Ruptured Aneurysm at the Origin of the Median Artery of the Corpus Callosum Associated With Accessory Middle Cerebral Artery

—Case Report—

Kiyoyuki YANAKA^{*,**}, Shizuo SHIRAI^{*}, Yasushi SHIBATA^{*}, and Tadao NOSE^{**}

^{*}Neurosurgery Division, Soujinkai Hospital, Ibaraki; ^{**}Department of Neurosurgery,
Institute of Clinical Medicine, University of Tsukuba, Tsukuba, Ibaraki

Abstract

A 62-year-old male presented with ruptured anterior communicating artery (ACoA) aneurysm manifesting as severe headache associated with the rare combination of median artery of the corpus callosum (MACC) and accessory middle cerebral artery (MCA). Computed tomography demonstrated diffuse subarachnoid hemorrhage. Left carotid angiography demonstrated an anomalous vessel originating from the ACoA complex and passing forward in the interhemispheric fissure between the two companion A₂ segments. This vessel was identified as the MACC. Another anomalous vessel originated from the left A₁-A₂ segment and passed into the sylvian fissure. This vessel was identified as the accessory MCA. Left frontotemporal craniotomy was performed to clip the neck of the aneurysm. After identifying both A₁ and A₂ segments, accessory MCA, and the MACC, the aneurysm neck was occluded successfully. The ACoA complex is one of the most frequent sites of vascular anomalies. Preoperative and intraoperative care is required to identify the presence of anomalies of the ACoA complex prior to clip placement, to avoid accidental damage or clipping, which may result in severe neurological deficits.

Key words: accessory middle cerebral artery, aneurysm, anterior communicating artery, median artery of the corpus callosum

Introduction

Vascular anomalies of the anterior communicating artery (ACoA) complex are common, and include ACoA aplasia, duplication of the ACoA, A₁ hypoplasia or aplasia, azygos anterior cerebral artery (ACA), and triplicate A₂ segments of the ACA.^{4,5,8,11)} The term median artery of the corpus callosum (MACC) is used to refer to the median artery of the triplicate A₂ segments, which supplies branches to the corpus callosum and adjacent cortex as well as the septal nuclei, and upper portion of the column of the fornix.²⁾ This artery has also been termed the medial ACA, the accessory ACA, the median callosal artery, the superior callosal artery, and the third A₂ artery.^{7,21)} However, these various terms are used without clear definition. MACC supplying one or more of the usual cortical branches

of ACA, and thus irrigating a relatively large cerebral cortical area, can be classified as the "accessory ACA."²⁾ The difference between these anomalies is that accessory ACA supplies one or more of the usual cortical branches but the MACC did not supply any of these branches. The accessory ACA can be divided into two types, the unihemispheric and bihemispheric accessory ACA.⁹⁾ The incidence of MACC in patients with ACoA aneurysms varies between 4.5–14.2%.^{1,8,13,22)}

Accessory middle cerebral artery (MCA) is an anomalous vessel that originates from the A₁ segment, the A₁-A₂ junction, or the ACoA complex, and runs through the sylvian fissure along with the MCA.¹⁷⁾ The angiographical incidence of this anomalous vessel is 0.24% to 3.2%.^{3,15,16)} Aneurysms are associated with the accessory MCA, and are usually located proximal to the accessory MCA and less often arise from the ACoA complex.^{10,14,17,21)}

We describe a case of ruptured aneurysm which

arose at the origin of the MACC associated with accessory MCA, an extremely unusual combination of two vascular anomalies.

Case Report

A 62-year-old male with hypertension and diabetes mellitus suddenly developed severe headache and nausea. The patient was transferred to our hospital immediately. Computed tomography demonstrated thick and diffuse subarachnoid hemorrhage with mild hydrocephalus (Fig. 1). Left carotid angiography showed a dominant left A₁ segment with filling of bilateral A₂ segments, and an anomalous vessel originating from the ACoA complex and passing forward in the interhemispheric fissure between the two companion A₂ segments. This anomalous vessel did not supply any of the usual cortical branches, and thus was identified as the MACC. Another anomalous vessel was seen originating from the left A₁-A₂ segment, which passed into the sylvian fissure and to the MCA cortical distribution. This vessel was identified as the accessory MCA (Figs. 2 and 3). Therefore, the diagnosis was aneurysm associated with two vascular anomalies, the MACC and the accessory MCA.

Left frontotemporal craniotomy was performed 6 hours after the onset of the symptoms to clip the neck of the aneurysm, using a left pterional approach. Both A₁ and A₂ segments were identified with some difficulty due to the presence of the ac-

Fig. 1 Computed tomography scan on admission showing subarachnoid hemorrhage and mild ventriculomegaly.

Fig. 2 Left carotid angiogram showing an anterior communicating artery aneurysm (thick arrow) at the origin of the median artery of the corpus callosum (arrowhead), which is associated with the accessory middle cerebral artery (arrows).

Fig. 3 Right carotid angiogram with compression of the left carotid artery clearly showing the triplicate A₂ segments.

cessory MCA, but exposure of the aneurysm and its adjacent structures was easy. The aneurysm was directed anteriorly and inferiorly to the frontal base. After identifying both A₁ and A₂ segments, the accessory MCA, and the MACC, the aneurysm neck was occluded with a Sugita No.1 Clip (Mizuho Ika Co., Tokyo). All major vessels around the aneurysm were found to be free of the clip. There was no obvious Heubner's artery in the operative field.

The postoperative course was uneventful and the patient was discharged 5 weeks after the onset with good capacity to engage daily life.

Discussion

Hemodynamic alterations caused by vascular anomalies or variations of the circle of Willis can lead to aneurysm formation.^{5,6,11,21)} The hemodynamic abnormalities impose stress on the bifurcation of the artery resulting in the development of an aneurysm.¹²⁾ In our case, the aneurysm originated from the ACoA complex where the left A₁ and A₂ segments, MACC, and accessory MCA originated. The aneurysm was directed anteriorly and inferiorly to the frontal base, and at a right angle to the ACoA and parallel to the MACC. Recurrent blood flow from the MACC may apply a greater force to the arterial junctions. In addition, the increased blood flow in the parent artery due to the presence of the accessory MCA is also thought to have caused hemodynamic stress.

Successful surgical treatment of an aneurysm is based upon complete obliteration of the aneurysm sac without injury to the associated vessels. Treatment of ACoA aneurysms involves numerous vessels to be identified and preserved including bilateral A₁ segments, the ACoA, bilateral recurrent arteries, all hypothalamic perforating arteries, and bilateral A₂ segments.^{4,5,13)} Anomalies of the vessels of the ACoA complex are common,⁸⁾ and the incidence of poor outcome due to surgical trauma is greater for ACoA aneurysms than for other anterior circulation aneurysms.²¹⁾ Two cases of ACoA aneurysms associated with MACC resulted in poor operative outcome due to inadvertent clip occlusion of the MACC.⁵⁾ Bilateral A₁ and two A₂ segments were identified before applying a clip, but failure to identify the MACC resulted in inadvertent occlusion of the MACC and cerebral infarction. An unsuspected MACC poses a particular threat to successful surgery as it can be left undissected and remain between the clips.⁵⁾ This kind of complication due to inadvertent clip occlusion is most effectively avoided by preoperative angiographic identification. In our case, we could identify these anomalous vessels before surgery, but angiography often does not provide enough resolution to completely define the anatomy of the ACoA complex due to spasm or intraluminal thrombus associated with subarachnoid hemorrhage.¹¹⁾ Therefore, direct visualization of the ACoA complex via the operative microscope is necessary to identify and preserve these vital structures and to establish the presence or absence of the MACC or recurrent arteries before clip application. Clinical application of intraoperative digital subtraction angiography could also prevent inadvertent clip occlusion of major vessels including MACC.¹⁸⁻²⁰⁾

Accessory MCA does not cause problems in the contralateral pterional or interhemispheric approaches to the aneurysm around the ACoA complex. We performed left frontotemporal craniotomy ipsilateral to the accessory MCA in this case because the left A₁ was dominant. There was some difficulty in identifying bilateral A₁ and two A₂ segments and the MACC because the accessory MCA hindered the operative view. However, by tracing the accessory MCA to the ACoA complex, we could recognize all major vessels and anomalous vessels, and carried out safe clipping of the aneurysm. Possible variations of the vascular system must be considered in surgical approaches to aneurysms in this area.

Acknowledgment

The authors wish to thank Stephen Spellman, B.A. of the Department of Neurosurgery at University of Minnesota (Minneapolis, Minn., U.S.A.) for his assistance in proofreading the article in English.

References

- 1) Aydin IH, Takci E, Kadioglu HH, Tuzun Y, Kayaoglu CR, Barlas E: Vascular variations associated with anterior communicating artery aneurysms — An intraoperative study. *Minim Invasive Neurosurg* 40: 17-21, 1997
- 2) Baptista AG: Studies on the arteries of the brain: II — The anterior cerebral artery: Some anatomic features and their clinical implications. *Neurology* 13: 825-835, 1963
- 3) Crompton MR: The pathology of ruptured middle cerebral aneurysms with special reference to the differences between the sexes. *Lancet* 2: 421-425, 1962
- 4) Dunker RO, Harris AB: Surgical anatomy of the proximal anterior cerebral artery. *J Neurosurg* 44: 359-367, 1976
- 5) Gibbons K, Hopkins LN, Heros RC: Occlusion of an "accessory" distal anterior cerebral artery during treatment of anterior communicating artery aneurysms. Report of two cases. *J Neurosurg* 74: 133-135, 1991
- 6) Gomes FB, Dujovny M, Umansky F, Berman SK, Diaz FG, Ausman JI, Mirchandani HG, Ray WJ: Microanatomy of anterior cerebral artery. *Surg Neurol* 26: 136-141, 1986
- 7) Huber P: *Krayenbühl/Yasargil Cerebral Angiography*, ed 2. Stuttgart, Georg Thieme Verlag, 1982, pp 79-136
- 8) Kwak R, Niizuma H, Hatanaka M, Suzuki J: Anterior communicating artery aneurysms with associated anomalies. *J Neurosurg* 52: 162-164, 1980
- 9) Morioka M, Fujioka S, Itoyama Y, Ushio Y: Ruptured distal accessory anterior cerebral artery aneurysm: Case report. *Neurosurgery* 40: 399-402, 1997

- 10) Nakamura T, Houkin K, Saitoh H, Abe H: Aneurysm of the anterior communicating artery associated with accessory middle cerebral artery. Case report. *Neurol Med Chir (Tokyo)* 37: 747-751, 1997
- 11) Perlmutter D, Rhoton AL: Microsurgical anatomy of the anterior cerebral-anterior communicating-recurrent artery complex. *J Neurosurg* 45: 259-272, 1976
- 12) Suzuki J, Ohara H: Clinicopathological study of cerebral aneurysms. Origins, rupture, repair, and growth. *J Neurosurg* 48: 505-514, 1978
- 13) Suzuki M, Ogawa A, Kayama T, Sakurai Y, Suzuki J: [Vascular anomalies associated with anterior communicating aneurysms]. *No Shinkei Geka* 16: 498-502, 1988 (Jpn, with Eng abstract)
- 14) Tacconi L, Johnston FG, Symon L: Accessory middle cerebral artery. Case report. *J Neurosurg* 83: 916-918, 1995
- 15) Umansky F, Dujovny M, Ausman JI, Fernando GD, Mirchandani HG: Anomalies and variations of the middle cerebral artery: A microanatomy study. *Neurosurgery* 22: 1023-1027, 1988
- 16) Watanabe T, Togo M, Shibuya S, Yoshida Y, Amo M, Fukumitsu T: [The accessory middle cerebral artery]. *No Shinkei Geka* 3: 31-35, 1975 (Jpn, with Eng abstract)
- 17) Yamamoto H, Marubayashi T, Soejima T, Matsuoka S, Matsukado Y, Ushio Y: Accessory middle cerebral artery and duplication of middle cerebral artery: Terminology, incidence, vascular etiology, and developmental significance. *Neurol Med Chir (Tokyo)* 32: 262-267, 1992
- 18) Yanaka K, Meguro K, Narushima K, Fukuda I, Noguchi Y, Nose T: Combined carotid endarterectomy and coronary artery bypass graft. *Neurol Med Chir (Tokyo)* 38: 836-843, 1998
- 19) Yanaka K, Meguro K, Narushima K, Takano S, Doi M, Nose T: Basal perforating artery aneurysm within the cavum septi pellucidi. *J Neurosurg* 88: 601-604, 1998
- 20) Yanaka K, Meguro K, Nose T: Intraoperative angiography. *J Neurosurg* 89: 501-502, 1998 (letter)
- 21) Yasargil MG: *Microneurosurgery. I. Microsurgical Anatomy of the Basal Cisterns and Vessels of the Brain, Diagnostic Studies, General Operative Techniques and Pathological Considerations of the Intracranial Aneurysms*. Stuttgart, Georg Thieme Verlag, 1984, pp 84-128
- 22) Yasargil MG, Smith RD: Association of middle cerebral artery anomalies with saccular aneurysm and moyamoya disease. *Surg Neurol* 6: 39-43, 1976

Address reprint requests to: K. Yanaka, M.D., Department of Neurosurgery, Institute of Clinical Medicine, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8575, Japan.