Journal of Cerebrovascular and Endovascular Neurosurgery
ISSN 2234-8565, EISSN 2287-3139, http://dx.doi.org/10.7461/jcen.2012.14.2.108

Case Report

# Mechanical Thrombolysis Using Coil in Acute Occlusion of Fenestrate M1 Segment

Byung-Sun Seo, MD[1], Yoon-Soo Lee, MD[1], Jeong-Ho Lee, MD[1], Hyuk-Gee Lee, MD[2], Kee-Young Ryu, MD[1], Dong-Gee Kang, MD[1]

[1]Department of Neurosurgery, Daegu Fatima Hospital, Daegu, Korea
[2]Department of Neurosurgery, Andong General Hospital, Andong, Korea

A fenestrated middle cerebral artery (MCA) is a rare congenital anomaly, and is related to interference in the normal embryonic development of the MCA. Fenestrated MCA has been regarded to have no clinical significance other than a rare event of hemorrhage from associated aneurysm. However, the fenestration within the arterial trunk can be an obstacle against thrombus migration and may be associated with a major cerebral infarction. Moreover, the presence of this anomaly can be hardly detected prior to thrombolytic procedures, and emergent treatments are proceeded without any information of anatomical configurations. Therefore, the recanalization procedures would carry a high risk of intraprocedural complications. We report a rare case of MCA territory infarction from occlusion of fenestrated M1 segment, and also introduce a safe method of mechanical thrombolysis using coil.

**Keywords** Cerebral infarction, Middle cerebral artery, Fenestration

J Cerebrovasc Endovasc Neurosurg. 2012 June;14(2):108~112

Received : 13 April 2012
Revised : 22 May 2012
Accepted : 13 June 2012

Correspondence to Yoon-Soo Lee, MD
Department of Neurosurgery, Daegu Fatima Hospital,576-31 Sinam-dong, Dong-gu, Daegu 701-600, Korea
Tel : (001) 82-53-940-7330,
FAX : (001) 82-53-954-7417
E-mail : paulyoonsoolee@hanmail.net

## INTRODUCTION

A fenestrated middle cerebral artery (MCA) is a rare anatomical anomaly with an incidence of 1% at autopsy and 0.17% on cerebral angiography.[5)11)12)] Fenestration is defined as the division of the lumen of an arterial segment into two distinct but parallel channels.[1)3)4)] Although the mechanism leading to MCA fenestration still remains unclear, this anomaly is thought to be closely related to the interference in the evolution process during embryonic development.

The fenestrated MCA is usually found incidentally either during an angiography or an operation performed for another pathology, and has been regarded to have no clinical significance other than a rare event of hemorrhage from associated aneurysm.[2)5)11)] There have been only a few cases where this anomaly was associated with cerebral infarction or ischemia, and those previous reports were usually related to transient ischemic attacks (TIA) or lacunar infarctions.[4)] However, it can also be related to a major territory infarction because the fenestration within the arterial trunk can act as an obstacle against thrombus migration and can possibly be the site of occlusion. To the best of our knowledge, there have been no reports on the major territory infarction from acute occlusion of fenestrated M1 segment, and the thrombolytic modalities and the risks have been hardly evaluated. We report a rare case of MCA territory infarction from occlusion of fenestrated M1 segment and also discuss the feasibility of our treatment option.

## CASE REPORT

A 44-year-old male was transferred to our institution with drowsy mentality and severe left hemi-

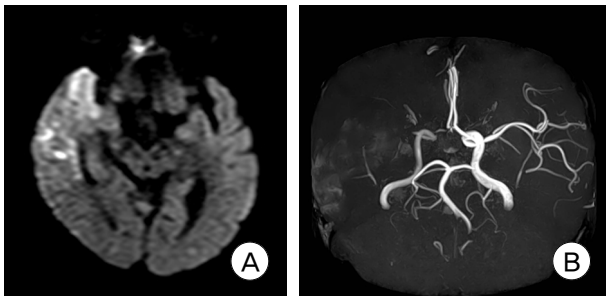


**Fig. 1.** *(A) Diffusion-weighted image shows hyperintensity at right middle cerebral artery territory. (B) Magnetic resonance angiography demonstrates right. M1 occlusion.*

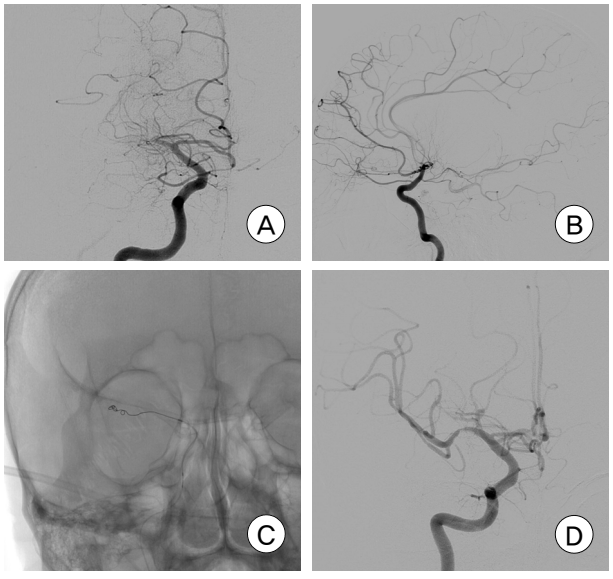


**Fig. 2.** *(A) Anterior-posterior view of right internal carotid angiogram shows right M1 occlusion. (B) Lateral view of right internal carotid angiogram reveals wide flow defect to the right middle cerebral artery territory. (C) The mechanical clot disruption was performed by simple to-and-fro maneuvers using coil. (D) Anterior-posterior view of right internal carotid angiogram shows remaining thrombus at the inferior portion of M1.*

paresis of grade I/V, and the symptom onset was approximately five hours ago. The National Institutes of Health Stroke Scale (NIHSS) score was 13. The vital signs were within normal ranges. Electrocardiogram showed normal sinus rhythm.

Computed tomographic (CT) scan revealed neither hematoma nor hypodense infarction. Diffusion-weighted magnetic resonance image demonstrated hyperintensity on right MCA territory, and magnetic resonance angiography (MRA) disclosed occlusion of right M1 segment (Fig. 1A, B). Then, the patient was promptly moved to angiography room without intravenous thrombolytic agent, because he was out of 3-hour time window. Subsequent conventional cerebral angiography disclosed complete occlusion of right M1 with insufficient leptomeningeal collaterals either from anterior or posterior cerebral arteries (Fig. 2A, B), but no severe atherosclerotic arterial changes were seen elsewhere, suggesting the likelihood of embolic infarction although no definite cardiac arrhythmia was evident on electrocardiogram.

The endovascular procedure was performed subsequently under local anesthesia. After placement of a 6F sheath into the right common femoral artery, the distal tip of a 6F guiding catheter (Envoy; Cordis Endovascular, Miami Lakes, Fl) was located at the straight portion of the right cervical internal carotid artery. The microcatheter (Prowler 14; Cordis Endovascular, Miami Lakes, Fl) along with 0.014-inch guidewire (Synchro; Boston Scientific, Fremont, CA) was cautiously navigated into the occluded vessel and the guidewire was passed beyond the thrombus. While advancing microcatheter across the occluded segment, unexpected moderate resistance was encountered and the microcatheter was locked in the occluded segment. However, it was able to proceed after multiple trials of forward and backward movement of microcatheter over the guidewire which already had passed beyond the thrombus. Then, a selective angiogram was obtained to evaluate the size of the thrombus burden and to confirm the presence of distal migrations. Microcatheter was placed just proximal to the thrombus. Since the resistance was obvious and hidden anatomical variations might exist, 360 soft coil (GDC; Boston Scientific, Fremont, CA) was delivered into the lesion to prevent vessel injury (Fig. 2C). After the mechanical clot disruption with coil by repeated simple to-and-fro maneuvers across the occluded segment, partial recanalization was achieved. Additional 50,000 units of Urokinase were injected intraarterially. At the end of the procedure,

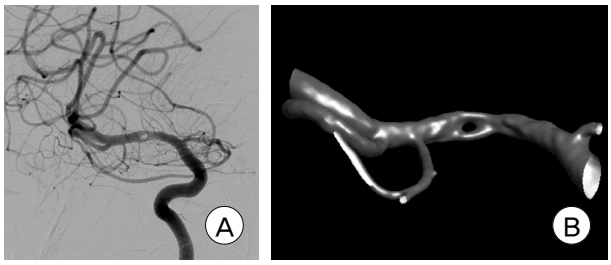


**Fig. 3.** (A) Follow-up angiogram after one month clearly demonstrates the anatomical contour of a fenestrated MCA. (B) The three-dimensional angiogram depicts the configuration of the fenestration with the temporopolar artery originating from distal M1.

the superior portion of M1 was recanalized and the adequate distal flow was achieved without delay or stagnation of contrast, but there was still remaining thrombus at the inferior portion of M1 (Fig. 2D).

The patient was closely observed in the intensive care unit. Low-molecular heparin was continued for 24 hours after the procedure, and the oral antiplatelet medications were started. He made an uneventful recovery, and the left hemiparesis was improved to grade III/V a week later. The follow-up angiography after one month clearly demonstrated the anatomical contour of a fenestrated MCA which seemed to be the cause of the resistance while advancing the microcatheter (Fig. 3A, B). The superior limb of fenestrated segment was recanalized by the former thrombolysis, and the inferior limb with previously remaining thrombus was spontaneously recanalized. The patient was discharged with alert mentality with improved left hemiparesis to grade IV/V. He was able to walk unassisted.

## DISCUSSION

Fenestration is a rare finding, and it is mostly found in the anterior communicating artery or the vertebrobasilar system.[4)11)12)] The low incidence of this anomaly based on cerebral angiography or MRA up to date may have been underestimated because it is often missed by poor quality angiography or MRA. Therefore, the frequency of 1% based on anatomic dissection reported by Umansky et al. is likely to be close to the real incidence of fenestrated MCA,[5)13)] and it is actually not very rare to find this anomaly when we treat diseases associated with the MCA.

Okudera et al.[8)] classified the fenestrated MCA into three types: the 'proximal type' at the proximal portion of M1, the 'intermediate type' at the center portion of the M1, and the 'distal type' at the portion just before the division of M2. They reported that the proximal type was most common although our case belonged to the intermediate type.

The mechanism leading to MCA fenestration remains unclear. During the normal embryonic development of the intracranial arterial system, the distal primitive internal carotid artery divides into a large branch, which becomes the anterior choroidal artery, and multiple plexiform arterial twigs, which subsequently become primitive anterior and middle cerebral arteries. These plexiform vascular networks evolve into a single main trunk by fusion and regression. The primitive MCA gradually coalesce into the adult form of the middle cerebral artery. Any interferences in this evolution process, due to either unknown mechanisms or fetal vascular insults, may lead to anomalous development of the MCA.[3)5-7)9)10)] Therefore, the fenestrated MCA is regarded to be a kind of persistent MCA plexus. Gailloud et al.[3)] reported five angiographic cases of MCA fenestrations, and, in each case, an early branching temporopolar artery (TPA) arose from the inferior limb of the fenestrated segment. Thus, they have suggested that early branching TPA may lead to the formation of the fenestration by interfering with the normal fetal development of the MCA. Uchino et al.[12)] have agreed that arterial fenestration is caused by the persistence of the primitive arterial network in the early embryonic period. However, they reported that early branching TPA related to fenestration was seen in only two of their six cases with MCA fenestration. In our case, the TPA was not incorporated into the fenestrated segment.

According to the previous reports, the fenestrated MCA has been regarded to have no clinical sig-

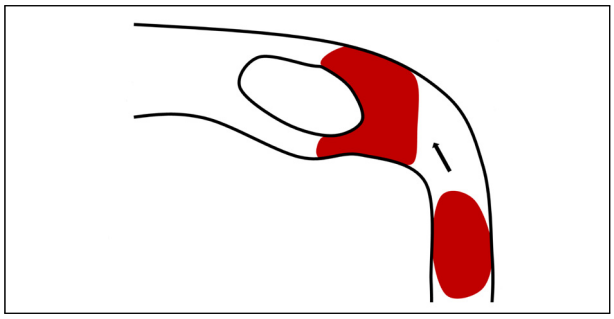

**Fig. 4.** The illustration shows that the fenestration within the arterial trunk may act as an obstacle against thrombus migration and can possibly be the site of occlusion.

nificance other than a rare event of hemorrhage from associated aneurysm which are usually located at the proximal end of the fenestration.[2)5)11)] However, Jeong et al.[4)] reported five cases of MCA fenestration associated with cerebral infarction or ischemia including one case of lacunar infarction and four cases of TIA. In this report, only one case with TIA was associated with one-limb obstruction of the fenestration in MRA and virtual endoscopy, and the remaining cases had intact anatomical configurations of fenestration. They proposed that the disturbance of the local hemodynamic flows within the MCA fenestration seemed to cause cerebral ischemia. Our report demonstrated the total occlusion of the fenestrated segment of the MCA mimicking typical M1 occlusion, and showed that this anomaly may also be associated with a major territory infarction. We propose that the fenestration within the arterial trunk may act as an obstacle against thrombus migration and can possibly be the site of occlusion (Fig. 4).

Since the angiographic configurations after the total occlusion of the fenestrated MCA may not differ from the configurations of typical M1 occlusion, there exists a high risk of arterial injury during the endovascular procedure. Balloon angioplasty carries a high risk by mistaken selection of oversized balloon compared to the caliber of superior or inferior limb of the fenestration. Excessive advancing force while introducing reperfusion catheter of Penumbra System (PS; Penumbra Inc, Alameda, CA) for suction thrombectomy may also cause arterial rupture. Stenting may not warrant optimal result because post-stent angiogram may resemble residual stenosis, and also subsequent balloon angioplasty carries the risk. In fact, any aggressive manipulations during interventional procedure such as thrombolysis, thrombectomy, angioplasty, or stenting may cause devastating outcome by arterial rupture at the fenestrated segment. Therefore, it is important to keep attention when any unusual resistance is encountered while crossing the occluded segment, because this type of congenital anomaly or any other underlying stenosis may exist. Although there have been no series of reports evaluating the efficacy of thrombolysis using coil, our treatment option seems to be feasible and safe, because the coil is obviously softer than any other microwires or microcatheters and also has ability to change its own shape according to the vessel diameter. Moreover, a coil with multiple three-dimensional loops may act better for clot disruption than a microwire with simple curves. Although acute cerebral infarction associated with MCA fenestration seems to be rare, special precautions to prevent arterial rupture should be taken when dealing with occlusion of the fenestrated MCA.

## CONCLUSION

A fenestrated MCA is a rare anatomical anomaly related to the interference in the evolution process during embryonic development. Although this type of congenital anomaly does not usually have clinical significance, it can be associated with a major territory infarction from occlusion of the fenestrated segment. Aggressive manipulations during interventional procedures should be avoided to prevent devastating result by arterial rupture. Thrombolysis using coil may be a feasible and safe treatment option.

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