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Original Article

Re-treatment of patients with embolized ruptured intracranial aneurysms

Yutaka KAI[1)] Junichiro HAMADA[2)] Motohiro MORIOKA[1)] Shigetoshi YANO[1)]
Takayuki KAWANO[1)] Yuki OHMORI[1)] Junichi KURATSU[1)]

1) Department of Neurosurgery, Graduate School of Medical Sciences, Kumamoto University
2) Department of Neurosurgery, Graduate School of Medical Sciences, Kanazawa University

●Abstract●

Objective: To establish a strategy for addressing recanalization of intracranial aneurysms previously embolized with Guglielmi detachable coils (GDC), efficacy and safety of additional treatments was evaluated.

Methods: A total of 168 patients with acute ruptured intracranial aneurysms were subjected to GDC embolization. Follow-up angiograms were obtained 6 months, and 1 and 2 years post-embolization. Patients with major recanalization that had not disappeared at 1 year after the first embolization underwent retreatment.

Results: Of the 168 patients, 18 (10.7%) underwent additional treatment, with 14 receiving a second coil embolization and 2 undergoing a total of 3 or more additional embolization procedures. One patient died after the 4th coil embolization. Both of the other 2 patients undergoing 3 or more embolization procedures required surgery, with it very difficult to achieve complete occlusion of the residual neck in one of them.

Conclusions: Additional treatment of previously coil-embolized aneurysms is safe. The strategy of retreating patients with angiographically confirmed major recanalization at 1-year follow-up is appropriate.

●Key Words●

aneurysm, embolization, retreatment

<Correspondence Address：1-1-1 Honjo, Kumamoto 860-8556 Japan　E-mail：ykai@kumamoto-u.ac.jp> (Recieved February 1, 2008：Accepted May 8, 2008)

Introduction

Placement of Guglielmi detachable coils (GDC) effectively prevents rebleeding after subarachnoid hemorrhage (SAH) due to aneurysmal rupture[3,18,26,32)], although some patients that undergo coil embolization develop aneurysm recanalization[19,20,25)] and require further treatment to prevent re-rupture. However, there is currently no established strategy to treat these patients[14,27,30,31,36)].

A total of 18 patients were found to have ruptured intracranial aneurysms that required additional treatment after the 1st coil embolization. Here the efficacy and safety of additional treatments is evaluated.

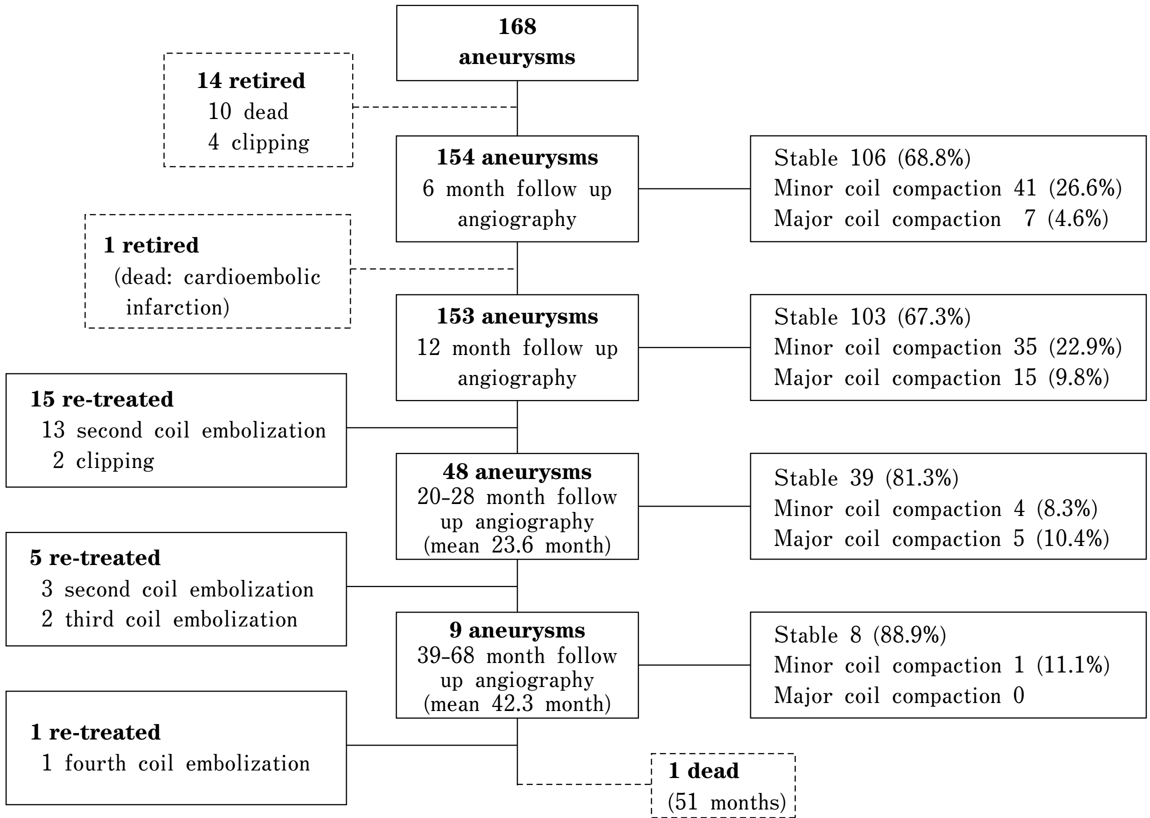
Materials and Methods

Between January 1997 and December 2006, 168 patients with ruptured intracranial aneurysms were treated by GDC embolization. There were 55 men and 113 women ranging in age from 24 to 86 years (mean 58.7 years). Locations of the 168 aneurysms were the basilar bifurcation (n=35, 20.8%), anterior communicating artery (Acom) bifurcation (n=26, 15.5%), middle cerebral artery (MCA) (n=9, 5.3%), posterior cerebral artery (PCA) (n=4, 2.4%), internal carotid artery (ICA) (n=65, 38.7%), vertebral artery-posterior inferior cerebellar artery (VA-PICA) bifurcation (n=19, 11.3%), and basilar artery-superior cerebellar artery (BA-SCA) bifurcation (n=10, 6.0%). Aneurysms at the basilar bifurcation, Acom, MCA, and PCA were categorized as terminal (n=74, 44.0%) based on the relationship between the parent artery and the aneurysmal protrusion. Aneurysms at the ICA, VA-PICA, and BA-SCA were categorized as side-wall aneurysms (n=94, 56.0%).

All patients underwent angiographic study to determine the size and neck of the aneurysm. Based on the largest diameter, 125 aneurysms (74.4%) were categorized as small (4-10mm) and 43 (25.6%) as large (11-25mm). There were no giant aneurysms (>25mm). Of the small aneurysms, 70 (56.0%) had a small neck (< 4 mm), and the neck was wide (< 4 mm) for the 55 others (44.0%). All 43 large aneurysms had a wide neck.

All 168 patients underwent endovascular surgery under general anesthesia. A Tracker 10 or Excel 14 microcatheter

Table 1 Algorithm for the embolization of ruptured aneurysms



with a two-tip marker (Boston Scientific/Target, Fremont, CA) was used for endovascular catheterization, and GDC-10 and GDC-18 for coil packing. Aneurysms were embolized by packing as densely as possible and embolization was stopped when angiograms confirmed complete aneurysm obliteration, i.e. when no more coils could be introduced into the sac, or when there was a danger of occluding the normal vascular branch.

Follow-up cerebral angiograms were obtained at 6 months, and at 1 and 2 years post-embolization. Minor recanalization was recorded when a residual neck was seen only on single-projection images, and major recanalization when there was contrast filling of the aneurysmal sac on several projections. Patients with major recanalization were retreated when compaction failed to disappear at the end of one year, or if minor recanalization progressed to major recanalization. The selection of additional coiling or direct clipping was made on a case-by-case basis, depending on the conditions of recanalization.

Results

Before 6-month follow-up, 10 patients had died of vasospasm or initial brain damage, with 4 others requiring additional surgery for the same aneurysm immediately after coil placement. Of the 154 patients that underwent follow-up angiographic study at 6 months, 106 (68.8%) were stable; 41 (26.6%) manifested minor and 7 (4.5%) major recanalization; 133 (86.4%) were in good condition; and 21 (13.6%) were moderately disabled, based on their Glasgow outcome scale (GOS).

Between 6 and 12-month follow-up, one patient died of cardioembolic cerebral infarction. Of the 153 patients alive at 12-month angiographic follow-up, 103 (67.3%) were stable, 35 (22.9%) manifested minor recanalization, and 15 (9.8%) major recanalization. Based on their GOS, 148 patients were in good condition and 5 were moderately disabled. Of the 7 aneurysms with major recanalization at 6-month follow-up, 5 continued to manifest major recanalization, the other 2 improved to minor recanalization. Among the 41 patients exhibiting minor coil recanalization at 6-month follow-up, 10 progressed to major recanalization. After 12-month follow-up, 15 patients underwent additional therapy for the same aneurysm, i.e. a second coil placement procedure was performed in 13 patients and 2 patients underwent clipping placement (**Fig. 1A-C, 2A-C; Table 1**).

Of 35 patients with minor and 15 with major recanalization

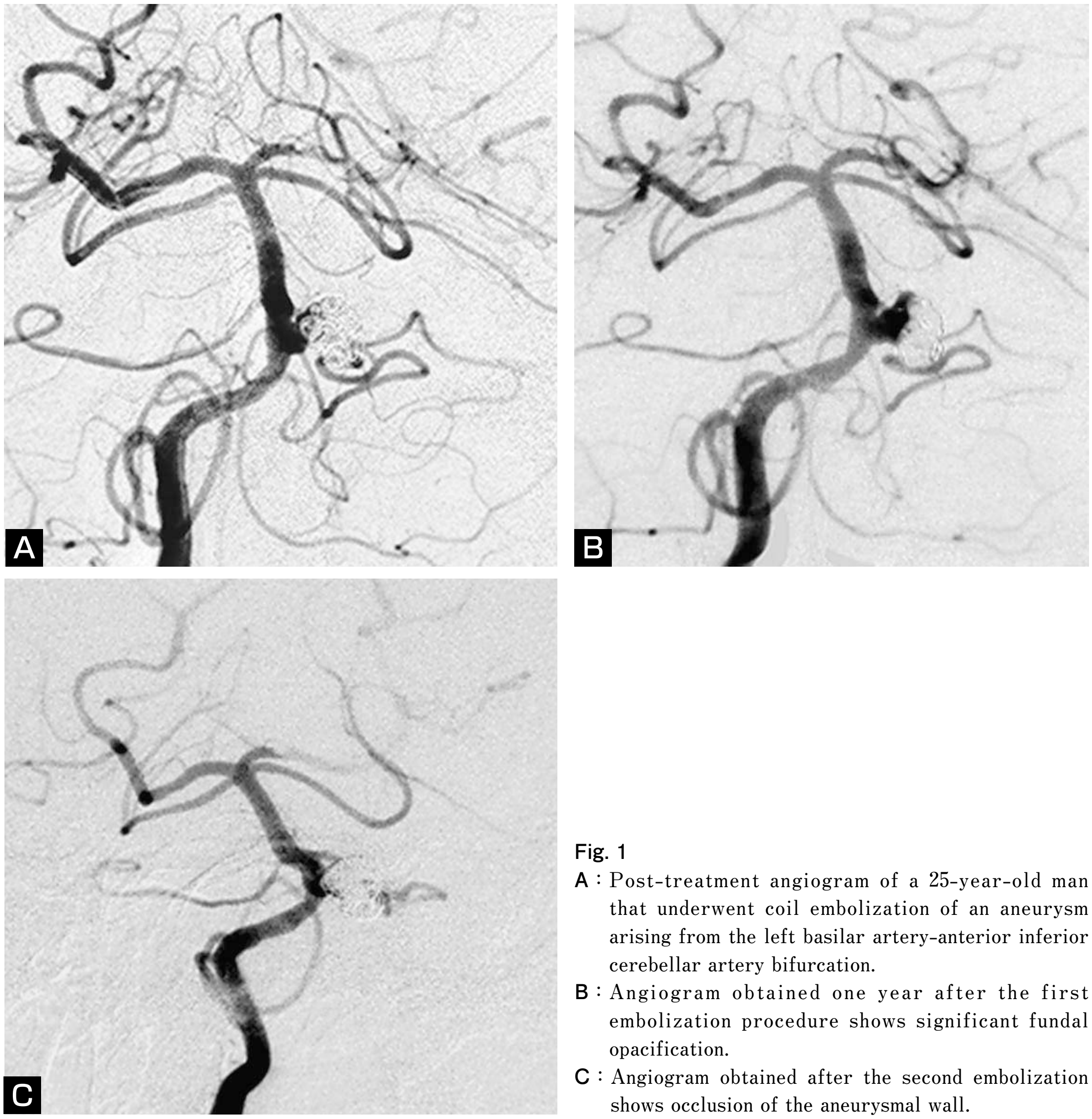


Fig. 1
A : Post-treatment angiogram of a 25-year-old man that underwent coil embolization of an aneurysm arising from the left basilar artery-anterior inferior cerebellar artery bifurcation.
B : Angiogram obtained one year after the first embolization procedure shows significant fundal opacification.
C : Angiogram obtained after the second embolization shows occlusion of the aneurysmal wall.

at 12-month follow-up, 48 underwent subsequent angiography at 20-28 months after the first embolization (median 23.6 months). The 2 patients subjected to aneurysmal clipping are not included in this data. Among the remaining 48 patients, 39 (81.3%) were stable, with 4 (8.3%) manifesting minor and 5 (10.4%) major recanalization. Three of the 35 aneurysms with minor recanalization at 12-month follow-up progressed to major recanalization and were addressed by a second coil placement procedure. Two of 13 aneurysms treated with a second coil placement procedure after 12-month follow-up failed to show improvement in their major recanalization at subsequent follow-up and were subjected to a third coil placement procedure.

At 39-68 months after the first embolization (median 42.3 months), we performed a fourth angiographic study in 4 patients with minor and 5 with major recanalization on 12-month follow-up angiograms. Only one aneurysm treated with 3 coil placement procedures persistently exhibited major recanalization and required a fourth coil placement procedure. This patient suffered rebleeding and died 51 months after the first coil embolization.

Of the 168 aneurysms in this series, 74 (44.0%) were terminal and 94 (56.0%) were of the side-wall type. Of the 18 patients that underwent additional treatment due to major recanalization, 13 had terminal and 5 had side-wall type aneurysms. Although the incidence of major recanalization was higher in patients with terminal type aneurysms, there was no statistically significant difference compared to patients with side-wall type aneurysms (p=0.62).

Four of the 18 aneurysms requiring additional treatment

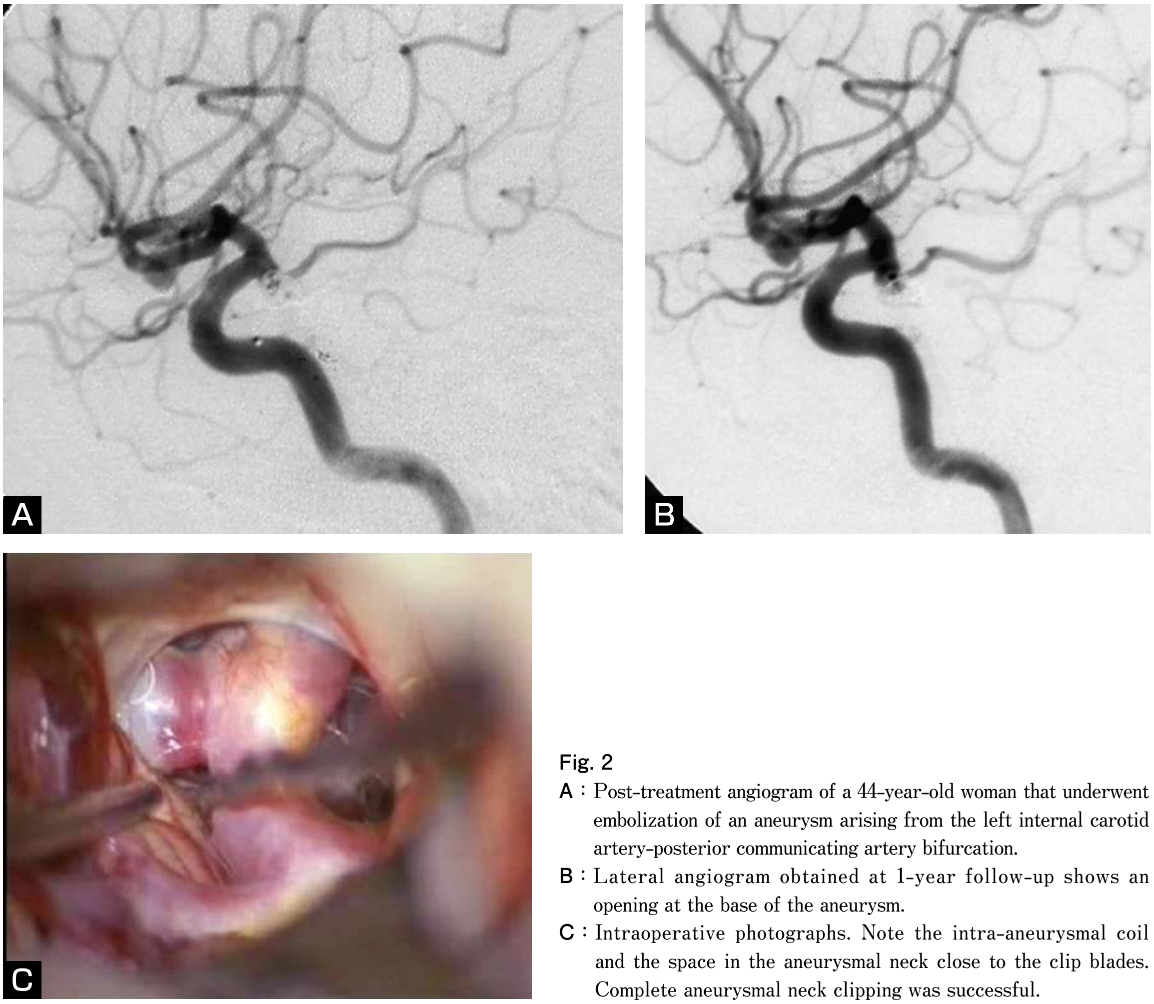


Fig. 2
A：Post-treatment angiogram of a 44-year-old woman that underwent embolization of an aneurysm arising from the left internal carotid artery-posterior communicating artery bifurcation.
B：Lateral angiogram obtained at 1-year follow-up shows an opening at the base of the aneurysm.
C：Intraoperative photographs. Note the intra-aneurysmal coil and the space in the aneurysmal neck close to the clip blades. Complete aneurysmal neck clipping was successful.

due to major recanalization were small aneurysms with a small neck, 5 were small aneurysms with a wide neck, and the other 9 were large aneurysms. With respect to major recanalization, there was a statically significant difference between small aneurysms with a small neck and large aneurysms ($p<0.05$).

Discussion

Although coil embolization effectively prevents rebleeding after SAH, it does not guard against aneurysmal recanalization, which reportedly occurred in 14–33% of aneurysms treated by coil embolization[23,26,29]. According to Hayakawa et al.[10], small aneurysms with a wide neck, plus large and giant aneurysms tend to recanalize after coil embolization. As patients with aneurysmal recanalization are at risk for delayed rupture, they may require further treatment[4,5,13,14,27,30,31,36] and must be followed with repeat angiographic studies. Kang et al.[14] recommended that even after angiographic confirmation of stable aneurysmal occlusion, patients should be re-examined after 12 months with conventional angiography[8]. In the current study, angiographic follow-up at 6 months post-embolization detected recurrence in 31% of cases and the number of patients that manifested major recanalization at 6-month follow-up increased at 12-month follow-up. Therefore, these findings suggest that patients should be followed for at least 24 months, even in the absence of angiographic evidence of aneurysmal recanalization after coil embolization.

Although repeat angiographic studies are not risk-free[6,8], they remain the standard follow-up technique. Magnetic resonance angiography (MRA) is a safe and non-invasive technique to monitor the status of coil-embolized aneurysms and may be superior to DSA for the visualization of voids in coil-embolized aneurysms[33,34]. However, as MRA cannot detect the coils per se, it cannot be used to judge whether an increase in the neck remnant is due to aneurysmal recanalization or regrowth.

In some instances it is difficult to determine whether coiling or clipping is the appropriate treatment for recanalized aneurysms[5,11,14,15,17,24,27,28,30,31,36]. Slob et al.[27] suggested that in embolized patients with recanalized aneurysms it may be reasonable to attempt re-embolization before resorting to surgery. Although recanalization may occur even after re-embolization, additional re-embolization procedures are minimally invasive and of low risk[1,7,9,14,21]. Coils available now are easily stabilized in the presence of a loosened coil meshwork. In patients with aneurysmal recanalization or regrowth, it may be necessary to produce a new coil frame, however we found that in some of our patients it was difficult to prepare a stable basket in the recanalized aneurysm because the recanalized lumen was small.

The treatment outcome varied in patients subjected to direct clipping after recanalization of their endovascularly coiled aneurysms[2,5,9,12,31]. In our experience, the successful clipping of embolized aneurysms requires that the height of the aneurysmal remnant be at least twice that of the neck. In addition, preservation of the parent vessel requires that the neck be of sufficient length. In many reported cases, coils adhered to the translucent membrane and were difficult to ligate. Furthermore, the configuration of the coil mass may be such that cutting unravels the coil mass rather than cutting individual coils[17].

The successful treatment of recurrent, previously coil-embolized aneurysms requires endovascular therapy that applies improved coils, stents, and balloon remodeling techniques. The development of a new generation of biologically active embolic devices is one means of improving the current anatomical outcome of GDC treatment[22]. Balloon-remodeling and stent-assisted coil embolization techniques have been applied to treat broad-based unruptured aneurysms and these methods were reportedly useful for addressing recurrent aneurysms[16,35].

Conclusion

Additional treatment of previously coiled aneurysms is safe and the strategy of retreating patients with major coil compaction that is seen to persist on 1-year follow-up angiograms is appropriate. Although it is difficult to achieve permanent obliteration with GDC in wide-necked aneurysms, repeat coil-embolization should be attempted before resorting to surgical treatment. However, surgery may be necessary in some patients to avoid development of parent vessel occlusion.

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