

## Case Report

# Saccular Aneurysm at the Anterior Communicating Artery Complex Associated with an Accessory Middle Cerebral Artery : Report of Two Cases and Review of the Literature

Dong-Hun Kang, M.D., Jaechan Park, M.D., Seong-Hyun Park, M.D., In-Suk Hamm, M.D., Ph.D.

Department of Neurosurgery, School of Medicine, Kyungpook National University, Daegu, Korea

Accessory middle cerebral artery (MCA) is an infrequent vascular anomaly of the brain. Cerebral aneurysms associated with this anomalous artery are also very rare. To our knowledge, there have only been ten previous reports of an aneurysm associated with accessory MCA. The authors present two patients with accessory MCA-related aneurysms. A 38-year-old male and a 59-year-old female both presented with sudden-onset severe headache. In both patients, computed tomography (CT) scan revealed subarachnoid hemorrhage. A subsequent angiogram demonstrated an accessory MCA arising from the anterior cerebral artery (ACA) and a saccular aneurysm at the anterior communicating artery (ACoA) complex associated with an accessory MCA. Surgical clipping allowed for complete exclusion of the aneurysm from the arterial circulation. Based on our review of the ten cases of aneurysms associated with accessory MCA documented in the literature, we suggest that accessory MCA-related aneurysms can be classified according to whether the accessory MCA originates from the proximal A1 segment or from the ACoA complex. We also emphasize the importance of precise interpretation of preoperative angiograms and intraoperative precaution in determining the presence of this anomalous artery prior to temporary clip placement.

**KEY WORDS :** Accessory middle cerebral artery · Aneurysm · Anterior communicating artery complex.

## INTRODUCTION

There are three major variations of the middle cerebral artery (MCA) : fenestrated MCA, duplicated MCA, and accessory MCA<sup>1,6,17</sup>. Accessory MCA is rare in comparison to other variations of the MCA. An accessory MCA is an anomalous vessel that arises from the anterior cerebral artery (ACA) and supplies the cortical territory of the orbitofrontal and/or prefrontal arteries. It runs through the sylvian fissure along with the MCA. There have been many reports of this anomalous vessel in autopsy and angiographic studies, and the incidence is estimated at 0.3% to 4%<sup>10,19,20,22</sup>. Furthermore, cerebral aneurysms occurring in

association with this anomalous artery are very rare. To our knowledge (based on PubMed search), there have only been ten previous reports of accessory MCA-related aneurysms, including nine saccular aneurysms originating from the junction of the accessory MCA<sup>3-5,7,8,12,13,16,18,21</sup>.

In the present study, we report two additional cases of ruptured saccular aneurysms at the anterior communicating artery (ACoA) complex in close association with accessory MCA.

## CASE REPORT

### Case 1

A 38-year-old male was admitted with severe headache, nausea and vomiting. He was alert with Hunt and Hess grade 3 and computed tomography (CT) scan revealed Fisher group 3 subarachnoid hemorrhage predominantly located on the left side (Fig. 1A). Left carotid angiography revealed an accessory MCA originating from the hori-

• Received : January 21, 2009 • Revised : March 5, 2009

• Accepted : October 26, 2009

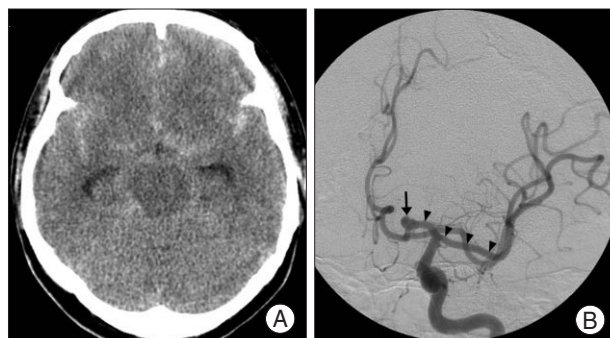
• Address for reprints : Jaechan Park, M.D.

Department of Neurosurgery, School of Medicine, Kyungpook National University, 50 Samdeok-dong 2-ga, Jung-gu, Daegu 700-721, Korea

Tel : +82-53-420-5656, Fax : +82-53-423-0504

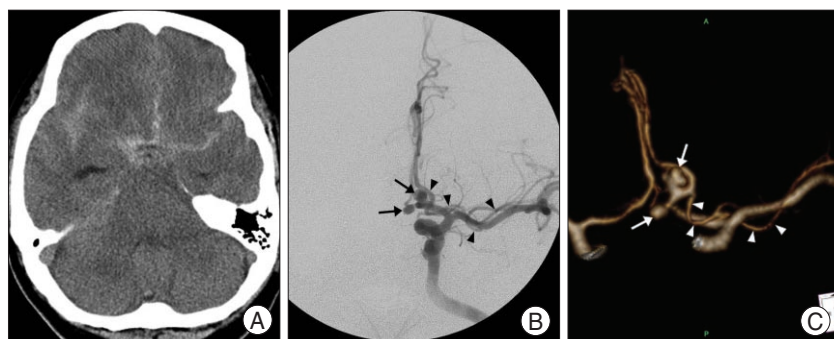
E-mail : kahdock@freechal.com

zontal segment (A1 segment) of the left ACA, as well as a saccular aneurysm arising from the junction of the distal



**Fig. 1.** Case 1. A : Unenhanced computed tomography scan showing diffuse subarachnoid hemorrhage in the basal cistern and bilateral sylvian fissures, predominantly located on the left side. B : Preoperative angiography revealing an accessory middle cerebral artery (MCA) (arrowheads) originating from the distal A1 segment of the left anterior cerebral artery, with a saccular aneurysm (arrow) arising from the junction of the distal A1 segment and accessory MCA.

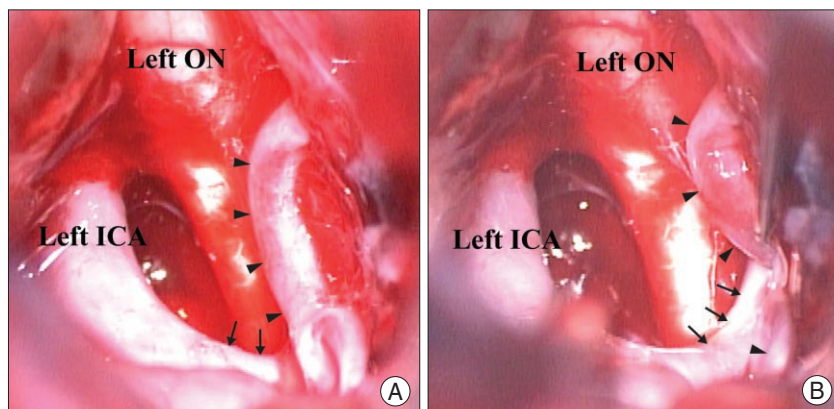
A1 segment and accessory MCA (Fig. 1B). The aneurysm was 4 × 5 mm in size and directed superomedially. No other vascular abnormalities were observed on right carotid and vertebral angiography. A left pterional craniotomy was performed on the day of admission. After opening the sylvian fissure, an accessory MCA arising from the distal A1 segment of the left ACA was observed, along with an aneurysm at the origin of the accessory MCA. The caliber of the accessory MCA was similar to that of the A1 segment. The neck of the aneurysm was carefully dissected and successfully clipped with a Yasargil titanium straight clip. Postoperative three dimensional-CT angiography confirmed that the aneurysm was successfully clipped and excluded from the arterial circulation. The postoperative course was uneventful, and the patient was discharged with no neurological deficits three weeks after the operation.



**Fig. 2.** Case 2. A : Unenhanced computed tomography (CT) scan showing a moderate amount of subarachnoid hemorrhage in the basal cistern and both sylvian fissures. Preoperative angiography B : and three dimensional CT angiography C : revealing an accessory middle cerebral artery (MCA) (arrowheads) originating from the proximal A2 segment of the left anterior cerebral artery (ACA) and two aneurysms (arrows) near the origin of the accessory MCA. One aneurysm was found on the ACoA, and the other was found on the fenestrated A2 segment of the left ACA.

## Case 2

A 59-year-old female was admitted with severe headache, vomiting. She was alert with Hunt and Hess grade 3 and CT scan revealed Fisher group 3 subarachnoid hemorrhage (Fig. 2A). Subsequent conventional angiography and three dimensional-CT angiography showed an accessory MCA originating from the proximal A2 segment of the left ACA and two aneurysms near the origin of the accessory MCA. An aneurysm was found on the ACoA in the inferior direction and another was found at the fenestrated A2 segment of the left ACA in the posterolateral direction (Fig. 2B, C). A left pterional craniotomy was performed on the day of admission. While preparing for temporary occlusion of the ipsilateral A1 segment, we encountered two arteries near the proximal ACA. One was the A1 segment of the left ACA, and the other was the accessory MCA. Due to the similarity of the course and caliber of the two vessels there was some debate regarding which artery should be temporarily clipped (Fig. 3). After confirming the origin of the accessory MCA, the A1 segment of the left ACA was temporarily clipped. The



**Fig. 3.** Intraoperative photograph demonstrating the area of accessory middle cerebral artery (MCA). A : After opening the sylvian fissure, we encountered two arteries around the proximal anterior cerebral artery (ACA). One was the A1 segment of the left ACA (arrows), and the other was an accessory MCA (arrowheads). B : After retracting an accessory MCA, the A1 segment of the left ACA was exposed. ON : optic nerve; ICA : internal carotid artery.

necks of the two aneurysms were carefully dissected and clipped successfully using Yasargil titanium straight clips. Postoperative three dimensional-CT angiography confirmed successful clipping. The postoperative course was uneventful, and she was discharged in good condition five weeks after the operation.

**DISCUSSION**

In 1962, Crompton described the first accessory MCA, which included duplication of the MCA, and the anomalous vessel originated from the A1 portion of the ACA, which ran parallel to the MCA and supplied the territory of the MCA<sup>2</sup>. In 1973, Teal et al.<sup>19</sup> described an anomalous vessel originating from the ACA as an accessory MCA and an anomalous vessel originating from the internal carotid artery as a duplication of the MCA<sup>19</sup>. This terminology is now widely accepted, and we therefore used the term “accessory MCA” according to their definition in the present study.

Hemodynamic stress is thought to be an important factor in the development of an aneurysm at the junction of an accessory MCA and the ACA. The direction of blood flow in the accessory MCA is recurrent to that in the parent vessel, and such recurrent blood flow is likely to cause high levels of hemodynamic stress at the arterial junction, leading to vessel tortuosity and aneurysm growth<sup>3,9,17</sup>.

The first case of an aneurysm of an accessory MCA was first reported in 1977. To the best of our knowledge, only eleven reports, including our own, of patients with aneurysms in conjunction with the accessory MCA have been reported in the literature<sup>3-5,7,8,12,13,16,18,21</sup>. Based on the angiographic findings of the previous studies, the reported cases can be classified into two subgroups based on the origin of the accessory MCA. Seven patients had an aneurysm associated with an accessory MCA originating from the proximal A1 segment. Five patients, including the two reported in the present study, had a saccular aneurysm arising from the ACoA complex with a nearby emitting accessory MCA (Table 1). The ACoA complex includes the distal portions of the A1 segment, the ACoA, and both A2 portions, together with the orbitofrontal artery and perforators arising

**Table 1.** Clinical characteristics of 12 reported cases of accessory middle cerebral artery related aneurysm

Case No.	Author (year)	Sex/ Age (yrs)	Presentation	Angiographic feature of accessory MCA related aneurysm		
				Side	Type	Location
1	Waga et al. (1977)	F/51	SAH	Left	Saccular	Proximal A1*
2	Handa et al. (1982)	F/55	SAH	Right	Saccular	Proximal A1*
3	Fuwa et al. (1984)	M/57	Incidental	Left	Saccular	Proximal A1*
4	Miyazaki et al. (1984)	M/42	SAH	Left	Saccular	Proximal A1*
5	Kuwabara et al. (1990)	F/73	SAH	Right	Saccular	ACoA complex †
6	Han et al. (1994)	F/34	SAH	Left	Saccular	Proximal A1*
7	Sugita et al. (1995)	M/53	Visual impairment	Right	Saccular	ACoA complex †
8	Otawara et al. (1997)	F/66	SAH	Right	Dissecting	Proximal A1*
9	Georgopoulos et al. (1999)	F/32	SAH, ICH	Left	Saccular	Proximal A1*
10	Fujiwara et al. (2003)	M/30	SAH	Right	Saccular	ACoA complex †
11	Present case 1	M/38	SAH	Left	Saccular	ACoA complex †
12	Present case 2	F/59	SAH	Left	Saccular	ACoA complex †

\*Aneurysm at the junction of the proximal A1 segment and the accessory MC. †Aneurysm at the anterior communicating artery complex in conjunction with accessory MCA. ACoA : anterior communicating artery, ICH : intracerebral hemorrhage, SAH : subarachnoid hemorrhage

from the ACoA<sup>15</sup>. Therefore, the authors used the term “aneurysm at the ACoA complex in association with accessory MCA” rather than “accessory MCA aneurysm” when describing our cases.

With respect to the clinical importance of accessory MCA, it has the potential to serve as a collateral blood supply to the MCA territory in cases of MCA occlusion<sup>11,14</sup>. Komiyama et al. reviewed angiograms from four patients with accessory MCAs with regards to the origin, size, and cortical supply of the anomalous vessels, along with the presence of perforating arteries and the recurrent artery of Heubner. The accessory MCAs supplied the cortical territory of the orbitofrontal and/or prefrontal arteries. The accessory MCA had perforating arteries in all four cases and coexisted with the recurrent artery of Heubner in three of the four cases, whereas the main MCA had perforating arteries in one case.

Due to the aforementioned functional importance of the accessory MCA, a precise and detailed interpretation of preoperative angiographic studies is required in patients with accessory MCA-related aneurysms. It is very important to determine the course, exact site of origin, and caliber of the accessory MCA, as such detailed angiographic

information will help neurosurgeons to prevent complications from developing during surgical intervention for an accessory MCA-related aneurysm. In the present cases, the accessory MCA was encountered earlier than the proximal A1 segment after opening the sylvian fissure. When performing temporary clip placement during the surgeries for accessory MCA-related aneurysm, careful discrimination between the accessory MCA and A1 segment of the ipsilateral ACA is necessary in order to prevent ischemic complications caused by prolonged clipping of the accessory MCA.

## CONCLUSION

Aneurysms occurring in association with accessory MCAs have rarely been reported. In the present study, we present two patients with saccular aneurysms at the ACoA complex associated with accessory MCAs. Based on our review of the previously reported cases, accessory MCA-related aneurysms can be classified according to whether the accessory MCA originates from the proximal A1 segment or from the ACoA complex. When performing surgery in these patients, careful interpretation of preoperative angiograms and intraoperative precaution in determining the presence of an accessory MCA prior to temporary clip placement are necessary, as taking care of important perforators in conventional aneurysm surgery with normal anatomy.

## References

- Choi JW, Joo SP, Lee JK, Kim TS : Middle cerebral artery variations associated with intracranial aneurysmal rupture. *J Korean Neurosurg Soc* 39 : 467-470, 2006
- Crompton MR : The pathology of ruptured middle-cerebral aneurysms with special reference to the differences between the sexes. *Lancet* 2 : 421-425, 1962
- Fujiwara K, Saito K, Ebina T : Saccular aneurysm of the accessory middle cerebral artery-case report. *Neurol Med Chir (Tokyo)* 43 : 31-34, 2003
- Fuwa I, Matsukado Y, Wada H : [Intracranial aneurysms associated with the accessory middle cerebral artery and duplication of the middle cerebral artery. Report of two cases.] *Neurol Med Chir (Tokyo)* 24 : 207-211, 1984
- Georgopoulos CE, Papanikolaou PG, Vlachos KI, Atzemi-Moldow N, Hatzidakis GI : Ruptured aneurysm at the trunk of the accessory middle cerebral artery. *Acta Neurochir (Wien)* 141 : 1233-1235, 1999
- Gibo H, Carver CC, Rhoton AL Jr, Lenkey C, Mitchell RJ : Microsurgical anatomy of the middle cerebral artery. *J Neurosurg* 54 : 151-169, 1981
- Han DH, Gwak HS, Chung CK : Aneurysm at the origin of accessory middle cerebral artery associated with middle cerebral artery aplasia : case report. *Surg Neurol* 42 : 388-391, 1994
- Handa J, Matsuda M, Okamoto K, Kidooka M : Association between accessory middle artery and cerebral aneurysm. Report of two cases. *Acta Neurochir (Wien)* 64 : 151-157, 1982
- Hashimoto N, Handa H, Nagata I, Hazama F : Experimentally induced cerebral aneurysms in rats : Part V. Relation of hemodynamics in the circle of Willis to formation of aneurysms. *Surg Neurol* 13 : 41-45, 1980
- Komiyama M, Nakajima H, Nishikawa M, Yasui T : Middle cerebral artery variations : duplicated and accessory arteries. *AJNR Am J Neuroradiol* 19 : 45-49, 1998
- Komiyama M, Nishikawa M, Yasui T : The accessory middle cerebral artery as a collateral blood supply. *AJNR Am J Neuroradiol* 18 : 587-590, 1997
- Kuwabara S, Naitoh H : Ruptured aneurysm at the origin of the accessory middle cerebral artery : case report. *Neurosurgery* 26 : 320-322, 1990
- Miyazaki S, Ito K, Ishii S : Aneurysm at the origin of the accessory middle cerebral artery. *Surg Neurol* 22 : 292-294, 1984
- Mueller DP, Sato Y, Yuh WT : Accessory middle cerebral artery as a source of collateral blood flow. *AJNR Am J Neuroradiol* 12 : 1223-1224, 1991
- Nathal E, Yasui N, Sampei T, Suzuki A : Intraoperative anatomical studies in patients with aneurysms of the anterior communicating artery complex. *J Neurosurg* 76 : 629-634, 1992
- Otawara Y, Suzuki M, Abe M, Tomizuka N, Ogawa A : Dissecting aneurysms of the anterior cerebral artery and accessory middle cerebral artery. Case report. *Neurosurg Rev* 20 : 145-148, 1997
- Park J, Hwang JH, Hamm IS : Aneurysm rupture at an anomalous collateral artery that extended from the proximal A2 segment to the middle of the M1 segment, bypassing atresia of the internal carotid artery bifurcation. Case report. *J Neurosurg* 100 : 332-334, 2004
- Sugita S, Yuge T, Miyagi J, Fujimura N, Shigemori M : Giant aneurysm at the origin of the accessory middle cerebral artery. *Surg Neurol* 44 : 128-130, 1995
- Teal JS, Rumbaugh CL, Bergeron RT, Segall HD : Anomalies of the middle cerebral artery : accessory artery, duplication, and early bifurcation. *Am J Roentgenol Radium Ther Nucl Med* 118 : 567-575, 1973
- Umansky F, Dujovny M, Ausman JI, Diaz FG, Mirchandani HG : Anomalies and variations of the middle cerebral artery : a microanatomical study. *Neurosurgery* 22 : 1023-1027, 1988
- Waga S, Kojima T, Morooka Y, Sakakura M : Aneurysm of the accessory middle cerebral artery. *Surg Neurol* 8 : 359-360, 1977
- 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