Rupture of Aneurysms during and after Embolization with Guglielmi Detachable Coils

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Summary

Between March, 1997 and June, 2000, 104 aneurysms, including 75 ruptured and 29 unruptured aneurysms, were treated with Guglielmi detachable coils by 120 embolizations in our institution. Intraprocedural perforation occurred in four cases, representing 3.3% of the embolizations. Subsequently, two cases deteriorated, and the other two cases recovered completely without any deficit. Aneurysmal perforations mostly occurred in acutely ruptured aneurysms, small aneurysms less than 4 mm, anterior communicating artery aneurysms, or first coil delivery. Rebleedings in the acute period of subarachnoid hemorrhage occurred in four cases of partial occlusion due to aneurysmal morphology, such as a wide neck or an irregular shape. Rebleedings in the chronic period occurred in two cases, one of which rebled two months after partial occlusion, and the other of which rebled 27 months after nearly total occlusion. No subarachnoid hemorrhages documented from previously unruptured aneurysms occurred after embolizations. Insufficient embolization for ruptured aneurysms cannot prevent rebleeding, and partially occluded aneurysms and recurring aneurysms in the follow-up period require immediate re-treatment.

Introduction

Embolization of intracranial aneurysms using Guglielmi Detachable Coils (GDC) was described in 1991^{1,2}. In our institution, the introduction of GDC embolization dramatically changed the management of cerebral aneurysms, making treatment less invasive. However, one of the most feared complications of aneurysmal embolization is that of intraprocedural perforations. Of concern is whether this therapy can prevent aneurysmal rupture or not. The purpose of this review is to describe the incidence, causes, management, and outcome of aneurysmal hemorrhages that occurred during and after endovascular treatment.

Material and methods

Between March, 1997 and June, 2000, 104 aneurysms, including 75 ruptured and 29 unruptured aneurysms, were treated with GDC by 120 embolizations in our institution. Seventy embolizations were performed in the acute period of subarachnoid hemorrhage (SAH), 5 embolizations in the chronic period after SAH, and 29 embolizations for unruptured aneurysms. Repeated embolizations were done 16 times. All procedures, except for the initial

Figure 1 Left internal carotid injection shows extravasation of the contrast from the anterior communicating artery aneurysm and the coil perforating the aneurysm (Case 2).

cases, were performed under general anesthesia. The microcatheters used were a Tracker 10 (Boston Scientific), a Fastracker 10 (Boston Scientific), a Prowler 14 (Johnson & Johnson), or an Excelsior (Boston Scientific); the microguidewire used was either a Dasher 14 (Boston Scientific) or a GT wire (Terumo). Aneurysmal measurements were performed during embolization after calibration, using an 11-mm-diameter metallic ball on the part of the skull where the embolization was performed. These patients were reviewed, and those that experienced new SAH during and after the procedures were identified.

Results

The perforation of aneurysms during embolization

We encountered 4 intraprocedural perforations (table 1). Overall, a procedural hemor-

rhage rate of 3.3% was seen. All cases were ruptured aneurysms treated within 72 hours after ictus, and the small aneurysms less than 4 mm. Of the perforated aneurysms, three involved the anterior communicating aneurysm, and one the posterior inferior cerebellar artery. All perforations occurred during first coil delivery. Subsequently, two patients deteriorated, but the other two experienced no neurological symptoms, and recovered without acquiring additional deficits. Permanent morbidity and mortality rates of the perforations were 0.8% and 0.8%, respectively.

Rebleeding in the acute period of SAH after embolization of ruptured aneurysms

We experienced 4 cases of rebleeding in the acute period of SAH (table 2). Overall, the rebleeding rate was 5.7% in the treatment of acutely ruptured aneurysms. Embolization of these four cases resulted in partial occlusion due to their morphology, such as a wide neck or an irregular shape.

Direct clipping with craniotomy had not been indicated in these 4 cases, because of the age of the patient, their neurological condition, or the location of the aneurysm. All cases died as the result of rebleeding or severe vasospasm.

Rebleeding in the chronic period of SAH after embolization of ruptured aneurysms

We experienced two cases of rebleeding in the chronic period of SAH (table 3). The aneurysm on the middle cerebral artery (case 9), had rebled 2 months after the initial embolization, which had resulted in partial occlusion. This patient had been treated with craniotomy and neck clipping, and recovered with a minor deficit.

The other aneurysm, on the ophthalmic segment of the internal carotid artery (case 10), had rebled 27 months after two embolizations, which had resulted in nearly total occlusion. The angiography carried out just after the rebleeding had revealed that the small neck remnant was enlarged. This patient was treated with a third embolization, and recovered without any deficits.

Bleeding of unruptured aneurysms after embolization

We had no cases of previously unruptured aneurysms bleeding after embolization in this series.

Discussion

Intraprocedural Perforation

The endovascular treatment of intracranial aneurysms involves many potential hazards for intraprocedural perforation. We have experienced 4 perforations out of 120 procedures, representing 3.3% of the total treated. The reported percentage of aneurysmal perforations varies from 2.7% to 4.2%^{3,4,5,6}. Valavanis et al reported that in their experience, the aneurysms that were perforated were only those that had bled previously⁴. Ricolfi et al reported the characteristics of maximal aneurysmal fragility, included recent rupture, small aneurysmal pouch, and presence of a daughter aneurysm⁷. Concerning the timing of the perforation, all of the perforations occurred during first coil delivery among our patients. Ricolfi et al also reported that three out of four perforations were caused by pressure applied to the aneurysmal wall by the loops formed during deposition of the first coil⁷. Regarding the location of aneurysms among our patients, three out of the four perforated aneurysms were located on the anterior communicating artery. Distal catheterization and a sharp angle turn at the junction of the internal cerebral artery and the anterior cerebral artery is needed to reach this lesion. These geometrical factors may cause excessive catheter tension. Management simply involves continuing embolization and reversing heparin therapy by using protamine sulfate. Ricolfi et al emphasized the effect of

Figure 2 At the rebleeding 27 months after the embolization, left internal carotid injection shows enlarged neck remnant (Case 10).

the emergency ventriculostomy (which should be performed in the angiographic suite), to reduce acutely increased intracranial pressure⁷. Outcomes vary among reports. Among our cases, two cases that suffered from perforation deteriorated, and the other two did not. McDougall et al reported that the majority of the patients studied survived without serious consequences⁸. However, Viñuela et al reported that 6 of 11 patients died as a result of aneurysmal perforation³.

Rebleeding after embolization

We have experienced 4 cases of rebleeding in the acute period of SAH after embolization, which resulted in partial occlusion, representing 5.7% of acutely ruptured aneurysm treatments. Partial embolization could not prevent rebleeding of acutely ruptured aneurysms. In contrast, totally or nearly totally occluded

Table 1 The cases of intraprocedural perforation

	Age/Sex	Location	Size (mm)	Hunt&Hess grade	Day of embolization	GOS
Case 1	39M	Acom	3	2	3	SD
Case 2	46M	Acom	4	4	0	GR
Case 3	72M	Acom	3	3	1	D
Case 4	46M	PICA	3	2	3	GR

Acom: anterior communicating artery, PICA: posterior inferior cerebellar artery

Table 2 The cases of rebleeding in the acute period

	Age/Sex	Location	Size (mm)	Hunt&Hess grade	Day of embolization	Result of embolization	Day of rebleeding	GOS
Case 5	80F	Acom	5	3	Day 6	Partial occlusion	Day 8	D
Case 6	77F	Pcom	10	4	Day 1	Partial occlusion	Day 6	D
Case 7	80F	MCA	6	3	Day 0	Partial occlusion	Day 1	D
Case 8	52F	Basilar	10	4	Day 1	Partial occlusion	Day 1	D

Acom: anterior communicating artery, Pcom: posterior communicating artery, IC: internal carotid artery, MCA: middle cerebral artery

aneurysms never rebled during the acute period of SAH in our patients.

Many authors have reported rebleedings after embolization. Viñuela et al reported that the rebleeding rate up to 36 months after endovascular treatment was 2.2%⁹. Byrne et al reported that annual rebleeding rates within 317 patients were 0.8% in the 1st year, 0.6% in the 2nd year, and 2.4% in the 3rd year after embolization, with no rebleeding in subsequent years. Byrne et al also reported that rebleedings occurred more frequently for recurrent aneurysms than for aneurysms that appeared stable on follow-up angiography¹⁰. Kiether et al reported that no completely occluded aneurysm hemorrhaged after GDC treatment (follow-up period, 1.9 years). Of near complete occlusion, 2.6% hemorrhaged after embolization at a rate of 1.4%/yr (follow-up period, 1.9 year)¹¹. However, Hodgson et al reported one case of a patient suffering SAH due to late recurrence of a previously unruptured aneurysm after complete endovascular occlusion¹². Tight packing of aneurysms is essential for long-term prevention of rebleedings.

To obtain successful packing, selection of the

case depending on the morphology of the aneurysm is very important¹³. Partially-occluded aneurysms need additional treatment.

Aneurysms of total or nearly total occlusion should be followed by angiography, and in the case of unstable embolization, which has a high risk of rebleeding, further treatment is needed. Mericle et al mentioned that angiographic follow-up may be beneficial up to 2 years after GDC treatment¹⁴. The patient who rebled 27 months after nearly total occlusion (Case 10), was revealed by the angiography performed just after rebleeding to have an enlarged neck remnant. The risk of rebleeding may be predicted by follow-up angiography.

Conclusion

Aneurysmal perforation in the course of embolization is a rare event, and the outcome of the event is not always fatal. Total or nearly total occlusion can prevent rebleeding in the acute period of SAH. However, follow-up with angiography and prompt further treatment for aneurysms with an unstable occlusion are important.

Table 3 The cases of rebleeding in the chronic period

	Age/Sex	Location	Size (mm)	Hunt&Hess grade	Result of embolization	Rebleeding	Treatment for rebleeding	GOS
Case 9	64M	MCA	10	1	Partial occlusion	2 months	Clipping	MD
Case 10	44M	Ophthalmic	7	2	Nearly total occlusion	28 months	Embolization	GR

MCA: middle cerebral artery

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