CLINICAL IMAGE

Fenestration of the Middle Cerebral Artery Detected by MR Angiography

Akira UCHINO*, Yukinori TAKASE, Keita NOMIYAMA, Ryoko EGASHIRA, and Sho KUDO

Department of Radiology, Saga Medical School
5–1–1 Nabeshima, Saga 849–8501, Japan
(Received January 6, 2006; Accepted February 8, 2006)

Unlike fenestration of the posterior cerebral arterial circulation, fenestration of the anterior cerebral arterial circulation has not been well described. We investigated the location and configuration of fenestration of the middle cerebral artery (MCA) detected by magnetic resonance (MR) angiography. We found 6 fenestrations of the MCA among cranial MR angiography images obtained from about 2,000 patients during the past 9 years at our institution using either of two 1.5T imagers. All images were obtained by the three-dimensional time-of-flight technique. Maximum-intensity projection images in the horizontal rotation view were displayed stereoscopically. All 6 fenestrations had small slit-like configurations, five located at the proximal M1 segment, the other, at the middle M1 segment. No associated aneurysm was found. Although MCA fenestration is extremely rare and cerebral artery fenestration usually has no clinical significance, an aneurysm can arise at the proximal end of the fenestration. Thus, recognizing MCA fenestration is important when interpreting cranial MR angiograms.

Keywords: middle cerebral artery, arterial variation, arterial fenestration, magnetic resonance angiography

Introduction

Fenestration or segmental duplication of the cerebral arteries has been well described angiographically.1 The majority of these anomalies are found in the vertebrobasilar system. Magnetic resonance (MR) angiographic features of fenestration of the basilar artery have been reported; there are two types: small slit-like fenestration and large convex-lens-like fenestration.2 Fenestration of the middle cerebral artery (MCA) is found in rare instances during selective cerebral angiography, during surgery, or at autopsy. However, the MR angiographic features of MCA fenestration have rarely been reported.3 Fenestrations are frequently accompanied by a cerebral aneurysm at the proximal end of the fenestration4,5 and are rarely associated with cerebral arteriovenous malformation.6

We present MR angiographic features of 6 fenestrations of the MCA and alert physicians to the importance of recognizing this anomaly when interpreting MR angiograms.

Materials and Methods

From April 1996 through December 2005, about 2,000 patients at our institution underwent cranial MR angiography carried out by the three-dimensional time-of-flight method on either of two 1.5T imagers (Signa Horizon or Signa Advantage, General Electric, Milwaukee, WI, USA). MR angiography was performed by the conventional single-slab acquisition technique in the majority of patients. Repetition time (RT) was 45.0 to 48.0 ms and echo time (ET) was 2.8 to 2.9 ms with the Signa Horizon imager; RT was 56.0 to 58.0 ms and ET was 4.5 ms with the Signa Advantage imager. The field of view was 16×16 cm, original slice thickness was 0.8 to 0.9 mm, slab thickness was 52.8 to 82.8 mm, imaging matrix was 256×160, and number of excitations was 1. To improve visualization of the peripheral small arteries, both presaturation pulse of the magnetization transfer contrast and ramped radiofrequency technique were used. No contrast material (gadolinium) was used in any patient. Maximum-intensity projection (MIP) images in the horizontal rotation view were displayed stereoscopically.
The majority of patients had or were suspected of having a cerebrovascular disease. MR imaging reports were reviewed, and patients with an MCA fenestration were identified. MR angiographic images of these patients were then reviewed and confirmed by the first author. Because patients with suboptimal imaging caused by artifacts or MCA occlusion were included in this study, the exact number of optimally evaluated patients was unknown.

Results
We found 6 fenestrations of the MCA (Figs.
A 17-year-old girl with a complaint of vertigo. Stereoscopic right anterior oblique-projection magnetic resonance (MR) angiograms show a small slit-like fenestration of the left middle cerebral artery at its proximal M1 segment (arrow). The right temporal artery arises normally from the distal M1 segment. No aneurysm is seen.

A 74-year-old woman with a left temporal subcortical hematoma. Stereoscopic right anterior oblique-projection magnetic resonance (MR) angiograms show a small slit-like fenestration of the left middle cerebral artery at its proximal M1 segment (long arrow). There is early branching of the right temporopolar artery, but there is no relation between the branching and the fenestration (short arrow). No aneurysm is seen.

1–6), five at the proximal segment of the M1 and one at the middle segment of the M1 (Fig. 5). All had small slit-like configurations. Early branching of the temporopolar artery was identified in four, but only 2 arteries arose from the fenestrated segment (Figs. 2, 6). No associated aneurysm was found at the fenestration or any other site. No associated cerebral vascular malformation was identified.

**Discussion**

MCA fenestration is rare. Crompton found only one in 347 MCAs examined at autopsy, an incidence of 0.28%. Ito’s group reported angiographic incidence of 0.26%. MR angiographic incidence in
Fig. 5. A 79-year-old man with Parkinsonism
Stereoscopic anteroposterior-projection magnetic resonance (MR) angiograms show a small slit-like fenestration of the right middle cerebral artery at its middle M1 segment (arrow). Early branching of the right temporopolar artery is not seen. No aneurysm is seen.

Fig. 6. An 85-year-old man with a cerebral infarction
Stereoscopic right anterior oblique-projection magnetic resonance (MR) angiograms show a small slit-like fenestration of the left middle cerebral artery at its proximal M1 segment (long arrow). Tiny early branching right temporopolar artery arises from the distal end of the fenestration (short arrow). No aneurysm is seen.

our series was not determined because the exact number of patients was not known. If the total number was regarded as 2,000, the incidence was 0.15% (6/4,000) per MCA, lower than the previously reported incidences. Very small fenestrations may not be identified by MR angiography, which has lower spatial resolution than that of selective cerebral angiography. Thus, tiny fenestrations may have been overlooked in our series. MCA dissection with a patent pseudolumen should not be confused with fenestration. On a selective cerebral angiogram, early branching MCA should not be misinterpreted as a fenestration because the branches may be superimposed in the anteroposterior projection. In contrast, MR angiographic images are made from three-dimensional data.
Thus, superimposition of the vessels can be identified easily.

The majority of reported MCA fenestrations have small slit-like configurations and are located at the proximal M1 segment, like five of the 6 fenestrations in our study.\textsuperscript{10,12} MCA fenestration is also seen at the distal M1 segment\textsuperscript{13} and middle M1 segment.\textsuperscript{8} Gailloud and associates\textsuperscript{14} reported angiographic diagnosis of 5 MCA fenestrations, and in each case, an early branching temporopolar artery arose from the inferior limb of the fenestrated segment. Thus, the investigators suggested that the early branching temporopolar artery might play an important role in the formation of the MCA fenestration. Because arterial fenestration is caused by the persistence of the primitive arterial network seen in the early embryonic period,\textsuperscript{15} we agree with this opinion. In our series, however, this early branching related to fenestration was seen in only two of the 6 cases. On MIP images, tiny arterial branches might not be identified. Thus, whether the low incidence was a true finding or was related to the low spatial resolution of the MR angiography is unknown.

Aneurysm at the proximal end of the fenestrated segment is frequently associated with cerebral artery fenestration.\textsuperscript{4,5,10,13} Both congenital weakness of the wall of the fenestrated arterial segment and hemodynamic stress at the origin of the fenestrated segment may play important roles in formation of the aneurysm. However, we found no aneurysm at the MCA fenestration in any patient.

Conclusions

Although MCA fenestration is extremely rare and usually has no clinical significance, we wish to stress that recognition and correct diagnosis of MCA fenestration with or without an aneurysm are important when interpreting cranial MR angiograms.

References