Neurol Med Chir (Tokyo) 51, 361~364, 2011

Coil Embolization of an Aneurysm Located at the Trunk of the Persistent Primitive Trigeminal Artery

—Case Report—

Yutaka KAI,[1] Yuki OHMORI,[1] Masaki WATANABE,[2]
Motohiro MORIOKA,[1] Teruyuki HIRANO,[2] Takayuki KAWANO,[1]
Tomotaka SAKURAMA,[1] Akiko MIURA,[1] and Jun-ichi KURATSU[1]

Departments of [1]Neurosurgery and [2]Neurology, Graduate School of Medical Sciences, Kumamoto University, Kumamoto

Abstract

A 71-year-old woman presented with an aneurysm at the trunk of the persistent primitive trigeminal artery (PPTA) manifesting as subarachnoid hemorrhage. Angiography and three-dimensional computed tomography revealed a wide-necked saccular aneurysm at the trunk of the left PPTA. Coil embolization with the balloon-assist technique was successful and PPTA patency was preserved. Preoperative conventional angiography should be performed to check for cross-filling of the PPTA. This case demonstrates that an aneurysm of the trunk of the PPTA can be successfully treated by coil embolization using the balloon-assist technique.

Key words: aneurysm, balloon assist technique, coil embolization, persistent primitive trigeminal artery

Introduction

Persistent primitive trigeminal artery (PPTA) is the most common embryological vascular remnant,[1,4] is located between the carotid and vertebrobasilar arteries,[17] and is recognized on 0.1–0.6% of cerebral angiograms. Saccular aneurysms associated with PPTA are very common, and account for 14–32% of all cerebral aneurysms.[3,4,6,7,11,14] Most aneurysms associated with the PPTA are located at the bifurcation of the carotid artery and the PPTA, whereas aneurysms arising at the PPTA trunk are extremely rare. The deep location of PPTA trunk aneurysms renders direct surgery very difficult,[17,18] so endovascular treatment has been attempted.[7,9] We present the case of an aneurysm at the trunk of the PPTA treated successfully by coil embolization using the balloon-assist technique.

Case Presentation

A 71-year-old woman was admitted with severe headache. Computed tomography (CT) revealed subarachnoid hemorrhage (SAH) primarily involving the posterior fossa (Fig. 1). CT angiography demonstrated a PPTA with an aneurysm. The PPTA was separate from the left carotid artery (C_5 portion) and connected to the basilar artery (Fig. 2). Three-dimensional (3D) left carotid angiography demonstrated a saccular aneurysm at the curved mid-portion of the trunk of the left PPTA. The aneurysm measured 5 × 5 × 7 mm, and the neck was 4.8 mm. The distal sites of the basilar artery, bilateral posterior cerebral arteries (PCAs), and bilateral superior cerebellar arteries (SCAs) were well opacified through the PPTA (Fig. 3). Right vertebral angiography showed hypoplasticity of the distal site

Fig. 1 Computed tomography scan obtained on admission showing subarachnoid hemorrhage predominantly located in the posterior fossa.

Received July 15, 2010; Accepted October 1, 2010

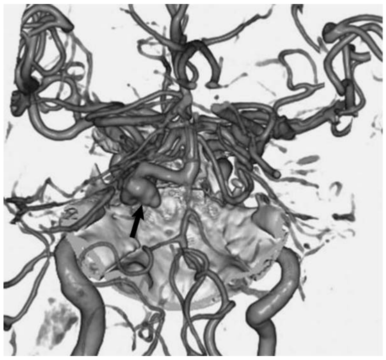

Fig. 2 Computed tomography angiogram showing a persistent primitive trigeminal artery (PPTA) separate from the left carotid artery (C_5 portion) and connected to the basilar artery, and an aneurysm arising from the PPTA trunk (*arrow*).

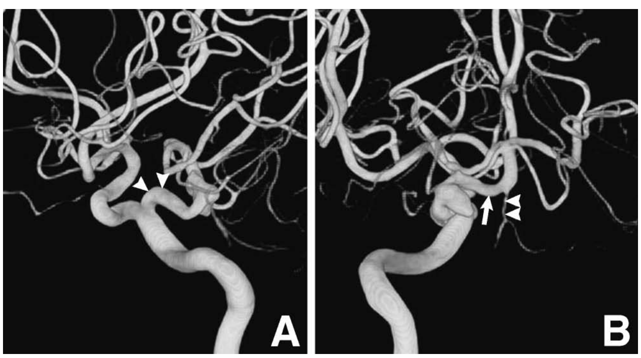

Fig. 3 A: Three-dimensional left carotid angiogram, lateral view, showing the left persistent primitive trigeminal artery (PPTA) (*arrowheads*), and the distal sites of the basilar artery and bilateral posterior cerebral and superior cerebellar arteries filled through the PPTA. B: Three-dimensional left carotid angiogram, posterior view, showing the PPTA and a saccular aneurysm arising from the PPTA trunk (*arrow*), with the right vertebral artery (*arrowheads*) and the junction of the bilateral vertebral arteries.

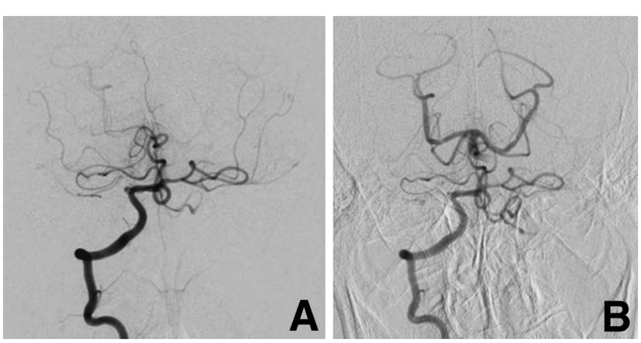

Fig. 4 A: Right vertebral angiogram, anterior view, showing hypoplasticity of the distal site of the right vertebral artery. B: Right vertebral angiogram, anterior view, after compression of the left carotid artery demonstrating the basilar artery and bilateral posterior cerebral and superior cerebellar arteries through the distal site of the vertebral artery.

Fig. 5 Left carotid angiogram, left anterior oblique view, showing the tip of the microcatheter in the aneurysm dome (*arrow*) and the HyperGlide occlusion balloon system (*arrowheads*).

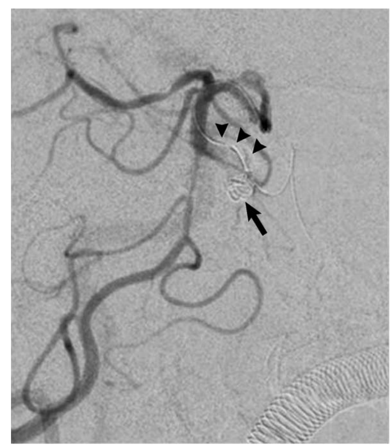

Fig. 6 Right vertebral angiogram, anterior view, after inflation of the HyperGlide balloon at the aneurysm neck (*arrowheads*) in the persistent primitive trigeminal artery trunk showing the basilar artery and bilateral posterior cerebral and superior cerebellar arteries through the distal site of the vertebral artery, and the first coil embolizing the aneurysm sac (*arrow*).

of the right vertebral artery, but the distal site of the basilar artery was visualized during left carotid artery compression (Fig. 4). These findings suggested that the PPTA could be temporarily occluded during treatment of the PPTA trunk aneurysm.

A 6-Fr guiding catheter (Slim Guide; Medikit, Tokyo) was placed in the left internal carotid artery (ICA) under general anesthesia. Intravenous anticoagulation was induced with a 3000-U heparin bolus, and the activated clotting time was maintained at approximately 250 seconds. A two-tip marked microcatheter was navigated into the aneurysm sac. A Guglielmi detachable coil (GDC), deployed as the first framing coil, failed to lock in the aneurysm sac and herniated into the PPTA trunk. We decided to proceed to neck remodeling because of the width using a microballoon catheter (Fig. 5). A HyperGlide™ oc-

Fig. 7 Left carotid angiogram, left anterior oblique view, showing complete occlusion of the aneurysm, and preservation of the patency of the persistent primitive trigeminal artery, the basilar artery, and bilateral posterior cerebral and superior cerebellar arteries.

Table 1 Summary of aneurysms associated with the persistent primitive trigeminal artery (PPTA)

	Location of aneurysm		
	ICA-PPTA	PPTA trunk	PPTA-BA
No. of cases	18	12	3
Symptom			
SAH	2	6	2
CCF	5	1	0
cranial nerve palsy	7	3	0
others	4	2	1
Treatment			
direct clipping	1	1	0
direct ICA occlusion	4	1	0
ICA occlusion with balloon	3	2	0
coil embolization	5	1	1
observation	5	0	0
unknown	0	7	2

BA: basilar artery, CCF: carotid artery-cavernous sinus fistula, ICA: internal carotid artery, SAH: subarachnoid hemorrhage.

clusion balloon system (5 × 10 mm; ev3 Neurovascular, Irvine, California, USA) was navigated to the aneurysm neck (Fig. 5). As the microballoon catheter was inflated, distal flow in the PPTA, basilar artery, and bilateral PCAs and SCAs was recognized through the right vertebral artery. The first coil (GDC 10–360°, 5 mm × 9 cm) was placed and neck remodeling was performed using microballoon inflation (Fig. 6). The HyperGlide occlusion balloon was deflated after the 2nd coil placement, then the aneurysm was completely embolized with 9 GDC-10 coils (total length 40 cm). Flow in the PPTA and the distal sites of the basilar artery and bilateral PCAs and SCAs was preserved (Fig. 7). No neurological deficits developed during the peri- or postoperative periods, and the patient returned home without neurological deficits 2 weeks after treatment.

Discussion

The PPTA originates from the ICA at the C_4 (cavernous portion) or the junction of C_4 and C_5 (petrosal portion). The PPTA exhibits 2 patterns: the medial type reflects a direct perforation of the central portion of the dorsum sellae and anastomosis with the basilar artery; and the lateral type courses along the lateral portion of the dorsum sellae, turns toward the central side, and forms an anastomosis with the basilar artery.[13,15] The lateral type runs underneath the abducens nerve, and continues caudally between the trigeminal and abducens nerves to join the distal basilar artery. Therefore, cranial nerve palsy is more frequent in individuals with PPTA of the lateral type.[7] In our patient, CT angiography demonstrated that the PPTA was the lateral type giving rise to perforating branches to the pons or trigeminal nerve root. The pontine branches can be functioning vessels in the brainstem and PPTA occlusion may produce ischemic brainstem lesions.[15,17] However, the clinical implications of perforating arteries from the PPTA remain unclear in patients undergoing treatment for PPTA aneurysms.

The specific hemodynamics of the PPTA, which directly branches and receives significant blood flow from the ICA, may induce the formation of aneurysms. Review of 261 patients with PPTA reported between 1950 and 2008 (including our case) found that 40 (15.3%) presented with PPTA-associated aneurysms.[8] The aneurysm was located at the bifurcation of the cavernous portion of the ICA in 18 patients, at the trunk of the PPTA in 12, and at the junction of the ICA and the basilar artery in 3. No location was given in the remaining 7 cases. In our patient, CT and 3D angiography demonstrated that the aneurysm arose from the trunk of the PPTA.

Three types of aneurysm location are summarized in Table 1. A small number of patients with aneurysms at the ICA-PPTA bifurcation presented with SAH, but the most common presentation was cranial nerve palsy (abducens or oculomotor palsy) or carotid artery-cavernous sinus fistula. On the other hand, the most prevalent symptom of PPTA trunk aneurysms was SAH. Interventional neurosurgery was the most common treatment to address aneurysms associated with the PPTA, using ICA occlusion by direct surgery or interventional techniques using balloons, and aneurysm embolization with detachable coils.

The trunk of the PPTA is located deep in front of the brain stem and close to the cranial nerves and perforating vessels, so the surgical approach is very difficult and PPTA occlusion has been performed.[10] Only 2 aneurysms on the PPTA trunk were treated directly, one by direct surgical clipping[8] and one by endovascular treatment.[5] The latter aneurysm arose from a PPTA variant. Our case demonstrates endovascular treatment of an aneurysm on the trunk of the PPTA. Flow preservation in the PPTA is highly important in patients undergoing treatment for PPTA trunk aneurysms, because insufficient flow in the main trunk of the PPTA compromises the circulation in the basilar artery and bilateral PCAs or SCAs, and may induce dangerous post-treatment sequelae.

The aneurysm neck was wide in our case, and the first attempt at coil placement failed because the coil mass herniated into the PPTA trunk. Therefore, we resorted to the balloon-assist technique using the HyperGlide occlusion balloon system. Complications associated with this technique include higher rate of thromboembolic events[16] and increased risk of aneurysm or vessel rupture.[12] To avoid these complications, precise control of the balloon placement and inflation is mandatory, and is facilitated by the technical properties of the HyperGlide balloon. We selected the HyperGlide because this low compliance balloon is indicated for sidewall aneurysms, and the aneurysm arising from the PPTA trunk was the sidewall type in our patient. On the other hand, the HyperForm™ balloon (ev3 Neurovascular) allows treatment of wide-necked intracranial aneurysms located on arterial bifurcations or small arteries.[2] This highly compliant balloon offers the advantage of changing easily from the cylindrical shape to bulge into the origin of the arterial bifurcation and seal the aneurysm neck.

Our endovascular treatment safely and successfully embolized the ruptured aneurysm completely. We recommend that conventional angiography be performed with left ICA compression in patients undergoing endovascular treatment of PPTA aneurysms, to ascertain that distal flow in the PPTA, basilar artery, and bilateral PCAs and SCAs will be redirected from the right vertebral artery after inflation of the HyperGlide balloon.

References

1) Agnoli AL: Vascular anomalies and subarachnoid haemorrhage associated with persisting embryonic vessels. *Acta Neurochir (Wien)* 60: 183–199, 1982
2) Baldi S, Mounayer C, Piotin M, Spelle L, Moret J: Balloon-assisted coil placement in wide-neck bifurcation aneurysms by use of a new, compliant balloon microcatheter. *AJNR Am J Neuroradiol* 24: 1222–1225, 2003
3) Brick JF, Roberts T: Cerebral arteriovenous malformation coexistent with intracranial aneurysm and persistent trigeminal artery. *South Med J* 80: 398–400, 1987
4) George AE, Lin JP, Morantz RA: Intracranial aneurysm on a persistent primitive trigeminal artery. Case report. *J Neurosurg* 35: 601–604, 1971
5) Hanabusa K, Murao K, Morikawa A, Taki W, Waga S: Endovascular treatment for a ruptured persistent trigeminal artery variant aneurysm on the distal portion—Case report. *Neurol Med Chir (Tokyo)* 40: 637–640, 2000
6) Ikushima I, Arikawa S, Korogi Y, Uehara H, Komohara Y, Takahashi M: Basilar artery aneurysm treated with coil embolization via persistent primitive trigeminal artery. *Cardiovasc Intervent Radiol* 25: 70–71, 2002
7) Kwon K, Kim K, Jeon P, Byun HS, Kim JS, Hong SC: Endovascular treatment for a persistent trigeminal artery aneurysm presenting as isolated sixth nerve palsy. *Neurointervention* 2: 113–116, 2007
8) Li MH, Li WB, Pan YP, Hang C, Wang W: Persistent primitive trigeminal artery associated with aneurysm: Report of two cases and review of the literature. *Acta Radiol* 45: 664–668, 2004
9) Mohammed MI, Sandhu JS, Wakhloo AK: Stent-assisted coil placement in a wide-necked persistent trigeminal artery aneurysm with jailing of the trigeminal artery: A case report. *AJNR Am J Neuroradiol* 23: 437–441, 2002
10) Morrison G, Hegarty WM, Brausch CC, Castele TJ, White RJ: Direct surgical obliteration of a persistent trigeminal artery aneurysm. Case report. *J Neurosurg* 40: 249–251, 1974
11) Palmer S, Gucer G: Vertebrobasilar insufficiency from carotid disease associated with a trigeminal artery. *Neurosurgery* 8: 458–461, 1981
12) Phatouros CC, Halbach VV, Malek AM, Dowd CF, Higashida RT: Simultaneous subarachnoid hemorrhage and carotid cavernous fistula after rupture of a paraclinoid aneurysm during balloon-assisted coil embolization. *AJNR Am J Neuroradiol* 20: 1100–1102, 1999
13) Piotin M, Miralbes S, Cattin F, Marchal H, Amor-Sahli M, Moulin T, Bonneville JF: MRI and MR angiography of persistent trigeminal artery. *Neuroradiology* 38: 730–733, 1996
14) Rossitti S, Raininko R: Absence of the common carotid artery in a patient with a persistent trigeminal artery variant. *Clin Radiol* 56: 79–81, 2001
15) Salas E, Ziyal IM, Sekhar LN, Wright DC: Persistent trigeminal artery: An anatomic study. *Neurosurgery* 43: 557–561, 1998
16) Soeda A, Sakai N, Murao K, Sakai H, Ihara K, Yamada N, Imakita S, Nagata I: Thromboembolic events associated with Guglielmi detachable coil embolization with use of diffusion-weighted MR imaging. Part II. Detection of the microemboli proximal to cerebral aneurysm. *AJNR Am J Neuroradiol* 24: 2035–2038, 2003
17) Suttner N, Mura J, Tedeschi H, Ferreia MA, Whe HT, de Oliveira E, Rhoton AL Jr: Persistent trigeminal artery: A unique anatomic specimen—Analysis and therapeutic implications. *Neurosurgery* 47: 428–433, 2000
18) Takase T, Tanabe H, Kondo A, Nonoguchi N, Tane K: Surgically treated aneurysm of the trunk of the persistent primitive trigeminal artery—Case report. *Neurol Med Chir (Tokyo)* 44: 420–423, 2004

Address reprint requests to: Yutaka Kai, MD, PhD, Department of Neurosurgery, Graduate School of Medical Sciences, Kumamoto University, 1–1–1 Honjo, Kumamoto 860–8556, Japan.
e-mail: ykai@fc.kuh.kumamoto-u.ac.jp