Incidence of Ischemic Complications after Endovascular Treatment for Ruptured Dissecting Vertebral Artery Aneurysms

Comparison between Those Arising Proximal to and Distal to the Origin of the Posterior Inferior Cerebellar Artery

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Summary

We analyzed the incidence of ischemic complications after internal trapping for ruptured VA dissecting aneurysms.

Between April 2001 and August 2005, nine cases of ruptured VA dissecting aneurysms, five in women, "proximal" or distal (distal type) to the origin of the PICA, were treated by internal trapping in the acute stage after SAH. There were four cases of proximal type and five of distal type. The demographics of the patients were reviewed in the medical charts and radiological findings were evaluated by neuroradiologists. The dissected site was completely obliterated and PICA was preserved in all cases. Follow-up angiography performed five to 19 days after treatment revealed complete obliteration of the aneurysm and patency of the PICA. The incidence of perioperative ischemic complications for the PICA-distal type (75%) was higher than that for the PICA-proximal type (20%).

Here we retrospectively analyzed and discussed the incidence and mechanisms of ischemic complications.

Introduction

With the recent progress of neuroimaging and increased awareness of this disease entity,

intracranial dissecting aneurysms are recognized as an important cause of stroke. The vertebral artery (VA) is one of the most common sites of intracranial dissection, and several excellent papers have been published regarding the clinical features and therapeutic approaches for VA dissecting aneurysms. Although surgical proximal occlusion and trapping remain valid options, the recent development of endovascular treatment enables these formidable lesions to be treated safely, especially in the acute stage after subarachnoid hemorrhage (SAH). This is important because recurrent bleeding from unsecured vertebral artery (VA) dissecting aneurysms is extremely high (50%-70%) and usually occurs within 24 hours of the initial rupture^{1,4,7}.

Recently, the authors advocated a management strategy for VA dissecting aneurysms based on their location in relation to the origin of the posterior inferior cerebellar artery (PICA)². Endovascular (internal) trapping, packing the dissected site with coils, is indicated for ruptured VA dissecting aneurysms in the acute stage, unless the origin of the PICA is not involved in the dissected segment; however, the incidence of ischemic complications has not been reported after internal trapping for ruptured VA dissecting aneurysms. Here we retrospectively analyzed the incidence of ischemic

Figure 1 A) A right VA dissecting aneurysm locating proximal to the PICA. B) PAO was achieved using GDCs and fiber coils. The PICA was filled from the contralateral VA.

complications and the mechanisms underlying the complications are discussed.

Clinical Material and Methods

Between April 2001 and August 2005, 285 cases of ruptured aneurysms were treated at our institution. During this period, nine cases of ruptured VA dissecting aneurysms (five women; average age: 54 years, range 39-59 years), proximal (proximal type) or distal (distal type) to the origin of the PICA, were treated by internal trapping in the acute stage after SAH. Aneurysms involving the origin of the PICA (PICA-involved type) were excluded from this study. There were four cases of proximal type and five of distal type.

After gross neurological examinations on admission, the patient was placed under general anesthesia to prevent fatal rebleeding. The demographics of the patients were reviewed in the medical charts and radiological findings were evaluated by neuroradiologists. Clinical and radiological features are summarized in table 1.

Endovascular Procedure

A No. 7 French balloon catheter was placed in the proximal VA. To secure the true lumen of

the VA, a microguidewire was advanced to the VA distal to the origin of the PICA through the lesion, if possible. A microcatheter was advanced to the distal portion of the lesion. The VA was packed using Guglielmi detachable and fibered coils from the distal portion of the dissected site to the VA proximal to the dissected site until the aneurysm was completely obliterated. If a PICA distal-type aneurysm is not completely occluded even after the VA is packed with coils from the aneurysm to just distal to the origin of the PICA, the VA segment distal to the aneurysm should be embolized by another microcatheter placed in the distal VA via contralateral VA.

Results

The Hunt & Kosnik Grades on admission were Grade 1 in two, Grade 2 in one, Grade 3 in three, Grade 4 in two, and Grade 5 in one patient (table 1). Endovascular treatment was performed on the day of admission for six patients, and on Day 1 for three patients post-SAH. All aneurysms located proximal or distal to the PICA were treated with endovascular trapping unless the contralateral VA was hypoplastic or absent such that the ipsilateral PICA would be filled from the contralateral or ipsilateral VA, respectively, after embolization

Figure 2 A) A right VA dissecting aneurysm locating distal to the PICA. B) PAO was achieved using GDCs and fiber coils. The PICA was filled from the ipsilateral VA extremely slowly. C) A left vertebral angiogram demonstrated that the dissecting aneurysm was completely obliterated.

(figure 1). Especially in the case of the PICA distal type, the ipsilateral VA and PICA was filled extremely slowly just after embolization on vertebral angiography (figure 2) because of the sudden decrease of blood flow demand in the VA. Follow-up angiography performed five to 19 days after treatment revealed complete obliteration of the aneurysm and patency of the PICA. Discrepancy of the diameters between the PICA and VA gradually decreased, and the velocity of the ipsilateral VA and PICA was normalized (figure 3).

The incidence of perioperative ischemic complications for the PICA-distal type was higher than that for the PICA-proximal type. Among four patients distal to the PICA, three patients (75%) suffered infarction (symptomatic lateral medullary infarction in one, asymptomatic cerebellar infarction in the PICA ter-

Figure 3 A) A right VA dissecting aneurysm locating distal to the PICA. B) The aneurysm was completely obliterated after PAO. The PICA was filled from the ipsilateral VA extremely slowly. C) Six months after PAO angiogram demonstrating that the diameter of the VA was decreased, and the velocity from the VA to the PICA was normalized.

ritory in two), whereas only one (20%) of five patients proximal to the PICA had fresh infarction (symptomatic lateral medullary infarction).

The final outcomes six months after SAH were good recovery in five, and moderate disability in four patients. The grade of each pa-

tient at presentation had a significant impact on the ultimate outcome. All patients who presented with Hunt & Kosnik Grades 1 and 2 made good recoveries, whereas only 33% with Grade 3 and 33% with Grades 4 and 5 recovered well. No symptomatic vasospasm was noted in this series.

Discussion

Because of the high rate of recurrent fatal bleeding from an unsecured VA dissecting aneurysm, especially within 24 hours of the initial rupture, ultra-early treatment for the dissecting aneurysm is recommended^{1,4,7}. Although various surgical treatments for ruptured VA dissecting aneurysms have been reported, such as VA trapping with/without PICA revascularization or VA proximal clipping^{3,7}, intraoperative rupture and procedure-related complications such as lower cranial nerve palsy (25%) are reported at a high rate³. Recently, the safety and efficacy of endovascular (internal) trap-

ping for VA dissecting aneurysms have been reported^{2,4-6,8}. Because of the lower invasiveness and the relatively lower risk of procedure-related complications, endovascular (internal) trapping is suggested as the first choice of treatment for ruptured VA dissecting aneurysm, unless the origin of the PICA is involved in the dissected site.

Although the PICA was preserved angiographically in all of our cases, ischemic lesions after treatment were observed in four cases (44%), two in lateral medullary infarction and two in cerebellar infarction in the PICA territory. As a cause of peri-procedural infarction, the following possibilities were considered:

- 1) compromised origin of the perforating arteries by initial dissection,
- 2) occlusion of the origin of the perforating arteries by the packed coils,
- 3) migration of the thrombus formed in the coil mass during intervention,
- 4) hemodynamic ischemia of PICA during intervention, especially during proximal balloon occlusion of the VA,
- 5) intra- or post-operative formation of a thrombus on the coil surface exposed at the stump near the origin of the PICA due to stagnant flow just after the intervention before and its distal migration.

Possible solutions to ischemic complications

Lateral medullary infarct might have already developed at the initial dissection, and endovascular trapping of the dissected site inevitably occludes perforating arteries involved in the dissected segment, even if some of the involved perforators remain patent. Because of the spatial resolutions of the currently available digital subtraction angiograms, the exact number and locations of these perforators are difficult to assess before intervention. This is one of the drawbacks of endovascular intervention compared with direct surgical trapping or proximal clip occlusion. Knowing this limitation, it is important to obliterate aneurysms using coils for as short a segment as possible to avoid such ischemic complications.

The mechanisms (3 and 4) underlying ischemic complications in the present series may be related to the use of proximal flow control. Proximal flow control is used for en-

case	age/sex	H&K	Fisher	location of PICA	after treatment		f/u angiography		infarction	complication due to infarction	GOS
					dissection	PICA	dissection	PICA			
1	49/M	1	2	distal	CO	preserved	CO	preserved	Cerebellum	None	GR
2	53/F	4	3	proximal	CO	preserved	CO	preserved	None	None	MD
3	69/F	3	3	distal	CO	preserved	CO	preserved	None	None	MD
4	59/F	3	3	distal	CO	preserved	CO	preserved	Medulla	LMS	MD
5	56/M	5	3	proximal	CO	preserved	CO	preserved	None	None	GR
6	39/F	4	3	proximal	CO	preserved	CO	preserved	None	None	MD
7	48/M	2	3	distal	CO	preserved	CO	preserved	Cerebellum	None	GR
8	58/F	1	3	proximal	CO	preserved	CO	preserved	None	None	GR
9	57/M	3	3	proximal	CO	preserved	CO	preserved	Medulla	LMS	GR

CO: completely obliterated LMS: lateral medullary syndrome GR: good recovery MD: moderate disability

Table 1

dovascular trapping of ruptured VA aneurysms for two purposes: 1) prevention of intraoperative rupture of this fragile aneurysm, and 2) prevention of migration of thrombus formed in the coils during intervention. To reduce the latter possibility, proximal VA is occluded by balloon catheter placed at the cervical portion during intervention to reduce flow through the coil mass. Of note, in the present series, cerebellar infarction was noted only in the PICA territory in the PICA distal type. During proximal flow control in the PICA distal type, a thrombus formed in the coil mass during intervention theoretically migrates only into the PICA territory by retrograde flow in the ipsilateral distal VA from the contralateral VA. Obviously, intra- and postoperative antiplatelets and anticoagulation therapy are important to prevent such thromboembolic complications, but

the vigorous use of such agents should be balanced against the potential risk of rebleeding after embolization.

The last possibility is that intra- or post-operative formation of a thrombus may be induced due to stagnant flow just after the intervention on the coil surface exposed at the stump near the origin of the PICA (described above). Due to the small number of cases, it remains an open question whether these five possibilities are responsible for each case.

Conclusions

We retrospectively analyzed the incidence of ischemic complications of endovascular trapping of ruptured VA aneurysms proximal or distal to the PICA and the mechanisms underlying the complications are discussed.

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