Clinical Outcomes of Coil Embolization for Acutely Ruptured Aneurysm

Comparison with Results of Neck Clipping when Coil Embolization is Considered the First Option

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Summary

The purpose of this prospective study was to evaluate clinical results in patients with acutely ruptured cerebral aneurysm treated by neck clipping (NC) or coil embolization (CE) when CE was considered the first option. Between 1998 and 2003, 280 patients with acutely ruptured cerebral aneurysms excluding intracerebral hematoma were evaluated.

Patients were managed prospectively according to the following protocol: primary treatment modality was CE (n=179). NC (n=101) was selected for the patients with aneurysms that were small (less than 2 mm) or an unsuitable shape for CE. Surgical complication rates were 4.5% for CE and 16.8% for NC. Symptomatic vasospasm occurred in 8.4% of CE patients and 29% of NC patients. Good recovery on the Glasgow Outcome Scale was achieved by 71% of CE patients and 50% of NC patients at discharge. Surgical complications and symptomatic vasospasm were significantly reduced in CE compared to NC.

Clinical outcome at discharge was also better with CE. Although 18.3% of CE patients showed various degrees of aneurysmal recanalization and 7% of CE patients required additional treatment (re-CE or NC), aneurysmal rebleeding occurred in only one patient during follow-up (mean, 3.95 years).

Introduction

The ISAT study [1,2] indicated that endovascular coil embolization of ruptured cerebral aneurysm is superior to neck clipping (NC) as defined by the proportion of dead or disabled patients at one year in a carefully selected group of patients deemed suitable for either therapy. The present prospective study aimed to evaluate treatment results for NC and CE in acutely ruptured cerebral aneurysm when CE was set up as the first option in the therapeutic strategy.

Clinical Materials

From January 1998 to September 2003, a total of 342 patients with acutely ruptured cerebral aneurysm (less than 72 hours after symptom onset) were treated at Kurume university hospital. Of these, 62 patients underwent evacuation of intracerebral haematoma (ICH). These patients were treat with NC, but most displayed disturbance of consciousness and/or focal neurological deficit, and probable poor outcome. Patients with ICH were thus excluded from this study.

The remaining 280 patients were enrolled in this study. Patients were managed prospectively according to the following protocol. The primary treatment modality was CE. NC was se-

lected for the patients with the aneurysm, that was small (less than 2 mm) or had unsuitable shape for CE. The evaluation of the size and shpae of the aneurysms were performed with three dimensional digital subtraction angiography (DSA). All CEs were performed under general anesthesia and systemic heparinization subsequent to diagnostic angiography. NCs were also performed as soon as possible (usually within a few hours after angiographic diagnosis). All CEs were performed by the same operators (MH and TA), NC was performed by one of six operators, contrary. All patients were managed in the neurosurgical intensive care unit and underwent the same postoperative treatment.

Surgical complication rate, incidence of symptomatic vasospasm and outcome at discharge as measured using the Glasgow Outcome Scale (GOS) were determined for both groups.

The complication rate, incidence of DIND and outcome at discharge between two groups were compared using the two-tailed unpaired Student's *t* test or χ^2 test. All surviving patients were followed on an outpatient basis. All patients except those displaying sever disabled (SD) or vegetative state (VS) underwent three-dimensional (3D) time-of-flight magnetic resonance angiography (MRA) every six months. When the recanalization of the aneurysm was demonstrated on 3D-MRA, the patient was evaluated by DSA.

Results

Treatment

CE was selected and performed for 179 patients (63.9%; Group CE). The remaining 101 patients (36.1%; Group NC) underwent NC due to unsuitable shape (n=51), small aneurysm (n=36), or other reasons (n=14).

Patient characteristics

No significant differences in distribution of age, sex, or Fisher group on CT were observed between the two groups. Severe clinical condi-

Table 1 **Characteristics of CE and NC (%)**

	CE = 179 (64)	NC = 101(36)	*P value*
Age	60.1 ± 13.5	61.9 ± 13.9	*0. 28*
Sex (F: M)	127 : 52	78:23	*0. 20*
H&H Grade			
II + III	136	101	
IV + IV	43 (24)	10 (9.9)	*0. 038*
Fisher CT Group 2	30	23	
3	136 (76)	77(76.2)	*0. 34*
4	13	1	
Location			
Ant Cir	143	96	
ICA	59	31	
ACA or AcoA	67	30	
MCA	17	35	
Post Cir	36 (20.1)	5 (4.9)	*0. 006*
BA	27	2	
VA	9	3	

CE: Coil Embolization. NC: Neck Clipping. H&H: Hunt and Hess. Ant Cir: Anterior circulation. ICA: Internal carotid artery. ACA: Anterior Cerebral Artery. AcoA: Anterior communicating artery. MCA: Middle cerebral artery. Post Cir: Posterior circulation. BA: Basilar artery. VA: Vertebral artery

tion (Hunt and Hess grade IV or V) was significantly more frequent in Group CE (24%) than in Group NC (10%; p=0.038). Posterior circulation aneurysm was also significantly more frequent in Group CE (21%) than in Group NC (3%; p<0.001) (table 1).

Frequency of surgical complications

Surgical complications were experienced on significantly fewer patients in Group CE (n=8, 4.4%) than in Group NC (n=17, 16.8%; p=0.0005) (table 2).

Angiographic results following CE

Angiographic results for Group CE comprised complete CE (n=106), small neck remnant (n=57), proximal dome filling (n=5) and dome filling (n=4).

Aneurysm rebleeding after incomplete surgery

Postoperative aneurysm rebleeding occurred in 3 patients from Group CE (1.6%) and 2 patients from Group NC (1.9%) due to incomplete obliteration of the aneurysm. Mean interval to rebleeding was 14.5 hours postoperatively (range, 12-72 h).

Frequency of symptomatic vasospasm

Symptomatic vasospasm occurred significantly less in Group CE (8.4%) than in Group NC (29%; p<0.0001) (table 3).

Outcome at discharge

The rate of Good recovery (GR) on the GOS at discharge was significantly high in Group CE (71%) than in Group NC (50%; p=0.0004) (table 4).

Follow-up for Group CE

All 163 survived patients were followed on an outpatient service (table 5), for a mean duration of 1435 days (range, 215 – 1435 days). Of them 37 patients with SD or VS did not perform the Radiographical follow-up. Of the remained 143 patients, 26 patients showed some degree of aneurysmal recanalization on follow-up MRA and subsequent DSA.

Frequency of recanalization was higher in patients with the internal carotid artery or basilar artery aneurysm than those of other location. Although the mean size of all aneurysms treated with CE was 5.6 mm, the mean size of aneurysm of the recanalized case was 8 mm. The mean size was larger in the patients with recanalization than those of total cases. Ten patients (7%) required additional treatment (re-CE or NC)The late rebleeding after CE occurred in only one patient (0.7%) (table 6).

Table 2 **Surgical complications (%)**

CE:		
Intraoperative rupture:	4	
Cerebral Infarction:	4	
Total:	8 (4.4)	p=0.0005
NC:		
Post OP: AEDH, ASDH, ICH:	4	
Cerebral Infarction:	7	
Cranial N Palsy:	3	
Cerebral Contusion:	3	
Total:	17(16.8)	

CE: Coil Embolization. NC: Neck Clipping, OP: Operation. AEDH: Acute epidural haematoma. ASDH: Acute subdural haematoma. ICH: Intracerebral haematoma. N: Nerve.

Table 3 **H & H Grade and SVS (%)**

CE	II	III	IV	Total
DIND	5/76 (6.6)	4/60 (6.7)	5/30 (17)	8/166 (8.6)
p value	*0.0011*	*0.006*	*0.37*	*< 0.0001*
NC	II	III	IV	Total
DIND	16/59(27)	10/32(31)	3/10 (30)	29/101 (29)

H&H: Hunt and Hess. SVS: Symptomatic vasospasm. CE: Coil embolization. NC: Neck clipping.

Table 4 **Clinical outcome (GOS Score) and treatment modality at discharge**

	GR	MD	SD	VS	Dead
CE	127 (71)	16 (9)	10 (5.6)	10 (5.6)	16 (8.9)
p value	*0.0012*	*0.43*	*<0.001*	*0.90*	*0.22*
	GR	MD	SD	VS	Dead
NC	50 (50)	12(12)	23 (28)	6 5.9	5 (5.5)

H&H: Hunt and Hess. SVS: Symptomatic vasospasm. CE: Coil embolization. NC: Neck clipping.

Table 5 **Follow-up results of CE Group**

Follow-up duration: 215 – 2308 (mean 1435) days
Follow-up rate (clinical): 180/180 (100)
Follow-up rate (MRI, DSA): 143/180 (79.4)
Radiographical Recanalization Rate: 25/143 (17.5)
Rebleeding Rate: 1/180 (0.56)

CE: Coil embolization. MRI: Magnetic resonance image. DSA: Digital subtraction angiography.

Discussion

Since the introduction of the GDC, the benefits of CE for treatment of ruptured cerebral aneurysms have been widely accepted [1-5]. However, many published endovascular series have been highly biased by the characteristics of patients or their aneurysms [2]. If the relative merits of CE and NC are to be discussed properly, prospective randomized studies are necessary. The aim of the present prospective study was to compare treatment results following NC and CE for acutely ruptured cerebral aneurysm when CE was considered the first option. This study design excluded patients with ICH, which required surgical evacuation, because these patients are always treated by NC. Many display persistent focal neurological deficits, and outcomes might be worse despite early evacuation of the ICH. Kiovisto et Al [3] reported a prospective randomized study of outcomes following early CE or NC of ruptured cerebral aneurysms. Good recovery (GR) on GOS was achieved in 77% of CE patients and 66% of NC patients as of one year after treatment. Although no statistically significant difference in the patient's characteristics was identified between the groups, except the CE group contained higher proportion of severe clinical status, the percentage of GR patients was higher in the CE group than those of NC group. The present results showed that frequency of surgical complications and vasospasms were lower in CE patients than in NC patients. Previous reports have described surgical complication rates after NC of 5.8-25.8% [6-9], and our result of 16.8% for Group NC was included in the range.

Table 6 **Characteristics of patients with aneurysmal recanalization: (n = 26)**

Location and Recanalization rate(%)		
ICA:	14/52	(27)
BA:	5/20	(25)
ACA or AcoA:	6/51	(11.8)
MCA:	1/14	(7.1)
VA:	0/6	
Size of AN:	4 – 15 (mean 8)mm Small:14. Large: 12	
Additional treatment	NC:	5
	Re CE:	5
	Observation:	16

ICA: Internal carotid artery. BA: Basilar artery ACA: Anterior cerebral artery. AcoA: Anterior communicating artery. MCA: Middle cerebral artery. VA: Vertebral artery. AN: Aneurysm. NC: neck clipping. CE: Coil embolization.

The frequency of Symptomatic vasospasm after aneurysmal subarachnoid haemorrhage treated by NC is reportedly 32.4-42% [10]. Recently, various adjuvant therapies have been tested to prevent DIND, including hypertensive, hypervolemic, haemodilution therapy, cisternal irrigation with urokinase and ascorbic acid [11], and transvenous infusion of fasudil hydrocholoride and/or ozagrel sodium [12]. These treatments can reduce the incidence of DIND, and Komada et Al[11] reported a frequency of DIND of only 2.8% after cisternal irrigation with urokinase and ascorbic acid. However, other recent papers [12] have reported that about 30% of patients treated with NC still suffer DIND. In our result of NC group, frequency of symptomatic vasospasm was 29%.

Osawa et Al [8] reported outcomes for 2055 patients treated using NC, and 52.5% of patients were able to return to their previous lifestyle. In 104 consecutive patients treated using NC, Yonekawa et Al[13] reported that 61% of patients showed GR (GOS). In the present study, 50% of NC patients had achieved GR by discharge.

In our series, NC patients demonstrated a 16.8% surgical complication rate, 29% frequency of symptomatic vasospasm and 50% frequency of GR. These treatment results after NC are not particularly impressive compared with the reported results of other studies, so simple comparison of outcome between CE and NC groups in the present study may underestimate

the potential utility of NC. However, the CE group displayed a 4.4% surgical complication rate, 8.4% frequency of vasospasm and 71% of GR. Theses results are clearly better than the optimal reported results after NC[6-9].

Rebleeding from residual aneurysm and recanalization of the aneurysm in the chronic phase represent substantial problems[4,5]. In the ISAT study[1], 20 CE patients and six NC patients experienced rebleeding within one month after surgery. In our series, 1.6% of the patients treated with CE and 1.9% of the patients treated with NC suffered from rebleeding within 1 month after surgery. In a series of 169 aneurysms reported by Cognard et Al[4] initial total occlusion was achieved in 80% of cases, but recurrence occurred in 20 patients (14%) 3-40 months after treatment. Cottier et Al[5] also reported recanalization in 24 patients (38%) from a series of 74 treated aneurysms (mean follow-up, one year). They also commented that 3D time-of-flight MRA could replace DSA for long-term follow-up. Since 1998, DSA has not been used for routine follow-up in our hospital. All patients in the present study underwent 3D time-of-flight MRA every six months. Only patients with suspected aneurysmal recanalization on MRA underwent follow-up DSA. Although 18.3% of our patients showed aneurysmal recanalization and 10 patients required additional treatment (re-CE or NC), rebleeding only occurred in one patient (0.7%) during follow-up.

Conclusions

Approximately 65% of patients with ruptured aneurysm can be treated using CE. The frequency of surgical complications and vasospasm is lower and outcomes are generally better than NC. If serial follow-up MRA examination is performed and required treatment is performed, rebleeding in the chronic stage will be minimized.

References

1 Molyneux A, Kerr R et Al: International subarachnoid aneurysm trial (ISTA) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: a randomised trial. Lancet 360: 1257-1274, 2002.

2 Derdeyn CP, Barr JD et Al: The international Subarachnoid Aneurysm Trial (ISTA): A position Statement from the executive Committee of the American Society of Interventional and Therapeutic Neuroradiology and the American Society of Neuroradiology. Am J Neuroradiol 24: 1404-1408, 2003.

3 Koivisto T, Vanninen R et Al: Outcomes of early endovascular versus surgical treatment of ruptured cerebral aneurysms. Stroke 31: 2369-2377, 2000.

4 Cognard C, Weill A et Al: Long-term angiographic follow-up of 169 intracranial berry aneurysms occluded with detachable coils. Radiology 212: 348-356, 1999.

5 Cottier JP, Bleuzen-Couthon et Al: Follow-up of intracranial aneurysms treated with detachable coils: comparison of plain radiographs, 3D time-of-flight MRA and digital subtraction angiography. Neuroradiology 45: 818-824, 2003.

6 Roos YBEM, Beenen LFM et Al: Timing of surgery in patients with aneurysmal subarachnoid haemorrhage: rebleeding is still the major cause of poor outcome in neurosurgical units that aim at early surgery. J Neurol Neurosurg Psychiatry 63: 490-493, 1997.

7 Auer LM: Unfavorable outcome following early surgical repair of ruptured cerebral aneurysms – a critical review of 238 patients. Surg Neurol 35: 152-158, 1991.

8 Osawa M, Hongo K et Al: Results of direct surgery for aneurysmal subarachnoid haemorrhage: outcome of 2055 patients who underwent direct aneurysm surgery and profile of ruptured intracranial aneurysms. Acta Neurochir (Wien) 143: 655-664, 2001.

9 Neil-Dwyer G, Lang D et Al: Outcome after aneurysmal subarachnoid haemorrhage: The use of a graphical model in the assessment of risk factors. Acta Neurochir (Wien) 140: 1019-1027, 1998.

10 Shimoda M, Takeuchi M et Al: Asymptomatic versus symptomatic infarction from vasospasm in patients with subarachnoid haemorrhage: Serial magnetic resonance imaging. Neurosurgery 49: 1341-1350, 2001.

11 Kodama N, Sasaki T et Al: Cisternal irrigation therapy with urokinase and ascorbic acid for prevention of vasospasm after aneurysmal subarachnoid haemorrhage. Outcome in 217 patients. Surg Neurol 53: 110-118, 2000.

12 K Nakashima S, Tabuchi K et Al: Combination therapy of fasudil hydrocholorile and ozagurel sodium for cerebral vasospasm following aneurysmal subarachnoid haemorrhage. Neuro Med Chir (Tokyo) 38: 805-811, 1998.

13 Yonekawa Y, Imhof HG et Al: Aneurysm surgery in the acute stage; results of the structured treatment. Neurol Med Chir (Tokyo) 38 Suppl: 45-49, 1998.

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