Follow-up of Large Aneurysms Treated with Coil Embolization at an Acute Stage in Patients with Poor-Grade Subarachnoid Hemorrhage

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Key words: coil embolization, coil compaction, large aneurysm, poor-grade, subarachnoid hemorrhage

Summary

This study evaluated the clinical and angiographic outcome of large aneurysms treated with coil embolization at an acute stage in patients with poor-grade subarachnoid hemorrhage (SAH).

Between July 1, 2001 and June 30, 2004, eight consecutive WFNS grade 5 patients with large aneurysms (15~23mm) were treated with endovascular coil embolization within two days and followed for at least 30 months. There were three middle cerebral and five internal carotid artery aneurysms. No patients were treated by craniotomy and none survived without treatment.

Two patients died of primary brain damage or cerebral vasospasm within one month. One patient died of pneumonia at 24 months. Four patients were alive with good recovery or moderate disability at the time of final follow-up (30~66 months). Angiography immediately after the procedure showed complete occlusion in three, neck remnant in four, and body filling in one patient. No complication was seen related to the procedure. Three aneurysms that were initially neck remnant developed body filling due to coil compaction. Two were re-treated with coils at six and 12 months and resulted in neck remnant. One patient refused re-treatment and died of re-bleeding.

Endovascular coil embolization can be selected at an acute stage for the treatment of aneurysms in patients with poor-grade SAH without intraparenchymal hematoma even if the aneurysm is large. Serial follow up by MRA/angiography is necessary for at least 12 months.

Introduction

It is well-known that patient age, size of aneurysm, severity of subarachnoid hemorrhage (SAH), and clinical condition are each independently and strongly associated with the outcome of patients with aneurysms treated using current open-microsurgical techniques and intensive care unit management^{9,11,13,15}. This study focused on poor-grade SAH patients with large aneurysms. Most neurosurgeons approved the management policy of Bailes et Al in poor-grade patients¹: when the neurological status has improved and intracranial pressure (ICP) is controlled after ventriculostomy, craniotomy and postoperative care can affect a favorable outcome in a significant percentage of cases. Ventriculostomy, however, sometimes induces re-rupture of the aneurysm^{3,6,10}. We sometimes delay early surgery when aneurysms are large or located in the posterior circulation to avoid technical difficulties and surgical complications due to brain swelling. Endovascular surgery can be applied for patients considered to have high-risk aneurysms in a poor condition with an unacceptable risk/benefit ratio for open surgery^{18,20}.

Figure 1 Angiography of eight large aneurysms in patients with severe SAH treated by coiling (numbers are as shown in Tables 1 and 2).

Since July 1, 2001, our policy for poor-grade SAH patients has been coil embolization at an acute stage when patients are not associated with intraparenchymal hematoma, even when the aneurysm is large. After obliterating the aneurysm, ventriculostomy is performed to control ICP, followed by aggressive treatment against vasospasm. Here we report the results and follow up of large aneurysms treated by coiling at an acute stage in patients with poor-grade SAH.

Materials and Methods

Patient population and management

Seventy-nine patients with subarachnoid hemorrhage were treated with aneurysm obliteration either by coiling or clipping at our medical center between July 1, 2001 and June 30, 2004. Our center has an advanced critical care center covering ten million people in the east Tokyo area, so many critical patients with poor-grade SAH are transferred to us. After neurological

examination and grading of the patients according to the WFNS (World Federation of Neurological Surgeons) scale², a central venous line was established. Nasotracheal intubation and artificial ventilation were established under sedation for respiratory dysfunction. Diagnosis of SAH and aneurysm was confirmed by CT scan and three-dimensional CT angiography. Our policy for poor-grade SAH patients is coil embolization in the acute stage when patients are not associated with intraparenchymal hematoma. After stabilization of vital signs, angiography is performed in those patients who were considered to be potential endovascular surgical candidates.

Basic management of postoperative patients is described briefly: intracranial hypertension was treated with cerebrospinal drainage and glycerol. Blood gas, serum electrolyte and glucose levels were determined and promptly corrected if abnormal. Hypoalbuminemia and anemia were corrected by human serum albumin and red blood cell transfusion. When systolic

Figure 2 Angiography preoperative (A), postoperative (B), 6 months (C), 12 months (D) and 3 years (E) after treatment in patient no.1. Contrast stains appeared near the neck 6 months after treatment (C), but the size did not change thereafter (neck remnant).

blood pressure was higher than 200 mm Hg, a calcium antagonist was administered. Nutritional support by parenteral feeding was initiated on the day after surgery. When patients could take nutrition via a feeding tube in the acute stage, an enteral nutrition was started⁸. Fasudil hydrochloride was administered routinely for 14 days after treatment and induced hypertension was indicated once signs of vasospasm were encountered.

Endovascular treatment

All procedures were performed with the patient under general anesthesia and without systemic heparin administration. All aneurysms were treated with Guglielmi detachable coils (GDCs) (Target Therapeutics, Boston, MA).

Evaluation of treatment and follow-up

Residual flow was categorized as neck remnant (flow at the neck or around the coil mesh that is continuous from the neck), body filling (flow in the coil mesh) and complete occlu-

sion^{14,21}. Follow-up MRA and angiography was generally scheduled three, nine, 15, 24, and 36 months, and six and 12 months after the first treatment, respectively. Plain x-ray films were also used to evaluate coil mass deformity. The clinical outcome was assessed using the Glasgow Outcome Scale (GOS) at three months and at the final clinical follow-up⁷.

Results

We consecutively experienced eight patients with a large aneurysm of 15 mm diameter or more and with poor-grade SAH treated by endovascular surgery between July 1, 2001 and June 30, 2004. No patients were treated by craniotomy and none survived without treatment. Table 1 shows the characteristics of the eight patients treated with coil embolization. They were aged between 55 and 84; all women; Glasgow coma scale (GCS) between 4 and 6; all WFNS grade 5; all Fisher group 3⁺; three middle cerebral and five internal carotid artery

Figure 3 Right middle cerebral artery aneurysm (A) was successfully treated by coil embolization (D) in patient no.7. Coil compaction was seen in angiography (B) and MRA (C) 6 months after treatment. Residual neck was coiled (E) and MRA showed no coil compaction 15 months after treatment (F).

aneurysms; aneurysm size between 15 and 23 mm. All patients received cerebrospinal drainage after endovascular surgery except for one (No. 4 in Tables 1 and 2). Figure 1 shows

the angiography of each aneurysm. Table 2 shows the treatment and follow-up of these patients. Two patients died of primary brain damage or cerebral vasospasm within one month.

Table 1 Eight patients with large aneurysms with severe subarachnoid hemorrhage treated by coiling.

No	Age	Sex	GCS	WFNS Grade	Fisher Group	Position	Size (mm)
1	58	F	4	5	3	Rt ICA	23 x 17
2	84	F	5	5	3	Lt MCA	20 x 14
3	69	F	4	5	3	Lt MCA	20 x 16
4	55	F	6	5	2	Lt ICA	20 x 18
5	73	F	4	5	3	Lt ICA	21 x 15
6	69	F	5	5	3	Lt ICA	15 x 11
7	56	F	5	5	3	Lt MCA	20 x 15
8	61	F	4	5	3	Rt ICA	22 x 15

ICA: internal carotid artery; MCA: middle cerebral artery

Figure 4 Left internal cerebral artery aneurysm (A) was successfully treated by coil embolization (B) in patient no.5. Coil compaction was seen 12 months after treatment and re-coiling was recommended and rejected (C). Enlargement of flow void was seen near the neck of aneurysm at 24 months (D) and the patient died of re-rupture of the aneurysm 36 months after treatment (E).

One patient died of pneumonia at 24 months. Four patients were alive with good recovery (GR) or moderate disability (MD) at the time of final follow-up.

Angiography immediately after the procedure showed complete occlusion in three, neck remnant in four, and body filling in one patient. No complication was seen related to the procedure, such as vessel occlusion, cerebral infarction or arterial dissection. Figure 2 shows patient no. 1. Contrast stains appeared near the neck six months after treatment (scored neck remnant), and did not change in size thereafter. Three aneurysms, initially neck remnant, developed to body filling due to coil compaction. Two were re-treated with coils at six and 12 months and resulted in neck remnant. Figure 3 demonstrates patient no. 7. Coil compaction was seen on angiography and MRA six months after treatment. Residual neck was coiled and no coil compaction was shown in MRA at 15 months after treatment. One patient refused re-treatment at 12 and 24 months and died of re-bleeding (Figure 4).

Discussion

In general, neurosurgeons delay open surgery in poor-grade patients with large aneurysm or aneurysm located in the posterior circulation to avoid technical difficulties and surgical complications due to brain swelling. There are, however, theoretical advantages to early occlusion for aneurysms in poor-grade patients. Re-bleeding is more frequent with a poor grade and larger aneurysm size^{9,11,13,15}.

The incidence of vasospasm is greater in poor-grade patients: optimum therapy is best performed after aneurysm occlusion. Early obliteration of ruptured aneurysms may provide poor-grade patients the most reasonable chance for a favorable outcome^{1,3,6,10}. Endovascular surgery can be applied for patients considered to have high-risk aneurysms in a poor condition with an unacceptable risk/benefit ratio for open surgery^{18,20}. Compared to open surgery, we do not need to hesitate about performing endovascular coil embolization in poor-grade patients with brain swelling.

Table 2 Treatment and follow-up of eight subarachnoid hemorrhage patients with large aneurysms treated by coiling in the acute stage.

No	First Coiling (Day)	Second Coiling	Outcome (3mon)	Follow-up	Final Occlusion
1	1 Complete	No Neck remnant	MD	MD (30mo)	Neck remnant
2	1 Neck remnant	No	SD	Dead (24mo, pneumonia)	
3	0 Body filling	No	Dead (primary brain damage)		
4	1 Complete	No	GR	GR (51mo)	Complete
5	1 Neck remnant	Rejected (12 and 24mo) Body filling	MD	Dead (36mo, re-bleeding)	
6	1 Neck remnant	Yes (12mo) Neck remnant	MD	MD (50mo)	Neck remnant
7	2 Neck remnant	Yes (6mo) Neck remnant	GR	GR (66mo)	Neck remnant
8	0 Complete	No	Dead (vasospasm)		

Initial occlusion of ruptured aneurysms was established and re-rupture was prevented without brain damage at an acute stage in all poor-grade patients in this study. No procedural complication was seen, such as vessel occlusion, cerebral infarction or arterial dissection. We could perform aggressive treatment against cerebral vasospasm, such as ICP control with ventricular drainage, hypertension, and hypervolemic therapy. We have had relatively better results using coil embolization at an acute stage for large aneurysm in patients with poor-grade SAH. Four of eight patients are living independently three years after onset. Compared to the current result, in our past review, for poor-grade patients with open-surgery at an associated hospital, only three out of 12 patients with WFNS grade 5 were independent⁸.

Angiography immediately after the procedure showed complete occlusion in three, neck remnant in four, and body filling in one patient. No complication was seen related to the procedure. Three aneurysms that were initially neck remnant developed body filling due to coil compaction. Two were re-treated with coils at six and 12 months and resulted in neck rem-

nant. One patient refused re-treatment at 12 and 24 months and died of re-bleeding. Risk factors for occurrence of late rebleeding were large aneurysm size, initial incomplete aneurysm occlusion, and incomplete occlusion at six-month follow-up angiography¹⁷. Serial angiographic follow-up is mandatory for timely detection of reopening of coiled aneurysms soon after acute management and additional therapy is required when the patient's condition is not poor.

The effectiveness and safety of coil embolization for small and medium-sized aneurysms was established. Its role in the treatment of large or giant aneurysms, however, is questioned because of frequent coil instability over time that results in re-opening of the aneurysm lumen^{5,16,19,20}. Long-term anatomical results for larger aneurysms showed no improvement over about ten years¹². It is well known that initial aneurysm occlusion and coil stability over time are poor, and that additional re-treatment is required in many patients. The treatment is more difficult to perform with wide-necked aneurysm, because of the risk of coil herniation and subsequent compromise of the parent ar-

tery. Future developments in endovascular treatments, such as new coils or embolization materials, balloon-assisted or stents-assisted techniques, may overcome some of these problems and improve clinical and angiographic results in patients with large aneurysms^{16,19}.

In conclusion, endovascular coil embolization can be selected at an acute stage for the treatment of aneurysms in patients with poor-

grade SAH without intraparenchymal hematoma, even the aneurysm is large. Serial follow-up by MRA/angiography is necessary for at least 12 months.

Acknowledgments

This work was supported in part by a grant-in-aid for scientific research (C) from the Japanese Ministry of Education, Culture, Sports, Science, and Technology (to H. K.).

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