

Interv Neuroradiol. 2019 Dec; 25(6): 644–647.

PMCID: PMC6838846

Published online 2019 Jun 17.

PMID: [31208253](#)

doi: 10.1177/1591019919857157: 10.1177/1591019919857157

Middle cerebral artery fenestration: Thromboembolic and hemorrhagic complications

[Mohamad Abdalkader](#),¹ [Christian Raftopoulos](#),² [Patrice Finet](#),² [Thanh N Nguyen](#),³ and [Pierre Goffette](#)⁴

¹Department of Radiology, Boston University—School of Medicine, Boston, USA

²Department of Neurosurgery, Université Catholique De Louvain, Brussels, Belgium

³Department of Neurology, Radiology, and Neurosurgery, Boston University—School of Medicine, Boston, USA

⁴Department of Radiology, Université Catholique De Louvain, Brussels, Belgium

Mohamad Abdalkader, Department of Radiology, Boston University-School of Medicine, FGH Building, 3rd Floor, 820 Harrison Avenue, Boston, MA 02118, USA. Email: mohamad.abdalkader@bmc.org

Received 2019 May 2; Accepted 2019 May 24.

[Copyright](#) © The Author(s) 2019

Abstract

Cerebral artery fenestrations are rare anatomical variants usually detected incidentally on cross-sectional imaging or cerebral angiography. Although considered benign findings, many reports have described their association with vascular abnormalities such as aneurysms or arteriovenous malformations, and to a lesser extent with ischemic or hemorrhagic complications. We report a case of middle cerebral artery fenestration associated with subarachnoid hemorrhage and middle cerebral artery thrombosis. To our knowledge, there has been no prior report of middle cerebral artery fenestration with a similar presentation.

Keywords: Middle cerebral artery, fenestration, subarachnoid hemorrhage, MCA occlusion

Introduction

Variations of the cerebral circulation are common findings on cross-sectional or angiographic imaging.¹ Their detection and knowledge of their clinical implication is important, especially in the setting of cerebrovascular diseases such as acute stroke and subarachnoid hemorrhage. In addition, some anatomical variants, such as fenestrations, harbor potential risk of vascular abnormalities such as aneurysms, arteriovenous malformations, or ischemic and hemorrhagic complications.^{2–4}

Case report

A 32-year-old man presented to the emergency department complaining of sudden onset of a thunderclap headache. His previous medical history was negative, and there was no significant social or family history. There was no history of recent head trauma.

A non-enhanced computed tomography (CT) scan of the head demonstrated subarachnoid hemorrhage seen predominantly in the right Sylvian fissure ([Figure 1\(a\)](#)). No intracranial aneurysms were detected on the CT angiography, which otherwise showed a suspicion of a fenestration versus focal dissection of the proximal M1 segment of the right middle cerebral artery (MCA; [Figure 1\(b\)](#)). Other investigative results, including laboratory results, electrocardiogram, and echocardiogram, were negative.

Cerebral angiography re-demonstrated the right MCA abnormality, more suggestive of a fenestration ([Figure 2](#)). However, after the acquisition of the rotational 3D angiography, the patient became agitated. Evaluation of the 3D angiography images showed acute thrombosis of the M1 segment of the right MCA ([Figure 3\(a\)](#)). Repeated angiogram five minutes later showed clearance of the M1 thrombus, with fragmentation of the clot and distal migration of small fragments seen as filling defects at the distal M2 segments. The patient was neurologically intact on physical examination. No anticoagulant or thrombolytic treatment was started because of the subarachnoid hemorrhage and the fragmentation of the clot on subsequent analysis. Magnetic resonance imaging (MRI) done later the same day showed focal areas of restricted diffusion within the right frontal lobe consistent with acute infarcts ([Figure 3\(b\)](#)).

One week later, cerebral angiography confirmed the presence of a fenestration at the proximal MCA, with clearer borders compared to the first angiogram ([Figure 4](#)). The previously seen filling defects of the right MCA had cleared. The patient was discharged home one week later, with no neurological deficit. Follow-up magnetic resonance angiography at three weeks and at six months showed a similar stable appearance of the fenestration.

Discussion

Anatomical variations of the MCA include fenestrations, duplication, accessory MCA, a single-trunk type of MCA, and trifurcation or quadrifurcation of the M1 segment.¹ A vascular fenestration is a segmental luminal division of a vessel to form two separate lumens lined by separate endothelial walls and having (or not) the same adventitia.⁵ The prevalence of MCA fenestrations ranges between 0.1% and 4.4%, with the highest numbers described in surgical and postmortem high-resolution imaging studies.^{2,5,6} The mechanism of formation of the MCA fenestration has not been elucidated. An early branching temporo-polar artery or prominent lenticulo-striate artery (which was present in our case) may play a role in the formation of MCA fenestrations either by precluding the fusion of the primitive twigs into a single trunk or by interfering with the regression of some of these twigs during fetal development of the MCA.³

Although usually detected incidentally with no clinical significance, many reports have described the association of fenestrations with cerebral vascular anomalies, such as aneurysms or arteriovenous malformations, with ischemic or hemorrhagic events.²⁻⁴

Authors who support the association between fenestrations and the neurovascular pathologies argue that fenestrations alter the vascular microflow at the site of the bifurcation, creating hemodynamic turbulence that leads to alteration of the subendothelium and creating

a media layer defect by the mechanical forces of blood flow that may lead to aneurysmal formation.⁷ In addition, the developmental structural weakness at the site of the fenestration makes the vessel wall more prone to cracking/fissuring, leading to the subarachnoid hemorrhage.⁴ Cerebral fenestrations, previously not suspected in cases of non-aneurysmal subarachnoid hemorrhage, are now thought to be one of the potential sources of subarachnoid hemorrhage.⁶ Hudák et al. found a significantly high frequency of fenestrations in patients in whom the source of the subarachnoid hemorrhage was not found.⁴

The association of fenestrations with ischemic complications was reported by Jeong et al. who described five cases of MCA fenestration that might have caused thromboembolic events. The alteration of the flow hemodynamics at the site of the fenestration may initiate an atherosclerotic process. In addition, the difference of caliber between the two limbs of the fenestration may increase the risk of thrombosis by creating a gradient of velocities, with resulting slower flow at the smaller limb.⁸

We believe that the MCA fenestration is the culprit causing the hemorrhagic and ischemic complications in our case. The subarachnoid hemorrhage was only seen in the right Sylvian fissure at the same side as the MCA fenestration, with no history of prior trauma or evidence of aneurysms. Furthermore, the irregular appearance of the fenestration seen during the first angiogram, as well as the acute formation of thrombus during the 3D angiogram, denote that there may be a vascular injury at the level of the fenestration causing or contributing to the patient's findings. To our knowledge, there is no prior report of MCA fenestration with concomitant hemorrhagic and ischemic complications.

Other differential considerations of “non-aneurysmal” subarachnoid hemorrhage include undetectable aneurysms, ruptured micro-aneurysms, or arterial dissection. Spontaneous intracranial arterial dissection is an important cause of stroke, such as subarachnoid hemorrhage and/or thromboembolic cerebral ischemia.^{9,10} It is crucial to differentiate a MCA fenestration from MCA dissection in order to prevent further inappropriate therapies such as stenting. High-resolution MRI vessel-wall imaging can be utilized to make the diagnosis of MCA dissection.^{11,12}

From an endovascular perspective, interventionalists should be aware of these variants because of the high risk of vessel injury during endovascular manipulation at the level of the fenestrations. This risk is especially high in the setting of emergent endovascular management of acute large vessel occlusion stroke where no prior information of the anatomical configurations is available.

Conclusion

Even though a causative link between arterial fenestration and vascular pathologies is not absolutely established, a fenestration detected in an artery relevant to the vascular symptoms should be carefully considered as an additional or causative factor for the clinical syndrome. Radiologists, interventionalists, and neurosurgeons should be familiar with cerebral vascular variants and the pathological associations in order to avoid potential complications or unnecessary treatment.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

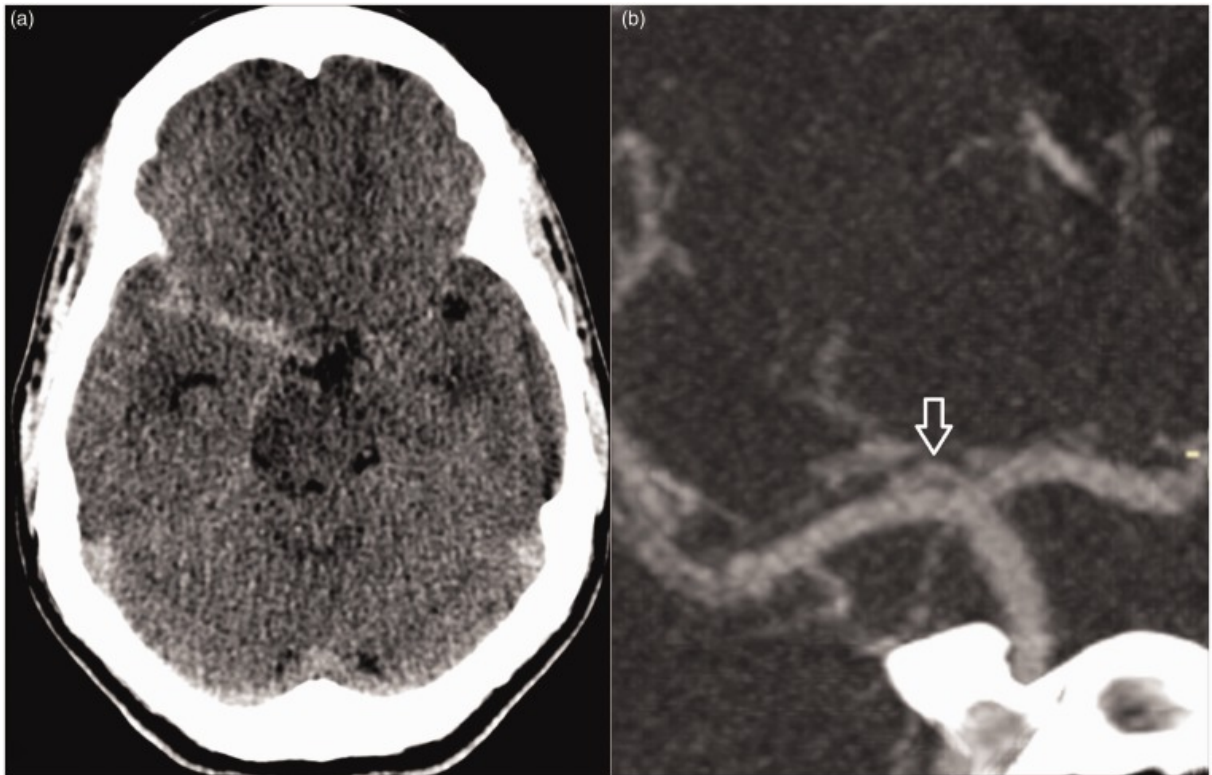
The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Dimmick SJ, Faulder KC. Normal variants of the cerebral circulation at multidetector CT angiography. *Radiographics* 2009; 29: 1027–1043. [PubMed: 19605654]
2. Sanders WP, Sorek PA, Mehta BA. Fenestration of intracranial arteries with special attention to associated aneurysms and other anomalies. *AJNR Am J Neuroradiol* 1993; 14: 675–680. [PubMed: 8517358]
3. Gailloud P, Albayram S, Fasel JHD, et al. Angiographic and embryologic considerations in five cases of middle cerebral artery fenestration. *AJNR Am J Neuroradiol* 2002; 23: 585–587. [PubMed: 11950648]
4. Hudák I, Lenzsér G, Lunenkova V, et al. Cerebral arterial fenestrations: a common phenomenon in unexplained subarachnoid haemorrhage. *Acta Neurochir (Wien)* 2013; 155: 217–222. [PubMed: 23275070]
5. Umansky F, Dujovny M, Ausman JI, et al. Anomalies and variations of the middle cerebral artery: a microanatomical study. *Neurosurgery* 1988; 22: 1023–1027. [PubMed: 3047592]
6. Cooke DL, Stout CE, Kim WT, et al. Cerebral arterial fenestrations. *Interv Neuroradiol* 2014; 20: 261–274. [PMCID: PMC4178766] [PubMed: 24976087]
7. Finlay HM, Canham PB. The layered fabric of cerebral artery fenestrations. *Stroke* 1994; 25: 1799–1806. [PubMed: 8073460]
8. Jeong S-K, Kwak H-S, Cho Y-I. Middle cerebral artery fenestration in patients with cerebral ischemia. *J Neurol Sci* 2008; 275: 181–184. [PubMed: 18801495]
9. Ono H, Inoue T, Suematsu S, et al. Middle cerebral artery dissection causing subarachnoid hemorrhage and cerebral infarction: trapping with high-flow bypass preserving the lenticulostriate artery. *Surg Neurol Int* 2017; 8: 157. [PMCID: PMC5535565] [PubMed: 28808606]
10. Asaithambi G, Saravanapavan P, Rastogi V, et al. Isolated middle cerebral artery dissection: a systematic review. *Int J Emerg Med* 2014; 7: 44. [PMCID: PMC4272800] [PubMed: 25593617]
11. Khattar NK, White AC, Adams SW, et al. MRI SPACE sequence confirmation of occluded MCA M2 dissection stump masquerading as a ruptured MCA aneurysm. *J Neurointerv Surg*. Epub ahead of print 24 January 2019. DOI: 10.1136/neurintsurg-2018-013996.rep. [PubMed: 30679205]
12. Oliver M, Rai V, Mulderink T, et al. High resolution vessel wall MRI in diagnosis of MCA dissection: a case report and review of the literature (P6.220). *Neurology* 2018; 90.

Figures and Tables

Figure 1.



Non-enhanced computed tomography (CT) scan of the head (a) showing subarachnoid hemorrhage mainly in the right Sylvian fissure. Coronal reconstruction of head CT angiography (b) showing a linear filling defect of the proximal right middle cerebral artery (white arrow), suggestive of fenestration or focal dissection. No aneurysm detected.

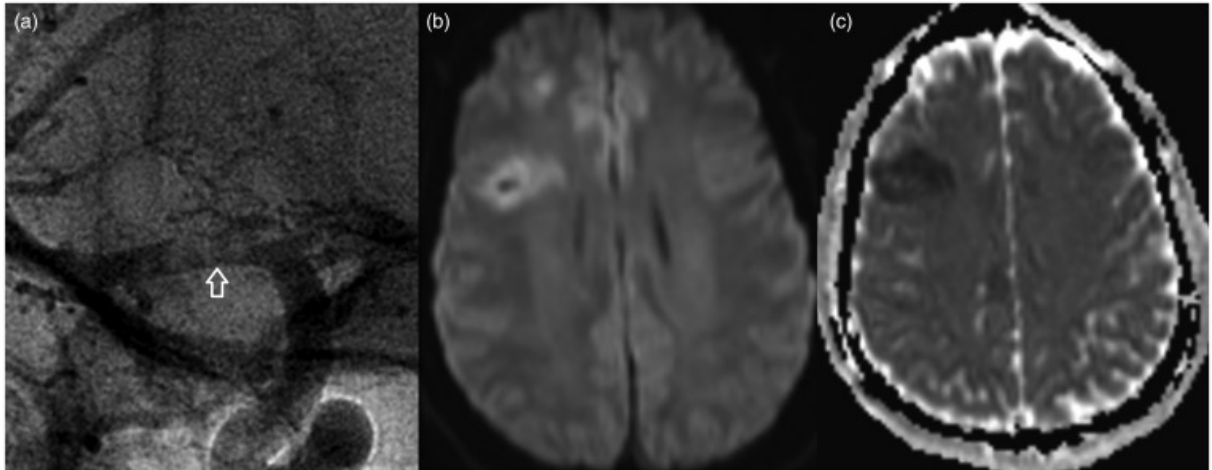
Figure 2.



[Open in a separate window](#)

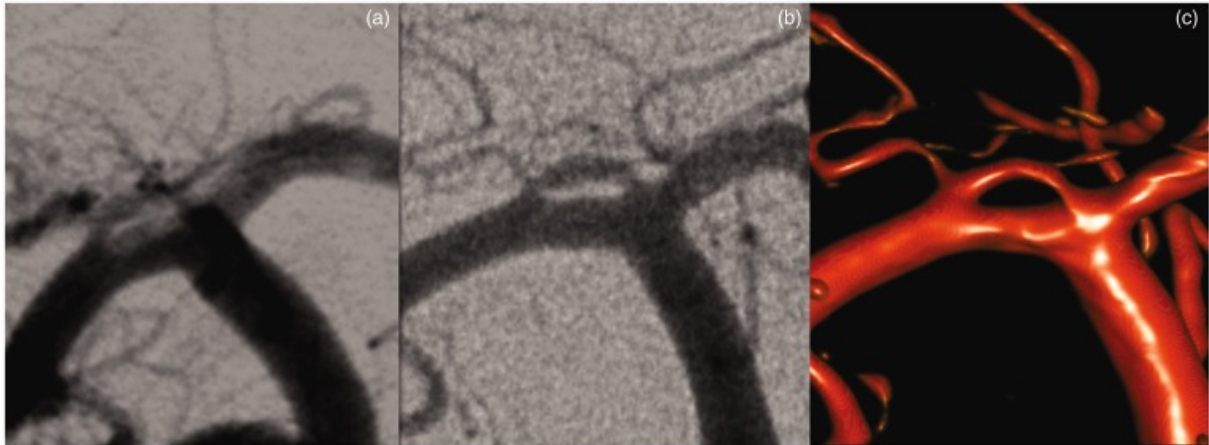
Right carotid angiogram (anteroposterior view) showing focal duplication of the proximal M1 segment of the right middle cerebral artery (MCA), suggestive of fenestration. Note filling defects and irregularities at the edges of the fenestration (white arrow).

Figure 3.



Non-subtracted angiogram of the right carotid (acquired during the 3D acquisition) (a) showing filling defect with near complete occlusion of the M1 segment (white arrow). Axial diffusion-weighted images (b) with ADC map (c) showing areas of restricted diffusion within the right frontal lobe, consistent with acute infarcts.

Figure 4.



Compared to the first angiogram on the first day (a), right carotid angiogram one week later (b) with volume rendering reconstruction (c), confirms the presence of fenestration at the proximal MCA with clearer edges. Note a prominent lenticulo-striate artery arising from the distal aspect of the superior limb of the fenestration, which is associated with fenestration development.