Anomalous Origin of the Middle Meningeal Artery from the Petrous Segment of the Internal Carotid Artery Associated with Multiple Cerebrovascular Abnormalities

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Citation

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Abstract

A 25-year-old male with a history of seizure disorder was found incidentally on cerebral angiography to have numerous congenital anomalies of the cerebral vascular system. Among these anomalies were the derivation of the left middle meningeal artery from the petrous portion of the internal carotid artery, the presence of a left cavernous angioma, cavernous origin of the left ophthalmic artery, and an accessory middle cerebral artery. Awareness of cerebral circulatory anatomical anomalies of this nature is of importance to all physicians who plan surgical and endovascular interventions.

INTRODUCTION

The middle meningeal artery in most individuals arises from the maxillary branch of the external carotid artery and enters the skull through the foramen spinosum. It then divides into anterior and posterior branches to supply the dura and adjacent calvarium. A few instances have been reported of the aberrant origin of the middle meningeal artery from branches of the internal carotid artery ([1,2,3,4,5,6]). We now describe the anomalous origin of the middle meningeal artery derived from the petrous portion of the internal carotid artery, revealed incidentally by cerebral angiography in a patient with multiple cerebrovascular abnormalities.

CASE REPORT

A 24-year-old right-handed male with a 6-year history of epilepsy and a left temporal lobe cavernoma (diagnosed two years previously) presented to our institution with a 2-week history of increased seizure activity and prolonged post-ictal weakness, blurred vision, and muffled hearing. His seizures had previously been relatively well controlled by three anti-epileptic medications. Both his father and his paternal uncle had a history of seizure disorders. The results of physical examination were essentially normal except for some disturbance of gait. All laboratory data were within normal limits. A computed tomography (CT) scan of the head showed a hyperdense lesion in the left temporal lobe and absence of the foramen spinosum (Fig. 1). Magnetic resonance imaging (MRI) with and without gadolinium revealed a left temporal lobe cavernoma and associated developmental venous anomaly in the region of the collateral gyrus that were unchanged from of first diagnosis (Fig. 2). An electroencephalogram (EEG) showed some mild cerebral dysfunction over the left temporal region with no epileptiform abnormality. Selective left vertebral and left internal carotid arteriography revealed several congenital anomalies including a middle meningeal branch arising from the petrous portion of the internal carotid artery with no contribution from the external carotid artery (Fig. 3); cavernous origin of the ophthalmic artery (Fig. 4), which courses through the superior orbital fissure; and an accessory middle cerebral artery arising directly from the left supraclinoid internal carotid proximal to the main middle cerebral artery segment (M1) (Fig. 3).

Because imaging revealed no new findings thought to be related to the patient's presenting symptoms and the cavernoma was located in an eloquent area with negative EEG findings, no neurosurgical intervention was warranted. The patient's anti-epileptic medication regimen was revised, and the patient was discharged with instructions for follow-up.

Figure 1

Figure 1: Axial CT scan of the skull base. The left foramen spinosum is absent posterolateral to the foramen ovale (arrow heads). Right foramen spinosum is shown (arrow).

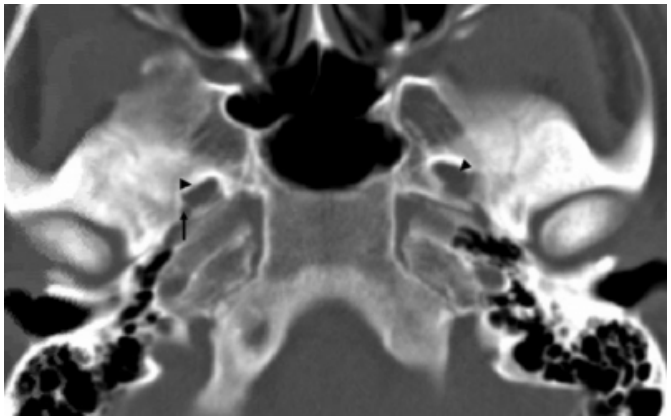


Figure 2

Figure 2: Axial T1-weighted MRI with gadolinium (A) and axial FLAIR (B). A, Enhancement is seen in the region of the left temporal lobe, including a linear enhancement that represents an associated developmental venous anomaly (arrow). B, Hemosiderin staining is seen about the left temporal lobe adjacent to the left temporal horn. It involves primarily the left collateral gyrus. These findings along with the findings on cerebral angiogram are consistent with a cavernous angioma.

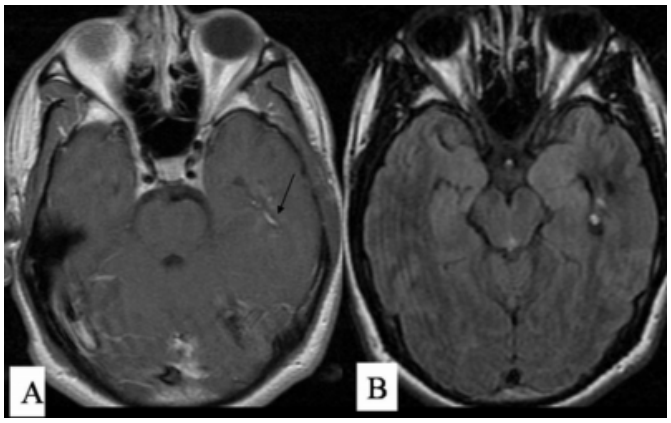


Figure 3

Figure 3:Left carotid arteriogram, frontal view. A, Early arterial phase shows a left middle cerebral artery branch origin (asterisk) arising directly from the left supraclinoid internal carotid proximal to the main branch (M1) and the left middle meningeal artery origin (arrow) arising from the petrous segment of the internal carotid artery. B, Late arterial phase illustrates the anterior and posterior divisions (arrowhead) of the middle meningeal artery (arrow).

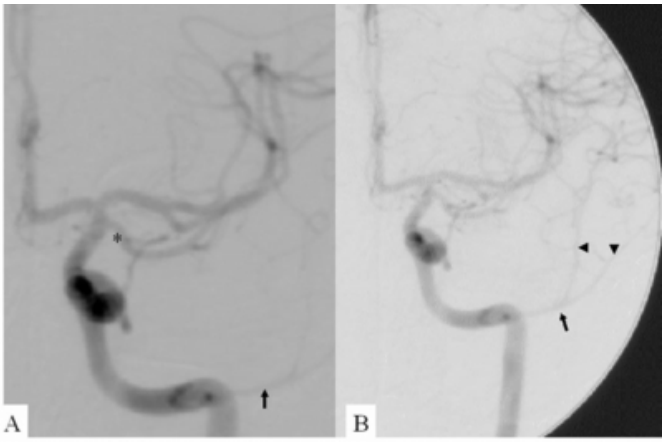
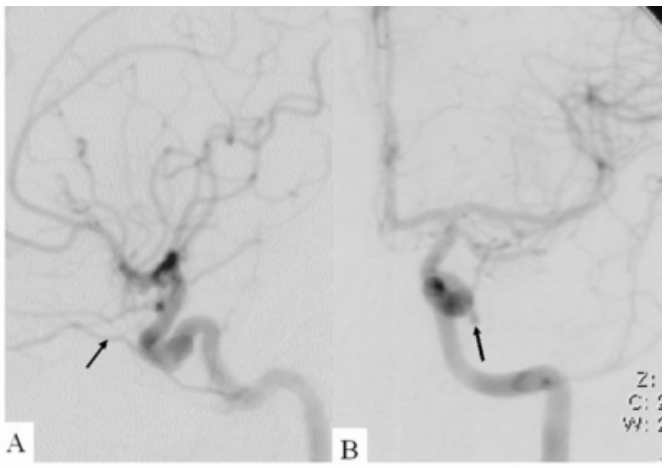


Figure 4

Figure 4: Lateral (A) and frontal (B) views of the left internal carotid arteriogram showing a cavernous carotid origin of the left ophthalmic artery (arrow).



DISCUSSION

Rare anomalous origins of the middle meningeal artery from the internal carotid artery circulation have been reported. In the most common anomaly, the middle meningeal artery originates from the ophthalmic artery ([2]). This variant was first reported in 1876 ([7]) and subsequently has been identified in both cadaveric and radiographic studies ([1, 2, 8, 9]). In some cases this anomaly is associated with absence of any external carotid artery contribution to the middle

meningeal artery and agenesis of foramen spinosum ([1]).

A less common anomalous origin of the middle meningeal artery from the internal carotid artery circulation is the "stapedial-middle meningeal artery" ([2]). This anomaly, first documented by Altmann in 1947 ([5]), likely results from the failure of the embryonic stapedial artery to involute. The stapedial artery is derived from the second aortic arch and connects to the developing internal carotid artery (third arch) via the hyoid artery. The stapedial artery then develops two main branches: a supraorbital division from which the extraocular arteries and intracranial middle meningeal artery arise and a maxillofacial division. As the embryo develops, the stapedial artery involutes, and the maxillofacial division joins the external carotid artery to form the maxillary artery, including the segment that will become the extracranial middle meningeal artery ([1, 2]). A persistent stapedial artery enters the middle ear, passes through the stapes, travels through the facial canal, exits via the stapedial foramen near the geniculate ganglion, continues between the dura and bone of the middle cranial fossa, and anastamoses with the middle meningeal artery ([5]).

The stapedial-middle meningeal artery anomaly has also been documented during surgical procedures on the middle ear. House and Patterson ([4]) noted that this anomaly was identified twice in 8000 middle ear procedures, and Baron ([3]) reported one such case. Likewise, this variant was identified as an anomaly during cerebral angiography ([1, 2, 6]). In this report we add another case to the literature of a patient whose middle meningeal artery arises from the petrous portion of the internal carotid artery, along with the presence of other vascular abnormalities. The uncharacteristic origin of the middle meningeal artery from the petrous part of the internal carotid artery is likely due to a persistence of the stapedial artery. In addition to the presence of an aberrant middle meningeal artery, our patient also had an anomalous origin of the left ophthalmic artery from the cavernous portion of the internal carotid artery, present in about 8% of the population ([10]), as well as an accessory left middle cerebral artery, which has an incidence of about 0.31% ([11]), and a cavernoma of the left temporal lobe with an associated venous angioma. These multiple anomalies of the left internal carotid and cerebral circulation may be related to a common process that caused deviation from normal embryologic development.

The process that leads to these anomalies likely takes place sometime in development between 35 to 44 days ovulation age. As elucidated by the work of Padgett ([12]) on the development of the cranial arteries, the stapedial artery is at its most mature stage in embryos at approximately 40 days ovulation age. At this same time the ophthalmic artery appears in its adult position caudal to the optic nerve and lateral to Rathke's pouch. The artery reaches its adult position by traveling caudally, likely by undergoing a series of anastomotic loops. At 44 days ovulation age, the definitive origin of the middle meningeal artery and dissolution of the stapedial artery is seen ([12]). It is likely that anomalies in the growth and development of our patient arose in this time period.

In summary we report a rare compilation of vascular anomalies in one patient. This could be caused by digression from normal embryological development. An awareness of the possibility of these anomalies are important for radiologists, endovascular interventionalists, neurosurgeons, and neurootologists who plan surgical or endovascular procedures.

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