Coil Embolization for Ruptured Cerebral Aneurysms of 2x3 mm Diameter

O. TONE, H. TOMITA, M. TAMAKI, H. AKIMOTO, K. SHIGETA,
O. SAMPETREAN, M. FUJII

Department of Neurosurgery, Musashino Red Cross Hospital; Tokyo, Japan

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Summary

Small ruptured cerebral aneurysms, such as those of 2x3 mm diameter, are considered to be difficult to embolize by detachable coils because of the risk of procedural perforation of the aneurysms. We have treated these small aneurysms and report the techniques and pitfalls of these embolizations. Twenty-four patients with ruptured cerebral aneurysms of 2x3 mm diameter were intended for treatment by coil embolization. Before coil embolization, three-dimensional digital subtraction angiography was performed, and the simulation of the volume embolization ratio (VER) was performed in all patients, except for the first basilar artery aneurysm patient. The tip of the microcatheter was steam-shaped several times and was placed on the neck of the aneurysm. A balloon neck remodeling technique was used for two aneurysms. GDC 10 softs and soft SRs were used for the first ten aneurysms, and Ultrasofts were used for the last eleven aneurysms. Out of twenty-four aneurysm embolizations, we aborted the procedure in three cases, because of a failure in catheterization; we performed clipping surgery for these cases. For the first case of a basilar tip aneurysm, the aneurysm was perforated, due to the use of too long a coil and the insertion of the tip of the microcatheter into the aneurysmal dome. Minor infarction occurred in one patient.

The mean VER was 33.9%, and two aneurysms recanalized, and out of these one needed a second embolization. Six months postoperatively, 81% of patients had made in a good recovery or had a moderate disability. We recommend the following techniques to embolize aneurysms of 2x3 mm diameter: the tip of the microcatheter should be stabilized on the aneurysmal neck by steam shaping of the microcatheter, GDC 10 soft and Ultrasoft should be selected for use, and the simulation of the VER should be performed before embolization to select coils of a suitable length.

Introduction

Although small aneurysm size has been reported to be one of the risk factors for perforation during coiling¹, the locations of aneurysms and the poor general conditions of patients result in the requirement for endovascular surgery. Furthermore, coil embolization seems to be desirable to preserve the neuropsychological functions of patients with an anterior communicating artery aneurysm. As the minimum loop size of detachable coils is 2 mm, cerebral aneurysms of 2x3 mm diameter are considered to be the smallest aneurysms that can be treated with coil embolization. In this paper, we represent the techniques and pitfalls in the embolization of aneurysms of 2x3 mm diameter.

Illustrative Case (figure 1)

A 53-year-old man suffered from subarachnoid haemorrhage (SAH). Angiography revealed an anterior communicating artery (AcomA) aneurysm of 2x3 mm diameter. Coil embolization was performed on the day of SAH under general anesthesia. After a 6Fr. sheath was inserted into the right femoral artery, 4000 U of heparin was administered intravenously, and the activated clotting time was measured to be 238 sec. Steam shaping of a microcatheter into an S-like shape was performed several times until the tip of microcatheter was stabilized at the neck of the aneurysm. A microguidewire, angled at 90 degrees, was inserted into the right distal anterior cerebral artery beyond the aneurysmal neck, to prevent the jumping of the microcatheter. The tip of the microcatheter was inserted into the aneurysmal neck using the microguidewire rotation technique. GDC 10 Ultrasoft 2 mm/3 cm and 2 mm/3 cm (Boston Scientific) were inserted into the dome of the aneurysm. The volume embolization ration (VER)² was 36.7%. The patient was discharged one month after SAH without any neurological or neuropsychological deficits. No recanaliza-

tion of the aneurysm was found by magnetic resonance angiography six months after the embolization.

Patient and Methods

Twenty-four patients with ruptured cerebral aneurysms of 2x3 mm diameter, intended for treatment by coil embolization from May 2000 to July 2004, were included in this study (table 1). Ruptured aneurysms were located in the following arteries: distal anterior cerebral arteries (2), AcomA (13), internal carotid arteries (ICA) (5), basilar tips (BA-tip) (2), and middle cerebral arteries (2). Following the identification of the ruptured cerebral aneurysm, three-dimensional digital subtraction angiography (3D DSA) was performed in all patients, except the first BA-tip patient, and the size and three-dimensional structure of the aneurysms were estimated. Following the simulation of VER to aid the selection of coils, coil embolization was performed under general anesthesia.

A microguidewire was inserted into the distal parent artery beyond the aneurysmal neck, to prevent the jumping of the microcatheter. Steam shaping of the microcatheter was per-

Table 1 **Summary of patients with ruptured aneurysms of 2x3 mm diameter.**

No. of cases		24	
Age (years)		30-82	mean 65.2
Gender	Male	4	
	Female	20	
Day of embolization	acute stage	20	
	chronic stage	4	
Hunt and Kosnik Grade	I	3	
	II	8	
	III	5	
	IV	5	
	V	3	
Location	distal ACA	2	including 1 aborted attempt
	AcomA	13	
	ICA	5	including 2 aborted attempts
	BA-tip	2	
	MCA (M1)	2	
ACA, anterior cerebral artery; AcomA, anterior communicating artery; ICA, intrrenal carotid artery; BA, basilar artery; MCA, middle cerebral artery

Figure 1 A,B) results from preoperative left carotid artery angiography and 3D DSA showing AcomA aneurysm of 2.0 x 3.3 mm diameter; C,D) angiographs after coil embolization.

formed several times until the tip of microcatheter was stabilized on the neck of the aneurysm. A half-inflation of the balloon in the neck remodeling technique³ was used for two ICA aneurysms (figure 2), to prevent coils from protruding from the aneurysmal neck. GDC 10 softs and soft SRs were used for the first ten aneurysms, and Ultrasofts were used for the last eleven aneurysms.

Results

Clinical outcomes and complications of this study are shown in table 2. The attempts of coil insertion were unsuccessful in three patients (12.5%; one distal ACA and two ICA aneurysms) because the tip of microcatheter was not stabilized at the aneurysmal neck. These

patients subsequently underwent clipping surgery.

Aneurysm perforation occurred in the first patient of this series. The 77-year-old female, diagnosed with an acutely ruptured BA-tip aneurysm of 2.1x2.4 mm diameter, underwent coil embolization two days after SAH. Aneurysm perforation occurred at the end of the insertion of the first coil (GDC 10 soft SR 2 mm/6 cm) because the tip of the microcatheter was inserted into the aneurysmal dome and this coil was too long to use as a first coil for this aneurysm. Intraventricular haemorrhage was controlled by heparin reversal and the opening of ventricular drainage, avoiding the immediate removal of the protruding coil.

The mean value of the VERs of the 21 aneurysms was 33.9%, which is higher than that

Figure 2 30-year-old male suffered from SAH grade 2. Results from angiography and 3D DSA show left IC-ophthalmic aneurysm of 2.1 x 2.1 mm diameter (A,B). Coil embolization was performed one day after SAH under general anesthesia. Because GDC Ultrasoft 2 mm/3 cm protruded from the aneurysmal neck, a balloon was half-inflated to protect the aneurysmal neck and Ultrasoft 2 mm/3 cm and 2 mm/3 cm coils were inserted into the aneurysmal dome, preserving the left ophthalmic artery (C). He was discharged 21 days following SAH without any neurological deficits.

of larger aneurysms. No postoperative haemorrhages occurred during the mean follow-up period of 21 months. Reversible minor ischemic complication occurred in one patient. Aneurysmal recanalization occurred in two patients and one patient underwent a second embolization. Six months postoperatively, 81% of the patients had made a good recovery or had a moderate disability.

Discussion and Conclusions

Although cerebral aneurysms of 2x3 mm diameter are considered to be the smallest aneurysms that can be treated by coil embolization, our results from the treatment of such aneurysms seem to be satisfactory. Treating aneurysms of 2x3 mm diameter requires the careful handling of the devices for embolization. Selection of the most suitable GDC is also essential to treat these minimum-sized aneurysms.

Cronqvist and Moret stated that the failure rate of treating very tiny aneurysms (<2 to 3 mm) has decreased since the introduction of soft coils⁴. GDC 10 soft and GDC 10 UltraSoft

are considered to be suitable to use for treating these small aneurysms.

Following the experiences of treating 24 ruptured aneurysms of 2x3 mm diameter, the authors propose the following technical recommendations to treat very small aneurysms:

1) The tip of microcatheter should be placed on the aneurysmal neck and not be inserted into the aneurysmal dome.

2) Steam shaping of the microcatheter should be performed several times until the tip of the microcatheter is stable on the aneurysmal neck.

3) Microguidewire should be inserted to the distal portion of the parent artery beyond the aneurysmal neck to prevent the jumping of the microcatheter. The tip of the microcatheter can be placed on the aneurysmal neck by rotating the angled microguidewire.

4) The appropriate GDC 10 softs and UltraSofts should be selected to use. Preoperative simulation of VERY is useful to avoid using too long a coil.

5) The half-inflation of the balloon in the neck remodeling technique may be useful to prevent the protrusion of coils from the aneurysmal neck, especially for ICA aneurysms.

Under careful handling and selection of the devices using these techniques, small aneurysms, such as those of 2x3 mm diameter, can be treated by coil embolization without major complications.

Table 2 Volume embolization ratio (VER), Complications, and Outcome.

Total cases	24	
Attempted cases	3 (12.5%)	
VER	33.9±9.3%	
Perforation during embolization	1	
Rebleeding after embolization	0	
Minor infarction	1	
Coil compaction	2	
2nd embolization	1	
follow-up	3-48 (mean 21) months	
GOS	GR	13
	MD	4
	SD	3
	VS	0
	D	1
<i>GOS, Glasgow outcome scale; GR, good recovery; MD, moderate disability SD, severe disability; VS, vegetative state; D, dead</i>		

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Osamu Tone, M.D.
Department of Neurosurgery
Musashino Red Cross Hospital
1-26-1, Kyonan-cho, Musashino City
Tokyo 180-8610, Japan