The Role of GDC Embolization as a Second Choice in the Treatment of Ruptured Cerebral Aneurysm

Retrospective Analysis from Mid-Term Outcome

H. MANABE, S. HASEGAWA, A. TAKEMURA

Department of Neurosurgery, Kuroishi City Hospital; Japan

Key words: ruptured aneurysm, GDC, direct surgery, mid-term outcome

Summary

We investigated the role of GDC embolization as a second choice for the treatment of ruptured cerebral aneurysm.

From september 1997 to may 2001, 139 ruptured aneurysms out of 151 consecutive ruptured aneurysms transferred to our hospital were treated by clipping (first choice) or GDC embolization (second choice). Patient selection was decided by more than two neurosurgeons under the policy that GDC embolization is the second choice of treatment. The mid-term (longer than three months) outcome of both group was examined.

One hundred and nineteen Ans (BA two, IC-paraclinoid one, IC-PC or IC-Ach 36, IC-ant. Wall two, ACoA34, ACA six, MCA38) were treated by clipping (clipping group), 20 Ans (surgical difficulty; BA three, IC-paraclinoid three, VA dissection six, general complications; IC-PC two, IC-dissection one, ACoA four, VA-PICA one) by GDC embolization (GDC group) within 24 hours after admission. SAH grade and GOS of each group were Gr1: 35&4, Gr2: 41&5, Gr3: 23&5, Gr4: 11&4, Gr5: 9&2, respectively, and GR: 79&14, MD: 8&3, SD: 11&0, VS: 8&0, D: 13&3 respectively. Good prognosis (better than MD) was gained in 73% of clipping group and 85% of GDC group. No rebleeding was seen in GDC group.

GDC embolization for the cases with surgical difficulty or general complication raised the overall outcome. GDC embolization would be suitable for IC-paraclinoid Ans, BA-VA Ans, and ruptured VA dissections. Because of the good clinical outcome gained in the GDC group, GDC treatment would be the first choice of treatment for such aneurysms as geometrically suitable for coiling.

Introduction

Although GDC embolization has become one of the treatment options for ruptured cerebral aneurysms, the indications for this treatment vary in each institute, and are controversial¹. In early reports of GDC embolization, only limited cases such as operative difficulty, high risk for general anesthesia or advance age were treated by this method, but recent reports investigate the possibility that GDC embolization can be the first choice of treatment for cerebral aneurysms².

However, even the overall outcome in all cases of ruptured cerebral aneurysms treated by either GDC embolization or neck clipping under the policy that GDC embolization is the second choice of treatment has not been well described.

In this series, the role of GDC embolization

as a second choice of treatment for ruptured cerebral aneurysms was investigated from mid-term outcome of all cases treated in our hospital.

Material and Methods

Between september 1997 and march 2001, 151 consecutive patients suffering from aneurysmal SAH were admitted to our hospital. They were treated by either direct clipping (clipping group), GDC embolization (GDC group) or non-surgical conservative treatment. The patients' clinical grade before treatment and outcome at three months after treatment was rated using Hunt & Hess grading system and Glasgow outcome scale (GOS), respectively. Patients treated by GDC embolization were followed by angiography three to six months, one year and two years after the embolization in order to check the coil compaction.

Patient Selection

Patients were received emergent angiography as immediate as possible after arrival to our hospital. After morphological analysis of aneurysm on angiograms, the method of treatment of each patient was decided by following criteria;

- 1) surgical clipping was considered as first choice of treatment.
- 2) coil embolization was considered for patients of presumed more surgical difficulty than that involved in coil placement, of poor general condition for general anesthesia.
- 3) The "difficulty" of treatment was judged by two or three neurosurgeons on the Board of the Japanese Neurosurgical Society.

Surgical Clipping and GDC Embolization

Surgical clipping was performed under general anesthesia using propofol. After neck clipping, subarachnoid membrane was dissected as widely as possible and Liliquest membrane and lamina terminalis were also opened to remove the subarachnoid clot and irrigate subarachnoid space by pH 8.0 Hartmann solution containing 1mg/ml of methylpredonizolone sodium succinate.

GDC embolization was performed in the angiography suite under general anesthesia using

propofol, or under combined local anesthesia and modified neuroleptoanesthesia using intravenous diazepam and pentazosine in cases of high risk for general anesthesia. After introducing of guiding catheter, a microcatheter was passed through it and navigated to the aneurysm. In cases of saccular aneurysm, after several GDCs delivered through a microcatheter were put in the aneurysm dome to occlude an aneurysm bleb which was thought as a rupture point, systemic heparinization started.

More GDCs were packed in the aneurysm dome as densely as possible to occlude the aneurysm. In cases of dissecting aneurysm, GDC were packed in dissecting pseudoaneurysm together with its immediate proximal parent artery under systemic heparinization. Heparinization was discontinued 24 hours after the embolization.

After surgical or endovascular occlusion of the aneurysm, The thromboxane A2 synthetase inhibitor and calcium channel blocker (diltiazem) was given for two weeks after the bleeding. The intentional hypervolemia, hypertension and haemodilution therapy (tiple-H) started routinely from 24 hours after operation/embolization and was continued for two weeks.

Results

One hundred and nineteen patients (79%) were treated by neck clipping, 20 patients (13%) by GDC embolization, and 12 patients (8%) by non-surgical treatment.

Patient Profile (table 1) and Outcome of Clipping Group (table 2)

Age distribution was 42 to 88 years (mean: 60 years) with 12 patients older than 75 years.

Eighty-three patients were female. Thirty-five patients (29.4%) were classified as H-H Grade 1, 41 (34.5%) as Grade 2, 23 (19.3%) as Grade 3, 11 (9.2%) as Grade 4, and nine (7.6%) as Grade 5. Aneurysm was located on the anterior circulation in 117 patients, posterior circulation in two.

One hundred and nine aneurysms were classified as small (< 12 mm), eight as large (12 mm < 25 mm), and two as giant (> 25 mm).

All aneurysms but two were successfully occluded by neck clipping. Of the two cases, one case of ruptured aneurysm at bifurcation of the

left internal carotid and the anterior choroidal artery had a second SAH five days after operation in which intraoperative puncture of aneurysm dome after neck clipping had made the aneurysm collapsed and brought no bleeding. The angiograms taken immediately after the second SAH revealed the aneurysm dome, suggesting the clip had slipped out.

In another case of brister-like aneurysm on the right internal carotid artery occurring re-haemorrhage one hour after operation, emergency craniotomy revealed that the aneurysmal neck was torn by a clip, and trapping was eventually performed. Surgery-related complications were seen in six cases (5.5%): perforator occlusion in four; slipout of clip in two. Symptomatic vasospasm was seen in 22 patients (18.5%). Of them, eight patients recovered

completely from their symptoms with no evidence of infarction on CT scan, ten patients (7.5%) eventually became disabled and four (3.7%) died.

Overall outcome at three months after operation was evaluated by Glasgow Outcome Scale (table 2).

Seventy-nine patients (66.4%) were evaluated as Good recovery (GR), eight (6.7%) as moderately disabled state (MD), eleven (9.2%) as severely disabled state (SD), eight (6.7%) as vegetative state (VS), and thirteen as (10.9%) death (D). The poor outcome (poorer than SD) is mainly due to symptomatic vasospasm in 12 patients, initial damage in 13, surgery-unrelated complications in two (unexpected subdural bleeding and pneumonia), and operative complication in four.

Table 1 **Patient's profile**

	Clipping group	GDC group
<i>case number</i>	119	20
<i>age</i>	42-88 (60) year	36-88 (57.8) year
<i>male : female</i>	36 : 83	9 : 11
<i>preoperative grade Hunt & Hess</i>		
1	35 (29.4%)	4 (20%)
2	41 (34.5%)	5 (25%)
3	23 (19.3)	5 (25%)
4	11 (9.2%)	4 (20%)
5	9 (7.6%)	2 (10%)
<i>aneurysm size</i>		
small (< 12 mm)	109	9
large (12-25 mm)	8	4
giant (25 mm <)	2	0
dissection	0	7
<i>location of An anterior circulation</i>	117	10
IC-paraclinoid	1	3
IC-PC or IC-Ach or IC-bif.	36	2
IC-anterior wall	2	1 (dissection)
A Co	34	4
ACA distal	6	0
MCA	38	0
Basilar A	2	3
<i>Vertebral A</i>	0	6 (dissection)

*Patient Profile (table 1)
and Outcome of GDC Group (table 2)*

Twenty patients were treated by GDC embolization. Age distribution was 36 to 88 years (mean; 57.8 years) with three patients older than 75 years. Eleven patients were female. Four patients (20%) were evaluated as H-H grade 1, five (25%) as grade 2, five (25%) as grade 3, four (20%) as grade 4, and two (10%) as grade 5. Aneurysm location was the IC paraclinoid portion in three patients, the IC C1 portion in three, anterior communicating artery in four, basilar artery in three and vertebral artery in seven. Nine saccular aneurysms were measured as small (< 12 mm), four as large (12-25 mm), and seven aneurysms (six aneurysms on vertebral artery and one on the C1 portion) were dissecting pseudoaneurysm. Intraaneurysmal occlusion was performed in 14 cases, occlusion of dissecting site together with its proximal parent artery in six cases of ruptured dissecting pseudoaneurysm on vertebral artery.

All aneurysms could be cannulated to be occluded by GDC packing. Angiographical results were classified into three categories: "complete occlusion" indicating no opacification of aneurysm neck nor dome, "neck remnant" indicating filling of aneurysm neck but no filling of dome, "body filling" indicating filling of dome. Of 13 saccular aneurysms, the immediate results in seven aneurysms were evaluated as "complete occlusion", five as "neck remnant", and one as "body filling". Six vertebral dissecting pseudoaneurysms were occluded completely together with its proximal vertebral artery immediately after the embolization. A dissecting pseudoaneurysm on C1 portion was treated by GDC packing into aneurysmal pouch with keeping the patency of its parent carotid artery, resulting in angiographical complete obliteration of the pouch immediately after the embolization. Stent-assisted embolization technique was used in two saccular aneurysms (basilar trunk aneurysm and IC paraclinoid large aneurysm). Two procedure-related complications were observed in GDC group; aneurysm perforation in one case and occlusion of PICA in one.

As for the outcome at three months after the embolization, 14 patients (70%) were evaluated as GR, three (15%) as MD, and three patients died (15%). The causes of death in the three patients were acute renal failure in one,

pneumonia and DIC in one, and vasospasm in one. No rebleeding was seen two to 41 (mean; 17) months after embolization in cases of saccular aneurysm, and 17-44 (mean; 30) months in cases of dissecting aneurysm.

Follow-up angiography (three months to two years, mean; 9.6 months) was performed in seven saccular aneurysms and one dissecting pseudoaneurysm which were treated by intraaneurysmal embolization. The marked aneurysmal recanalization was detected in a case of dissecting pseudoaneurysm on IC and VA-PI-CA saccular aneurysm. The former was obliterated by combination of STA-MCA anastomosis and proximal IC coil occlusion ten months after the embolization, and the latter was treated by reembolization with GDC. The other six aneurysms showed no aneurysmal recanalization nor coil compaction.

Discussion

Although coil embolization has become a choice of treatment for ruptured cerebral aneurysms since clinical application of Guglielmi's detachable coils, the indication of this treatment varies in each institute¹. The goal of treatment of ruptured cerebral aneurysms is to avoid second rupture.

Although clip occlusion of cerebral aneurysms is an established treatment that hardly leaves risk of future rerupture, the long-term observation in cases treated by GDC embolization has not been investigated yet. The possibility of rerupture from partially embolized aneurysm has been reported³, and other reports suggested the smaller number of aneurysms than expected could be embolized completely⁴.

Moreover, not all aneurysms can be treated by GDC embolization for geometrical reasons^{1,2}. On the contrary, other reports stated that the rate of rerupture from GDC embolized aneurysm was 2.2% during 6-36 months follow-up period, and concluded that, even in those cases of incompletely occluded, GDC embolization improves the natural history of ruptured aneurysm⁵. Therefore, the general assessment of GDC embolization as a treatment of choice for ruptured aneurysm has not been established.

In this series, the outcome of GDC group is rather better than that of clipping group. The

good outcome (better than MD) was gained in 85% of the GDC group and 73% in the clipping group. Taking it into consideration that the cases treated by GDC embolization were of surgical difficulty or of high risk for general anesthesia or craniotomy, these cases would have ended in poorer outcome than actual outcome if treated by neck clipping. The low incidence of symptomatic vasospasm in GDC group would contributed the better outcome in GDC group than that in clipping group. As for the overall outcome of all cases treated by either GDC or neck clipping, the good outcome was gained in 75%, and death in 12%. This was rather better than that of reported cases treated by direct surgery, in which 68-72% of cases is rated as good outcome, and 12-27% of cases had died⁶⁻⁹. The GDC embolization raised the overall outcome in our series.

The location of aneurysm is a major factor which is considered in choosing the treatment method. In this series, several aneurysms of IC paraclinoid portion and basilar artery, and ruptured vertebral dissection were chosen for GDC embolization due to their surgical difficulty. Although the surgical difficulty during direct surgery for these aneurysms may be met in drilling of bony structure around the aneurysm, in dissection of perforator behind or adhered to aneurysmal dome, or in manipulation of aneurysmal dome at narrow or deep working space, it is not considered in GDC emboliza-

tion. GDC embolization would be suitable for IC paraclinoid aneurysm, basilar aneurysm and vertebral dissection because of the surgical difficulty.

The interest in long-term observation after GDC embolization for ruptured aneurysms is recanalization and rerupture. In this series, although two cases received a second treatment, no rerupture was seen in two to 44 months observation. To gain a complete occlusion is most important to avoid recanalization. It is well known that the aneurysm of high dome/neck ratio is likely to be occluded completely¹. Taking into consideration that the outcome in GDC group was rather better than that of the clipping group, GDC embolization could be the first choice of treatment for such aneurysms as have high dome/neck ratio.

Conclusions

When chosen as a second choice of treatment, GDC embolization was performed in 13% of ruptured aneurysms in this series. GDC embolization is suitable for IC-paraclinoid aneurysm, BA-VA aneurysms and ruptured vertebral dissection. GDC embolization for cases with surgical difficulty or poor general condition raised the overall outcome. GDC embolization could become the first choice of treatment for ruptured aneurysms which have a good shape for coiling.

Table 2 Results & outcome

		Clipping group	GDC group
Outcome (Glasgow scale)	GR	79 (66.4%)	14 (70%)
	MD	8 (6.7%)	3 (15%)
	SD	11 (9.2%)	0
	V	8 (6.7%)	0
	D	13 (10.9%)	3 (15%)
Main factors of poor outcome*	initial damage	14	0
	procedure-related	4	0
	vasospasm	12	1
	general complication	2	2
GR: good recovery, MD: moderately disabled, SD: severely disabled, V: vegetative state, D: dead * poorer than SD			

References

- 1 Debrun GM, Aletich VA et Al: Selection of cerebral aneurysms for treatment using Guglielmi Detachable Coils: the preliminary university of Illinois at Chicago experience. *Neurosurgery* 43: 1281-1297, 1998.
- 2 Raftopoulos C, Mathurin P et Al: Prospective analysis of aneurysm treatment in a series of 103 consecutive patients when endovascular embolization is considered the first option. *J Neurosurg* 93: 175-182, 2000.
- 3 Manabe H, Fujita S et Al: Rerupture of coil-embolized aneurysm during long-term observation. Case report. *J Neurosurg* 88: 1096-1098, 1998.
- 4 Brilstra EH, Rinkel GJE et Al: Treatment of intracranial aneurysms by embolization with coils. A systemic review. *Stroke* 30: 470-476, 1999.
- 5 Vinuela F, Duckwiler G et Al: Guglielmi detachable coil embolization of acute intracranial aneurysm: perioperative anatomical and clinical outcome in 403 patients. *J Neurosurg* 86: 475-482, 1997.
- 6 Kassell NF, Torner JC et Al: The international cooperative study on the timing of aneurysm surgery. Part 2: Surgical results. *J Neurosurg* 73: 37-47, 1990.
- 7 Seiler RW, Reulen HJ et Al: Outcome of aneurysmal subarachnoid haemorrhage in a hospital population: a prospective study including early operation, intravenous nimodipine and transcranial Doppler ultrasound. *Neurosurgery* 23: 598-604, 1988.
- 8 Findlay JM, Kassell NF et Al: A randomized trial of intraoperative, intracisternal tissue plasminogen activator for the prevention of vasospasm. *Neurosurgery* 37: 168-178, 1995.
- 9 Kassell NF, Haley EC et Al: Randomized double-blind, vehicle-controlled trial of tirilazad mesylate in patients with aneurysmal subarachnoid haemorrhage: a cooperative study in Europe, Australia and New Zealand. *J Neurosurg* 84: 221-228, 1996.

Hiroshi Manabe, M.D.
Department of Neurosurgery
Kuroishi City Hospital
1-70, Kitami-cho Kuroishi Aomori
036-0541, Japan
E-mail: irobee@infoaomori.ne.jp