, we retrospectively studied angiographic results, clinical results, and complications in patients treated with additional surgery.

METHODS

From April 2003 to April 2013, patients with recurrent aneurysms after initial endovascular coil embolization, who were treated at our institution were included in this study. During this period, 274 patients underwent endovascular treatment for intracranial aneurysms as the first-line treatment, including 105 patients with SAH and ruptured aneurysms (38.3%). Our retreatment indication for recurrent aneurysm after endovascular coil embolization is 1) residually more than 30% of the original aneurysm, 2) progressing neck remnants, 3) aneurysm

growth without coil compaction, and 4) outgrowth of a new daughter aneurysm. It was our policy to individualize treatment of recurrent aneurysms. When technically feasible, such as when recurrent aneurysms could be treated by simply adding coils in the previous cage or new cages could be made for additional coils, we attempted to treat endovascular aneurysm recurrences by additional coiling procedures. Among aneurysms not feasible for standard recoiling (e.g., aneurysms with a wide neck and remarkable space for applying clips) microsurgical clippings were selected. All operations were performed by a senior investigator (I.N.).

Clinical evaluations were performed at 1 and 6 months after treatment, and annually thereafter. Follow-up imaging study was, or will be, annually performed in all patients by 3-dimensional computed tomographic angiography.

The protocol was approved by the Ethics Committee of our institution, and written informed consent was obtained from all patients.

Surgical Technique

In patients with aneurysms in the posterior communicating artery (Pcom), anterior communicating artery (Acom), and ophthalmic segment of the internal carotid artery (Oph), microsurgical clipping was performed through the ipsilateral pterional approach. In the case with an ophthalmic aneurysm, ipsilateral proximal internal carotid artery (ICA) was prepared at the neck for proximal control. In the patient with vertebral artery-posterior inferior cerebellar artery (PICA) aneurysm, ipsilateral lateral suboccipital craniotomy was performed.

In all cases, except for a patient with a PICA aneurysm, direct neck clipping without intraaneurysmal coil removal was performed successfully. In the patient with a PICA aneurysm, direct clipping of the aneurysm was decided against due to the close proximity of the perforating artery to the medulla oblongata; therefore, an occipital artery to posterior inferior cerebellar artery (OA-PICA) bypass and a parent artery occlusion (PAO) was performed. Successful exclusion of the aneurysm and preservation of the branches was verified using intraoperative indocyanine green video angiography (ICG-VA) and/or intraoperative microvascular Doppler ultrasonography.

RESULTS

During the 10-year study period, 21 patients, or 7.7 % of the group, received endovascular treatment for cerebral aneurysms, and experienced relevant aneurysm recurrences. Eight of the 21 patients refused the treatment and were followed by imaging studies. Therefore, 13 patients required additional treatment. Six patients were treated with endovascular recoiling, and 7 patients were treated surgically. The surgical series included 1 man and 6 women. The mean age was 60.3 years (range, 45–68 years) (Tables 1 and 2).

The initial presentations were an SAH with Hunt and Kosnik grades I, III, and IV in each patient, grade III in 3 patients, and incidental finding in 1 patient. The aneurysm locations were Pcom (3 cases), Acom (2 cases), ophthalmic segment of ICA (1 case), and PICA (1 case). The initial sizes ranged from 3–11.5 mm in diameter (mean, 6.6 mm), maximum neck width ranged from 2.2–6.7 mm (mean, 4.5 mm), and aspect ratio was 1.2 to 3.4 (mean, 1.9). Four of 7 aneurysms had a neck width more than 4 mm. In these 7 aneurysms, the initial coiling was performed without adjunctive techniques (e.g., balloon-assisted coiling or stent-assisted coiling). The results of the initial coiling were complete occlusion in 5 patients and neck remnants in 2 patients. The mechanisms underlying aneurysm recurrence were coil compaction in 3 aneurysms, aneurysm regrowth in 3 aneurysms, and fundal migration in 1 aneurysm. The median recurrence latency was 28.8 months (range, 0.7–115 months). Regarding multiple intracranial aneurysms, case 4 had a left middle cerebral artery aneurysm, and case 6 had an Acom aneurysm. Direct neck clipping of the aneurysm without coil removal was achieved in 6 patients. One patient (case 6) was treated by a PAO under OA-PICA bypass protection. Fenestrated clips in combination with another type of clip were used for 4 of 6 patients who were treated with direct neck clipping.

The mean interval between coiling and surgery was 28.8 month (range, 21 days–115 months).

In all cases, except case 4, complete occlusion of the aneurysms was surgically achieved as proven by postoperative 3-dimensional computed tomographic angiography. Only in case 4 was the exclusion of the aneurysm confirmed by digital

Table 1. Patient Characteristics

Case No.	Age (year)	Sex	Initial Status	H and K Grade	Aneurysm Location	Maximum Width (mm)	Neck Width (mm)	Aspect Ratio	Result of Initial Embolization	Mode of Recurrence
1	45	M	SAH	2	Acom	7.4	4.3	1.2	Complete obliteration	Regrowth
2	68	F	SAH	3	Acom	11.5	6.7	3.4	Complete obliteration	Compaction
3	63	F	SAH	2	Pcom	3	3	2	Complete obliteration	Fundal migration
4	58	F	SAH	2	PICA	4.3	2.2	2	Slight neck remnant	Regrowth
5	62	F	Unruptured	0	Oph	4.3	4.8	1.6	Complete obliteration	Regrowth
6	65	F	SAH	1	Pcom	7.7	3.9	1.6	Complete obliteration	Compaction
7	61	F	SAH	4	Pcom	8	6.4	1.8	Slight neck remnant	Compaction

M, male; F, female; SAH, subarachnoid hemorrhage; H and K, Hunt and Kosnik; Acom, anterior communicating artery; Pcom, posterior communicating artery; PICA, posterior inferior cerebellar artery; Oph, ophthalmic artery.