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Endovascular treatment of unruptured cerebral aneurysms

T. Terada, M. Tsuura, H. Matsumoto, O. Masuo, T. Tsumoto, H. Yamaga, and **T. Itakura**

Department of Neurological Surgery, Wakayama Medical University, Wakayama, Japan

Summary

76 consecutive patients with 78 unruptured cerebral aneurysms underwent endovascular therapy from July 1999 to May 2004 in our institute. For the wide-necked aneurysms, the remodeling technique, double microcatheter technique, or stent-assisted coil embolization was used, while a parent artery occlusion or covered stent was applied for the giant or fusiform aneurysms. Immediate angiographical results demonstrated 33 complete occlusions, 26 neck remnants, and 14 dome fillings. Four cases were treated with parent occlusion or stenting only, and one case was not treated with embolization but with clipping due to the rupture of the aneurysm during coil embolization. Immediate angiographic findings demonstrated that in aneurysms between 5 to 10 mm, the rate of complete occlusion was 48%, that of neck remnants 33%, and that of dome fillings 27%. In aneurysms between 11 to 25 mm, the rate of complete occlusion was 14%, that of neck remnants 28%, and that of dome fillings was 58%. In the angiographic follow-up results, all aneurysms smaller than 5 mm showed complete occlusion. In aneurysms between 5 to 10 mm, 74% of the aneurysms showed complete occlusion, and 21% showed neck remnants, and 5% showed dome filling. In aneurysms between 10 to 24 mm, 25% showed complete occlusion, while 75% showed dome filling. The overall mortality rate was 0% and the morbidity rate was 3.7% (2 major strokes, 1 minor stroke) at 30-days after embolization. In the clinical follow-up study, one case of a large basilar tip aneurysm caused a fatal rupture 28 months after the initial embolization. Endovascular therapy was performed on the unruptured aneurysms and was found to be an acceptable treatment, except for durability in cases of large aneurysms.

Keywords: Embolization; detachable coil; unruptured aneurysm; remodeling technique; stent.

Introduction

The efficacy of coil embolization for ruptured cerebral aneurysms has been proven by a randomized controlled trial [6]. However, the efficacy of endovascular therapy for unruptured cerebral aneurysms is still unknown [1], although several papers reported the superiority of embolization over direct surgery in a short-term follow-up period [2, 5, 6]. Coil embolization has shown a short-term clinical and angiographical efficacy as a therapeutic alternative to the surgical treatment of intracranial aneurysms [2, 5, 6]. However, the long-term effect of coil embolization to prevent growth or rupture of unruptured aneurysms has not been proven. We report the results of coil embolization in 76 patients with 78 aneurysms, including clinical outcome, morbidity-mortality rate, and long-term follow-up data.

Materials and methods

76 patients with 78 unruptured cerebral aneurysms underwent coil embolization at Wakayama Medical University and its branch hospitals from July 1999 to May 2004. The male/female ratio was 24/52 and mean patient's age was 59.4 years with a range of 24–79 years.

Patients were classified into three groups: 55 patients had unruptured aneurysms discovered incidentally during angiography or magnetic resonance angiography (MRA). 15 patients had unruptured aneurysms associated with a ruptured one. Eight patients had unruptured aneurysms with a mass effect, such as cranial nerve palsy etc.

Location of the aneurysms is shown in Table 1. There were 41 aneurysms located in the anterior circulation and 37 in the posterior circulation. The most common location of the aneurysms in our series was basilar tip (n = 22).

The aneurysms were classified into five groups by size, as follows: less than 5 mm, 5–10 mm, 11–24 mm, >25 mm, and the fusiform

Table 1. *Location of aneurysms*

Anterior circulation		Posterior circulation	
– Paraclinoid	18	– BA tip	22
– ICPC	5	– BA trunk	7
– MCA	4	– VA	8
– Acom	8	Total	37
– Cav-pet	2		
– IC top	2		
– IC-Ach	1		
– IC trunk	1		
Total	41		

type. There were 14 aneurysms less than 5 mm, 50 that were 5–10 mm, 7 that were 11–24 mm, 4 that were >25 m, and 3 fusiform aneurysms.

Coil embolization was performed based on the following criteria.

Age <= 70 years

Aneurysm >= 5 mm

Coil embolization was chosen for basilar tip, basilar trunk, and paraclinoid aneurysms.

For aneurysms in other location, coil embolization was chosen if the shape of the aneurysm was suitable for coil embolization using a single microcatheter and usual coils only (simple technique).

Method of embolization

The procedure was performed under general anesthesia and systemic heparinization. A microcatheter was navigated into the aneurysm under the road mapping mode and a detachable coil (mainly a GDC) was delivered sequentially and deployed into the aneurysm until tight packing was achieved. For wide-necked aneurysms, a remodeling technique [9] using compliant balloons such as the Commodore (J&J) or Hyperform (MTI), double microcatheter technique or stent-assisted coil embolization was used. 62 aneurysms were embolized using these simple techniques. 13 cases were treated using the remodeling technique, two with the stent-assisted technique, and two with the double microcatheter technique. For aneurysms with mass effect, parent occlusion using coils or balloons or a covered stent was deployed across the neck of the aneurysm.

Clinical and angiographic follow-up was performed as follows. Angiographical follow-up was performed every 6 months until 24 months after embolization, and an MRA was performed every year from 2 years after embolization. The angiographical data was classified into the following three categories: complete occlusion, neck remnant, and dome filling.

Results

Immediate angiographic results demonstrated 33 complete occlusions, 26 neck remnants, and 14 dome fillings. Four cases were treated with parent occlusion or stenting only, and one case was not treated with embolization but with clipping.

Immediate angiographic results were analyzed according to the size of aneurysm. In aneurysms smaller than 5 mm, the rate of complete occlusion was 36%, that for the neck remnants 36%, and that for the dome filling aneurysms 28%. In aneurysms between 5 to 10 mm, the rate of complete occlusion was 48%, that for the neck remnants 33%, and that for the dome fillings 27%. In aneurysms between 11 to 25 mm, the rate of complete occlusion was 14%, that for the neck remnants 28%, and that for the dome fillings 58%.

Angiographic follow-up results demonstrated that all aneurysms smaller than 5 mm showed complete occlusion. In aneurysms between 5 to 10 mm, 74% of the aneurysms showed complete occlusion, and 21% showed neck remnants, and 5% showed dome filling. In aneurysms between 10 to 24 mm, 25% showed complete occlusion, while 75% showed dome filling.

As for complications during the procedure, one aneurysm was perforated with the first GDC coil. An immediate angiography demonstrated extravasation of the contrast medium. Heparin was immediately reversed. Then, the coil that penetrated the aneurysmal wall was deployed in extra and intraaneurysmal space. However, the entire lumen of the aneurysm was not packed. Therefore, the patient was moved to the operation room and surgical clipping was performed for the partially embolized MCA aneurysm. The patient was discharged without any new neurological deficits after surgery. Five thrombo-embolic complications appeared in 82 aneurysms. The overall mortality rate was 0%, and the morbidity rate was 3.7% (2 major strokes, 1 minor stroke) at 30-days after embolization.

In the clinical follow-up study, one case of a large basilar tip aneurysm caused a fatal rupture 28 months after initial embolization. In this case, the patient had not visited the hospital for 28 months after embolization. He finally came to our hospital 28 months after embolization due to abdominal pain. At that time, a plain craniogram was examined, and a change in the shape of the embolized coil was found. An angiography was scheduled, but the day before admission he suffered a massive subarachnoid hemorrhage and died. The rupture rate of all aneurysms in our series was 1.3% in the follow-up period of mean 3.2 years. Therefore, the annual rupture rate in our series was 0.4%.

Representative cases

A 67-year-old male was admitted to our hospital for the treatment of unruptured basilar tip aneurysm of $10 \times 8 \times 8$ mm in size, which was found on angiography for the diagnosis of cerebral infarction (Fig. 1 a,b). Coil embolization was performed under general anesthesia. The aneurysm was wide-necked, and a remodeling technique was used for the coil embolization. A Commodore double lumen balloon catheter was introduced from the left vertebral artery and a microcatheter for coil embolization (Prowler-14) was introduced from the right vertebral artery. A GDC-18 coil (8 mm × 20 cm) was introduced into the aneurysm under dilatation of the balloon placed from the left posterior cerebral artery to the basilar artery. After deployment of the first coil to preserve the bilateral pos-

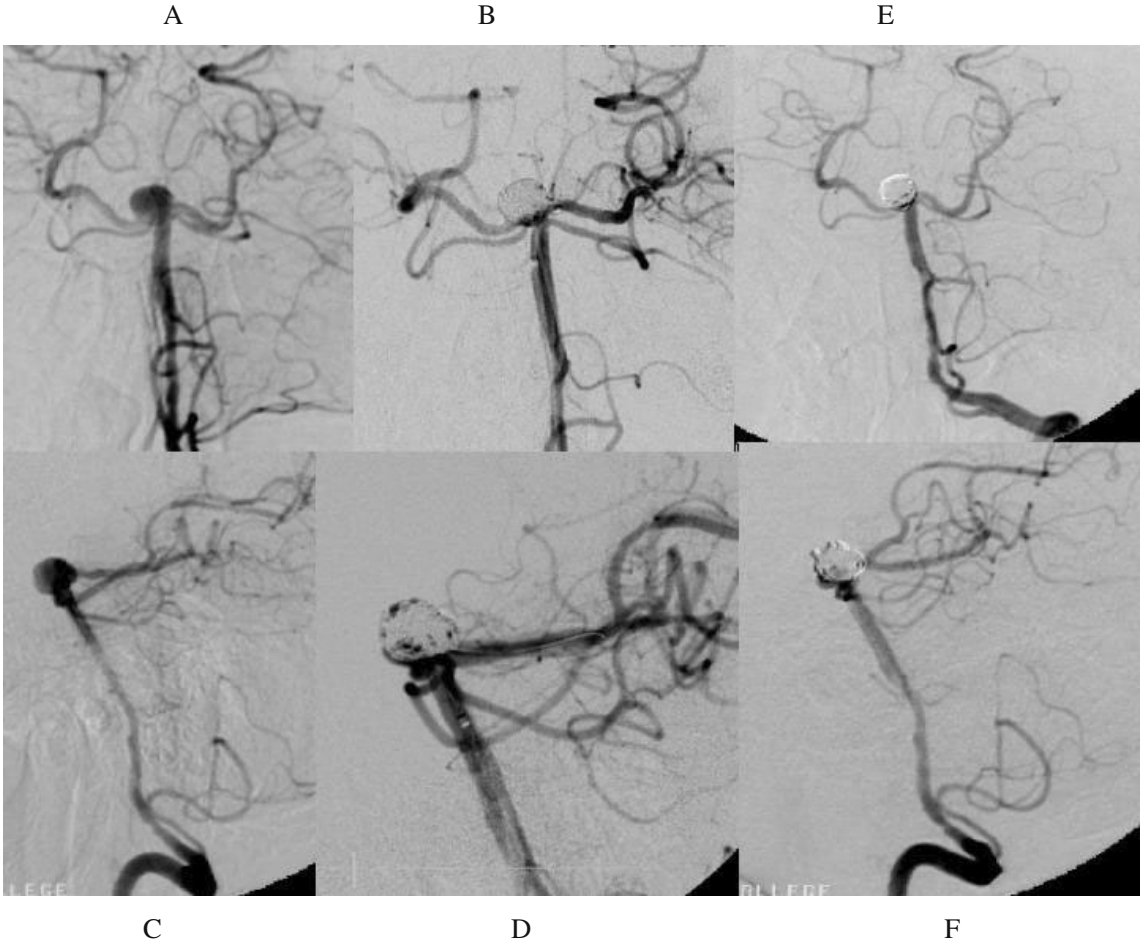

Fig. 1. Angiographic findings of case 1. (A) AP view of the vertebral angiography. A wide-necked aneurysm was demonstrated. (B) Lateral view of the vertebral angiography. (C) AP view of the vertebral angiography after coil embolization. Bilateral posterior cerebral arteries were preserved. (D) Lateral view of the vertebral angiography. (E) AP view of the vertebral angiography one year after initial embolization. Dome filling was not demonstrated. (F) Lateral view of the vertebral angiography one year after initial embolization

terior cerebral arteries, packing coils were introduced into the framing coil (Fig. 1 c,d). Embolization was completed under the condition of dome filling. On the follow-up angiogram one year after embolization, the aneurysm had been obliterated keeping the bilateral posterior cerebral arteries patent (Fig. 1 e,f).

A 50-year-old male had a small intracerebral hemorrhage. On CT, an isodensity mass was found in the interpeduncular cistern. Angiography revealed a large unruptured basilar tip aneurysm $14 \times 10 \times 11$ mm in size (Fig. 2 a,b). The neck of the aneurysm was broad, and bilateral posterior cerebral arteries had branched from the dome of the aneurysm. The double microcatheter technique was used to embolize this aneurysm. GDC-18 coils 12 mm $\times$ 30 cm and 10 mm $\times$ 30 cm were deployed into the aneurysm from microcatheters introduced from the bilateral vertebral arteries. The aneurysm was embolized but the dome of the aneurysm was partially filled with contrast medium to keep the bilateral posterior cerebral arteries patent (Fig. 2 c,d). The patient had not visited our hospital until 28 months after the procedure, at which time deformity of the initially embolized coil was found (Fig. 2 e,f). The evening of the day of his visit to the hospital, a massive subarachnoid hemorrhage occurred and he died.

Discussion

Aneurysmal SAH has a 30-day mortality rate of 45% and an approximately 50% rate of disabilities among survivors. The prevention of SAH has been

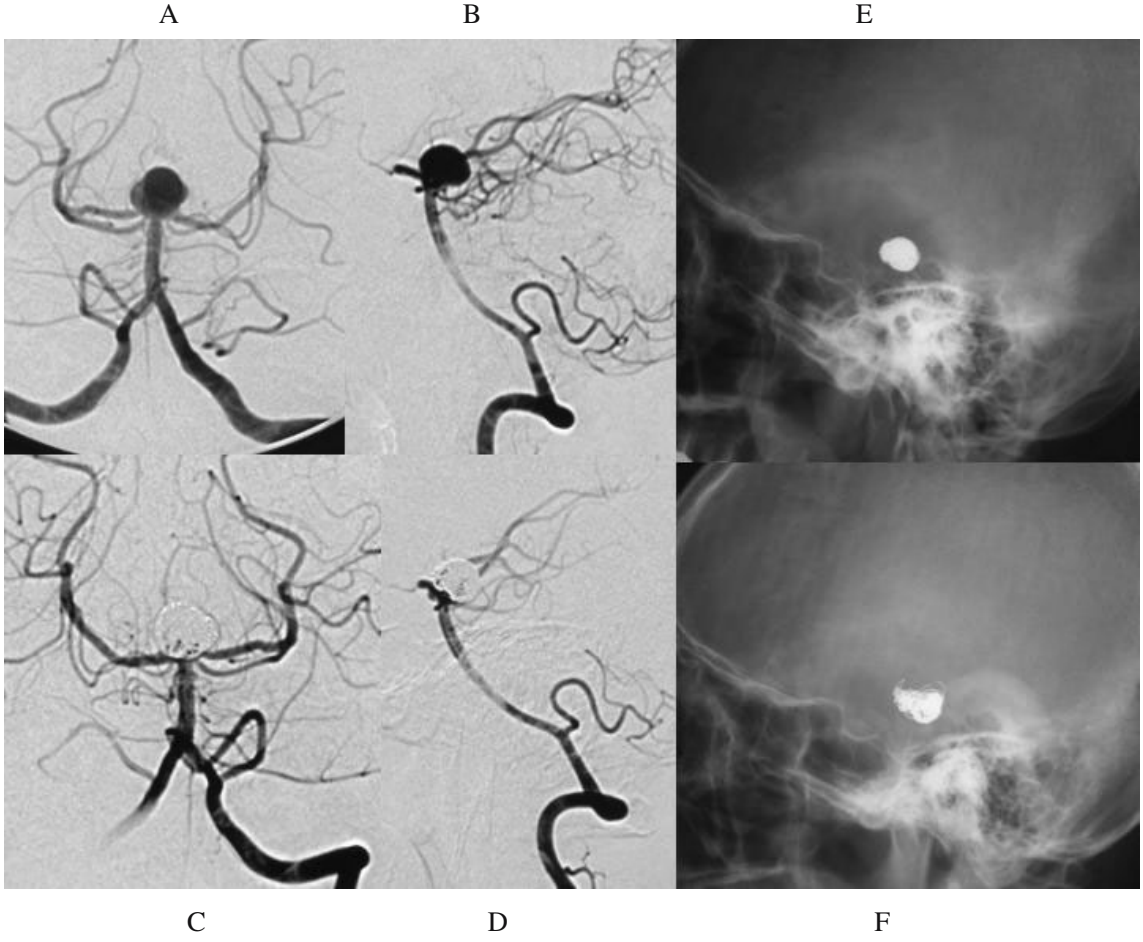

Fig. 2. Radiological findings of case 2. (A,B) Vertebral angiography demonstrated wide-necked basilar tip aneurysm. (C,D) The aneurysm was embolized and left the bilateral posterior cerebral arteries patent. (E) Plain craniogram after initial coil embolization. (F) Plain craniogram 28 months after initial embolization

promoted as the most effective strategy for reducing the morbidity and mortality rate. Recently, the largest study of unruptured cerebral aneurysms, the International Study of Unruptured Intracranial Aneurysms, reported a rupture rate of 0.05% for unruptured aneurysms < 10 mm in diameter and no history of SAH, and 0.5% for those with previous SAH. In aneurysms > 10 mm, the rupture rate was approximately 1% [3]. More recently, the ISUIA published a slightly higher rate of rupture of unruptured cerebral aneurysms after detailed evaluation of aneurysma location [3].

For treating unruptured cerebral aneurysms, coil embolization has proven to be effective in early and clinical evaluations. Johnston *et al.* [4] reported the results of surgical clipping and coil embolization of unruptured cerebral aneurysms. A morbidity rate of 18.5% was found in the surgical group and 10.6% in the endovascular group, and the mortality rate was 2.3% and 0.4%, respectively. We treated 78 unruptured cerebral aneurysms, on which direct surgery was difficult to perform. Therefore, many aneurysms in the posterior circulation and paraclinoid area were included in our series. Morbidity and mortality rates at 30-days were 3.7% and 0%, respectively. These results are acceptable for the treatment of unruptured cerebral aneurysms. However, the biggest problem with coil embolization is recanalization after embolization. In smaller aneurysms of <10 mm, the recanalization rate was lower than 25%, while in large aneurysms of $>=11$ mm, the recanalization rate was 75%. Of the large aneurysms, one aneurysm caused a fatal subarachnoid hemorrhage 28 months after embolization.

Various types of new coils have been developed to

solve this problem, such as the Matrix coil [9], hydrocoil, or bFGF core coils [5], which are supposed to induce fibrosis inside the aneurysm to prevent recanalization.

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Correspondence: Tomoaki Terada, 811-1 Kimiidera, Wakayama City, 641-0012, Japan. e-mail: teradato@wakayama-med.ac.jp